MARYLAND

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SILURIAN

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ARTHROPODA

CLASS CRUSTACEA

Superorder OSTRACODA

Family LEPERDITIIDAE

Genus LEPERDITIA Rouault

Examples of this prolific genus are quite abundant in the higher Silurian strata of the Eastern United States but the species are so closely related to the equally well represented Early Devonian species that their close discrimination can only be made after a more intensive study of the genus than is possible at present. In most instances the Maryland Silurian forms have been identified as varieties of Early Devonian species, but when edge views of the related forms have been prepared and compared the varieties will probably be found to be worthy of specific rank.

LEPERDITIA ELONGATA WILLSENSIS new variety

Plate XXXVI, Figs. 3-6

Cf. *Leperditia elongata* Weller, 1903, Geol. Surv. New Jersey, Rep. Pal. iii, p. 259, pl. xxiii, fig. 13.

Description.—The numerous specimens upon which this variety is founded seem to represent a somewhat smaller, earlier form of the type of *L. elongata*. (See Plate XXXVI, Figs. 1, 2.) They are much less convex and higher in the antero-ventral region. Furthermore the eye spot is further removed from the anterior extremity and the valves are also slightly shorter. Average length, 8.0 mm.; height, 4.5 mm.

Occurrence.—WILLS CREEK FORMATION. Pinto (48 feet above base), Cedar Bluff (172 feet above base) and Cumberland, Maryland (235 feet above base).

Collection.—Maryland Geological Survey.

LEPERDITIA MATHEWSI n. sp.

Plate XXXVI, Figs. 7, 8

Description.—This well-marked species although allied to several Silurian and Early Devonian forms is easily distinguished from its nearest

allies by the well-defined border on each valve. It is perhaps closest to *L. elongata* Weller, but is less convex and the border is better developed. Length, 6.0 mm.; height, 3.9 mm.

The specific name is in honor of Dr. E. B. Mathews, State Geologist of Maryland, to whom more than anyone else besides the authors the publication of the present work is due.

Occurrence.—TONOLOWAY LIMESTONE. Grasshopper Run section near Hancock, Maryland.

Collection.—Maryland Geological Survey.

LEPERDITIA ALTOIDES MARYLANDICA n. var.

Plate XXXVI, Fig. 11

Cf. *Leperditia altoides* Weller, 1903, Geol. Surv. New Jersey, Pal. iii, p. 252, pl. xxiii, figs. 1, 2.

Description.—Although related to *L. altoides* Weller (see Plate XXXVI Figs. 9, 10) from the Lowest Devonian of New Jersey (Rondout formation) and Maryland (Keyser formation) the present form clearly is not the same, being higher posteriorly and the anterior outline less regularly rounded. Length, 7.0 mm.; height, 3.0 mm.

Occurrence.—WILLS CREEK FORMATION. 182 feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

LEPERDITIA SCALARIS PRAECEDENS n. var.

Plate XXXVI, Figs. 12, 13

Cf. *Leperditia gibbera scalaris* Jones, 1858, Ann. Mag. Nat. Hist., 3d ser. 1, p. 250, pl. x, figs. 10, 11.

Description.—The exact relationships of the various forms referred by authors to *Leperditia scalaris* have not yet been determined, indeed the limits of the species itself are still unknown. Under these circumstances it seems best to designate the Maryland Silurian form as a new variety. Length, 5.0 mm.; height, 4.0 mm.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, West Virginia, and Pinto, Maryland.

Collection.—Maryland Geological Survey.

LEPERDITIA ALTA (Conrad) Jones

Plate XXXVI, Figs. 14-17

Leperditia alta (Conrad) Jones, 1856, Ann. Mag. Nat. Hist., 2d ser., vol. xvii, p. 88, pl. vii, figs. 6, 7.

Description.—Specimens resembling this species which occurs so abundantly in the Manlius limestone of New York are found in equal abundance in numerous zones throughout the McKenzie, Wills Creek and Tonoloway formations of Maryland and neighboring states and are so identified in the detailed stratigraphic sections. Figures of both New York and Maryland examples are given on Plate XXXVI for comparison, but it is possible that future studies will reveal the presence of several distinct varieties, if not species, among these numerous occurrences.

Occurrence.—Abundant in the McKenzie, Wills Creek and Tonoloway formations of Maryland and neighboring states. A characteristic fossil of the Manlius limestone of New York.

Collection.—Maryland Geological Survey.

LEPERDITIA ALTA CACAPONENSIS n. var.

Plate XXXVI, Fig. 18

Description.—This variety differs from the typical form of the species in the outline of the anterior side, in the eye spot which is more clearly indicated, and in the ventral slope which descends more gradually than in typical *L. alta*. Length, 7.1 mm.; height, 4.6 mm.

Occurrence.—CLINTON (*Drepanellina clarki* zone). Four feet above Keefer sandstone, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

LEPERDITIA ALTA BREVICULA n. var.

Plate XXXVI, Fig. 19

Description.—As indicated in the varietal name this form is distinguished from typical *L. alta* by the relative shortness of its valves, which moreover are much smaller. Length, 3.0 mm.; height, 2.0 mm.

Occurrence.—WILLS CREEK FORMATION. 120 feet below the top at Pinto, Maryland.

Collection.—Maryland Geological Survey.

Family APARCHITIDAE new family

Genus APARCHITES Jones

APARCHITES (?) OBLIQUATUS n. sp.

Plate XXXVI, Fig. 23

Description.—Of the simple, straight-hinged *Aparchites*-like ostracoda none has been described that matches this in anterior narrowness, general obliquity of outline, and surface markings. The large, smooth spot in the middle of the dorsal three-fifths of the valve together with the shallow pits arranged in radial series about it make a characteristic marking. As to its generic position it is not at all certain that this is a true *Aparchites*. The smooth spot mentioned suggests *Kirkbya* and certain species of *Primitia*. However, until these simple or merely bilobed Beyrichiacea have been subjected to critical and comprehensive investigation more or less of artificiality of classification is to be expected. Length, 2.0 mm.; height, 1.25 mm.

Occurrence.—TONOLOWAY LIMESTONE. Near top at Keyser, W. Va., and at other localities in the upper part of the formation.

Collection.—Maryland Geological Survey.

APARCHITES (?) PUNCTILLOSA n. sp.

Plate XXXVI, Fig. 21

Description.—Though falling well within the prevailing loose definition of *Aparchites* we are far from satisfied that this is really a congener of the Ordovician type of the genus. There is a small, smooth median spot and around this to all parts of the edge the moderately convex surface is covered with distinct punctæ. There is no border of any kind. As in the case of *Aparchites obliquatus* this also may prove to be an ally of *Kirkbya* rather than *Aparchites*. Length, 0.80 mm.; height, 0.60 mm.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

APARCHITES (?) VARIOLATUS n. sp.

Plate XXXVI, Fig. 20

Description.—This minute species, although doubtful in its generic affinities, is easily recognized by its rounded outline and by the rather large and widely spaced pores or pits ornamenting the surface of the valves. Length, 0.50 mm.; height, 0.40 mm.

Occurrence.—CLINTON. Fifty-seven feet above Tuscarora sandstone along Wills Creek at Cumberland, Md.

Collection.—Maryland Geological Survey.

APARCHITES ALLEGHANIENSIS n. sp.

Plate XXXVI, Fig. 22

Description.—The small short, subovate valves of this species with their smooth surface and undefined dorsal angles are so different from all other Appalachian Silurian ostracoda that a detailed description seems unnecessary.

Occurrence.—CLINTON. (*Drepanellina clarki* zone), 5 feet below top at Cumberland, Md.

Collection.—Maryland Geological Survey.

Genus ERIDOCONCHA new genus

ERIDOCONCHA ROTUNDA n. sp.

Plate XXXVI, Fig. 24

Description.—This is an altogether peculiar ostracod. Its dorsal side projects beyond the short but straight hinge line in a manner to suggest certain brachiopods. Something like this occurs in the new Ordovician genus *Eridoconcha*. The irregularly concentric rows of punctæ, the thickened ventral lip, subovate form, and rounded dorsal outline are its most characteristic features. Length, 0.70 mm.; height, 0.55 mm.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, at Lakemont, Pa.

Collection.—U. S. National Museum.

Superfamily BEYRICHIACEA

Family PRIMITIIDAE new family

Genus PRIMITIELLA Ulrich

PRIMITIELLA EQUILATERALIS n. sp.

Plate XXXVII, Fig. 28

Description.—The species of these very simple ostracods are naturally very similar to each other, but *Primitiella equilateralis* may be distinguished by its elongate form, small size, and equal ends. The general outline is as in the typical Ordovician species, but the slight mesial depression is scarcely observable. Length, 0.55 mm.; height, 0.3 mm.

Occurrence.—CLINTON. *Drepanellina clarki* zone at McKees farm, 7 miles west of Lewiston, Pa.

Collection.—U. S. National Museum.

Genus EUPRIMITIA new genus

EUPRIMITIA BUTTSI n. sp.

Plate XXXVII, Figs. 1, 2

Description.—In spite of the numerous species referred to *Primitia* the present new form named in honor of Mr. Charles Butts is readily distinguished by its comparatively large size and especially by the well-developed furrow and the delicate surface reticulation. The species is further interesting in that a closely allied form, differing only in wanting the surface reticulation, is present in the Gun River formation of Anticosti Island. Length, 1.5 mm.; height, 1.1 mm.

Occurrence.—CLINTON. *Zygobolba erecta* zone, 1½ miles southwest of Cherrytown, Pa.

Collection.—U. S. National Museum.

Genus LACCOPRIMITIA new genus

LACCOPRIMITIA RESSERI n. sp.

Plate XXXVII, Fig. 3

Description.—This new species, named in honor of Dr. Charles E. Resser, belongs to that section of this prolific genus in which the furrow is

replaced by a well-defined, more or less elongated pit in the middle of the dorsal half. The material so far collected is not sufficient for a detailed description, but the scarcity of Primitian Ostracoda in the Silurian rocks of the Appalachian region warrants its recognition. Length, 0.60 mm.; height, 0.35 mm.

Primitia humilis Jones and Holl from the Silurian of Europe is perhaps the closest ally, but the exact characters of that species have not yet been determined.

Occurrence.—CLINTON. *Dreponellina clarki* zone, 5 feet below top, at Cumberland, Md.

Collection.—Maryland Geological Survey.

Genus PARÆCHMINA new genus

PARÆCHMINA SPINOSA (Hall)

Plate XXXVIII, Figs. 1-3

Cytherina spinosa Hall, 1852, Nat. Hist. New York, Pal. II, p. 317, pl. lxvii, figs. 17-21.

Description.—*Parachmina spinosa* is distinguished from other species by its rather short, subequally ended (very slightly oblique) valves, distinctly depressed over their median parts, the depressed area enclosed by a strong wall-like ridge of equal thickness and height around the ends and ventral side. The spine is large, sharply pointed and high. The pit lies as usual on the posterior side of its base. Average specimens. Length, 0.95 mm.; height without spine, 0.6 mm.

Occurrence.—CLINTON. *Dreponellina clarki* zone at Cumberland and other localities in Maryland and at McKees farm, 7 miles west of Lewiston, Hollidaysburg, etc., Pennsylvania. Exceedingly abundant in the Rochester shale of western New York.

Collection.—Maryland Geological Survey.

PARÆCHMINA CRASSA n. sp.

Plate XXXVIII, Fig. 14

Description.—Is distinguished from *P. spinosa* which probably is nearer than any of the other species now recognized by its much thicker marginal

ridge and consequently much smaller size of the depressed space between the outer ridge and the base of the spines. The anterior end also is lower so that the outline of the valves is correspondingly more oblique. In other directions the species simulates *P. postica* but differs decidedly from that species in the proportionally lesser elevation of the posterior part of the ridge and its greater height in the anterior half. In fact the marginal ridge in *P. postica* declines anteriorly and passes over into a much lower and less defined diagonal convexity. Profile views of the two species therefore are very different. In most of its features *P. crassa* may be said to be intermediate between the two others with which it has been compared. Length, 1.0 mm.; height without spine, 0.6 mm.

Occurrence.—CLINTON (*Mastigobolbina typus* zone), Hollidaysburg, Pennsylvania.

Collection.—U. S. National Museum.

PARÆCHMINA ABNORMIS Ulrich

Plate XXXVIII, Fig. 11

Aechmina abnormis Ulrich, 1890, Journal Cincinnati Soc. Nat. Hist., XIII, p. 183, pl. xii. figs. 7a, 7b.

This species is generally associated with *P. spinosa* (Hall) but it is easily distinguished by it larger size, and by the division of the marginal ridge into two large, unsymmetrically arranged lobes giving the valve an abnormal appearance. Length, 1.0 mm.; height without spine, 0.65 mm.

Occurrence.—CLINTON, Rochester shales at Lockport and other localities in Western New York. Abundant in the *Drepanellina clarki* zone at Rose Hill and other localities in Maryland.

Collection.—U. S. National Museum.

PARÆCHMINA POSTICA n. sp.

Plate XXXVIII, Figs. 6-10

Description.—*Parechmina postica* has a thick, high and rather undefined posterior ridge which lowers as it turns down to the ventral side and

thence passes in antero-dorsal direction into a still lower broad convexity. In edge view therefore the posterior end is thick, the profile descending at first slowly and then with increasing rapidity to the anterior edge. These features distinguish the species from *P. crassa* to which probably it is more closely related than to any other now known. It might also be compared with *P. spinosa* and *P. abnormis*, but it certainly is distinct from both of the Rochester shale species. The latter of these perhaps is the nearer of the two but the ventrally broken marginal ridge gives it a strikingly different aspect. Length of average specimen, 1.1 mm; height without spine, 0.6 mm.

Occurrence.—CLINTON. Common in the *Drepanellina clarki* zone at Cumberland and other localities in Maryland and in the same zone at Lakemont, Hollidaysburg, McKees farm 7 miles west of Lewiston, etc., Pennsylvania.

Collection.—Maryland Geological Survey.

PARAECHMINA INTERMEDIA n. sp.

Plate XXXVIII, Figs. 12, 13

Description.—It differs from *P. spinosa* in its more elongate form and incomplete and thinner marginal ridge. This fails on the anterior side. It is perhaps no less closely related to *P. altimuralis* but it also has the marginal ridge continued around the anterior end. In *P. postmuralis* the shape of the valves is different and the incomplete ridge farther from the edge. In *P. inæqualis*, a McKenzie formation species, the outline is somewhat different, the antero-dorsal edge descends more abruptly and the marginal ridge, which in that species is confined to the posterior half, rises more abruptly and to greater height. Length, 1.1 mm.; height without spine, 0.55 mm.

Occurrence.—CLINTON. *Drepanellina clarki* zone. McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—U. S. National Museum.

PARÆCHMINA ALTIMURALIS n. sp.

Plate XXXVIII, Figs. 23-26

Description.—This well-marked species is allied to *Paræchmina spinosa* (Hall) but the valves are more elongate and the marginal ridge very high, thin and sharply keeled. Length, 2.0 mm.; height without spine, 0.6 mm.

Occurrence.—CLINTON. *Drepanellina clarki* zone at McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—U. S. National Museum.

PARÆCHMINA DEPRESSA n. sp.

Plate XXXVIII, Fig. 22

Description.—Related to *P. spinosa* and *P. altimuralis* agreeing with those species in having a continuous and unchanging high marginal wall around the ends and ventral side. The marginal ridge curves well on to the dorsal edge, this feature being more striking in *P. depressa* than in the mentioned Upper Clinton species. It differs further in that the ends are less nearly equal the anterior being considerably narrower than the posterior; and on both ends the outer is more convexly curved inward in passing into the dorsal edge. In other words the dorsal angles are more obtuse. Length, 0.85 mm.; height without spine, 0.50 mm.

Occurrence.—MCKENZIE FORMATION. Middle portion at Cumberland, Maryland.

Collection.—U. S. National Museum.

PARÆCHMINA POSTMURALIS n. sp.

Plate XXXVIII, Fig. 19

Description.—The distinguishing characters of this species are (1) its elongate and anteriorly tapering form, (2) the restriction of the curved submarginal ridge to the posterior half and (3) the unusual width of the visible part of the slope outside of the marginal ridge. The spine is broken but judging from the remaining base it was probably small and sharply pointed. There are other species in which the marginal ridge

is incomplete but their other characters are too different to require detailed comparison. Length, 1.0 mm.; height without spine, 0.6 mm.

Occurrence.—CLINTON, *Zygobolbina emaciata* zone. Near tollgate, Cove Gap, 4½ miles northwest of Mercersburg, Pennsylvania.

Collection.—U. S. National Museum.

PARÆCHMINA BIMURALIS n. sp.

Plate XXXVIII, Fig. 15

Description.—The distinctive feature of this species is the small wall-like ridge around the ventral and lateral side of the base of the spine which unfortunately was broken away in cleaning. The marginal ridge is high and thin and extends all around from angle to angle. The umbilical pit lies as usual on the posterior side of the base of the spine. The depressed convex area between the inner and outer ridges is punctate. This combination of characters distinguished the species readily enough from all others and particularly from such of its nearer allies as *P. altimuralis*, *P. spinosa*, *P. depressa* and *P. punctata*. Length, 0.85 mm.; height, 0.5 mm.

Occurrence.—MCKENZIE FORMATION, 20 feet above base. One and one-half miles east of Great Cacapon, West Virginia.

Collection.—U. S. National Museum.

PARÆCHMINA INÆQUALIS n. sp.

Plate XXXVIII, Figs. 16-18

Description.—The relations of this species seem to be with *P. intermedia* and *P. postmuralis* with which it agrees in the restriction of its marginal ridge to the posterior half. In the anterior half the margin is merely raised a trifle before descending abruptly to the contact edge. The species differs from its allies in the abrupt elevation and extraordinary height of the dorsal half of the posterior marginal ridge. Because of its height and vertical sides the ridge commonly is more or less broken away in freeing specimens from the limestone matrix in which they occur. The spine is thick and strong in its lower half but tapers above gradually to a fine point. Length, 0.80 mm.; height without spine, 0.40 mm.

Occurrence.—McKENZIE FORMATION. 78 and 82 feet below top. Flintstone, Maryland.

Collection.—U. S. National Museum.

PARÆCHMINA CUMBERLANDIA n. sp.

Plate XXXVIII, Fig. 4

Description.—This species is thought to be most closely related to *P. punctata* having a similarly coarsely punctate surface and nearly the same outlines. But the spine, of which only the base remains in the type specimen, is located much farther forward, nearly in the middle of the anterior half and hence much farther from the umbilical pit than in either that or any other species. The marginal ridge is very low and the punctation of the very gently convex median area extends almost to the edge. Length, 1.00 mm.; height, 0.60 mm.

Occurrence.—CLINTON. *Dreponellina clarki* zone at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

PARÆCHMINA PUNCTATA n. sp.

Plate XXXVIII, Fig. 21

Description.—This is a typical species of the genus with a long spine and rather low marginal ridge. The ends are somewhat unequal, the anterior being slightly narrower and with a rather well-marked dorsal angle. The inner area is not deeply depressed and its surface is covered with distinct and rather large punctæ. The low ridge enclosing the punctate area is smooth. Though related to *P. spinosa* and *P. depressa* the punctate inner area, low marginal ridge and sharper antero-dorsal angle should serve very well in distinguishing them. Length, 0.8 mm.; height without spine, 0.5 mm.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, two miles west of Hollidaysburg, Pennsylvania.

Collection.—U. S. National Museum.

PARÆCHMINA ? DUBIA n. sp.

Plate XXXVIII, Fig. 5

Description.—The generic position of this small species is doubtful. The type specimen is a right valve and not so well preserved as is desirable. There is a suggestion of *Ctenoholbina* (*e. g., C. minima*) but it would seem unnaturally placed in that genus. The small node behind the broadly depressed middle of the dorsal half is believed to give a truer clue to its systematic position. So far as can be seen the specimen presents nothing positively opposed to its reference to *Paræchmina*. The size of the spine varies greatly in this genus, being small in some. Aside from the relatively minute size of the spine the species is not greatly different from *P. postica*. Another difference when compared with that older (Lakemont) species is that the convex part of its surface is minutely yet distinctly punctate instead of smooth. There is also more of a flattened border around the ends. Length, 0.60 mm.; height, 0.40 mm.

Occurrence.—TONOLOWAY LIMESTONE. Upper part, Keyser, West Virginia.

Collection.—Maryland Geological Survey.

Genus ÆCHMINA Jones and Holl

ÆCHMINA SIMPLEX n. sp.

Plate XXXVIII, Fig. 20

Description.—A simple unridged species suggesting *Æchmina bovina* Jones and Holl but less evenly convex. In fact the surface is flat or even slightly concave in front of the middle of the valves. Length, 0.9 mm.; height without spine, 0.50 mm.

Occurrence.—CLINTON. *Drepanellina clarki* zone. McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—U. S. National Museum.

Genus BOLLIA Jones and Holl

BOLLIA PULCHELLA n. sp.

Plate XXXVII, Figs. 26, 27

Description.—This is a fine and apparently quite typical species of *Bollia*. It is one of the largest known and more elongate and more convex than usual. The horseshoe-shaped thin ridge which incloses the umbilical pit lies about midlength of the dorsal half. Then there is a thin but otherwise well-developed submarginal ridge. It lies near yet clearly within the extreme edge. This outwardly sloping marginal strip is characteristic. In nearly all the other species the ridge is quite marginal with the edge dropping vertically or with concave overhang from the base of the ridge. Between the two ridges the surface is more than usually convex and covered with a fine network of angular pores. Some of the specimens show a peculiar low swelling between the bottom of the loop and the ventral edge. These may be females. Length, 0.90 mm.; height, 0.50 mm.

Compared with *Bollia immersa* and *B. nitida*, the present species differs mainly in the greater convexity of the valves and the extension of the anterior edge far beyond the submarginal ridge.

Occurrence.—WILLS CREEK FORMATION. Pinto, Md., 125 feet above base where it is abundant on the surface of thin slabs.

Collections.—Maryland Geological Survey, U. S. National Museum.

BOLLIA IMMERSA n. sp.

Plate XXXVII, Fig. 24

Description.—This is a smaller ostracod than *Bollia pulchella*, which occurs 80 feet higher in the same formation—the Wills Creek—at Pinto. Its valves agree with those of that species in being uncommonly convex and finely reticulated but differ in many other respects. It is a shorter form, with the outer ridge at the extreme edge, and the inner ridge very low and failing to reach the dorsal edge. No other species known to us looks very much like it. *B. nitida*, which is found with this in the Wills Creek formation at Pinto, Md., is a much flatter form with a thicker and more oblique horseshoe ridge. Length, 0.60 mm.; height, 0.45 mm.

Strangely all the known Appalachian species of *Bollia* were found at Pinto, Md., in two horizons of the Wills Creek formation.

Occurrence.—WILLS CREEK FORMATION. Pinto, Md., 45 feet above base.

Collection.—Maryland Geological Survey.

BOLLIA NITIDA n. sp.

Plate XXXVII, Fig. 25

Description.—This is distinguished from the other two species of the genus found in the Silurian rocks of Maryland by its flatter and much more obliquely outlined valves. Like the others the area between the marginal and inner ridges is minutely reticulated. However, the inner looped ridge is thicker, oblique, and more prominent, especially toward the dorsal edge. Length, 0.70 mm.; height, 0.45 mm.

Occurrence.—WILLS CREEK FORMATION. Pinto, Md., 45 feet above base.

Collection.—Maryland Geological Survey.

Genus HALLIELLA Ulrich

HALLIELLA FISSURELLA n. sp.

Plate XXXVII, Figs. 22, 23

Description.—Similar to *Halliella seminulum* Jones but has a narrow fissure-like median sulcus. It is interesting to note that the female of this type like so many of the Silurian Beyrichiacea also has a ventral brood pouch. Length, 1.10 mm.; height, 0.60 mm.

Occurrence.—TONOLOWAY LIMESTONE. Upper part, Keyser, W. Va.

Collection.—Maryland Geological Survey.

HALLIELLA SUBEQUATA n. sp.

Plate XXXVII, Fig. 20

Description.—Similar to *Halliella fissurella* but its median sulcus is narrower above and seems to close entirely just before reaching the dorsal

edge. The border is narrower on the anterior side but fully as wide and thicker on the posterior end and more depressed on the ventral edge. Finally, the hinge line is shorter and the dorsal angles more obtuse. Length, 1.00 mm.; height, 0.70 mm.

Occurrence.—WILLS CREEK FORMATION. Pinto, Md., 45 feet above base.

Collection.—Maryland Geological Survey.

HALLIELLA ? TRIPLICATA Ulrich and Bassler

Plate XXXVII, Fig. 21

Halliella (?) *tripticata* Ulrich and Bassler, 1913, Maryland Geol. Survey, Lower Dev., p. 521, pl. 93, figs. 17, 18.

Description.—A well-preserved ostracode collected in the Lower Tonoloway limestone at Keyser, W. Va., is so similar to the type of *Halliella ? tripticata* Ulrich and Bassler described from the lowest Devonian at the same place that doubt is possible as to the exact stratigraphic position of the latter. It is possible, of course, that the species may range through both the Tonoloway and Keyser limestones, but it is more probable that the original type of the species was derived from a loose fragment of Tonoloway limestone erroneously identified as Keyser limestone. Length, 0.90 mm.; height, 0.60 mm.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

Subfamily EURYCHILININAE new subfamily

Genus CHILOBOLBINA new genus

Carapace with the broad striated frill characteristic of the subfamily, a simple, short, more or less deeply impressed median furrow or spot, the median lobe barely elevated above general convexity of surface, the male closely resembling the older, simply sulcate section of *Eurychilina*. The female differs in having a prominent long ovate brood pouch that covers approximately the posterior three-fifths of the ventral part of the frill and laps slightly onto the convex part of the valve.

Genotype.—*Chilobolbina* (*Primitia*) *dentifera* Bonnema,[1] Kuckers formation of Esthonia. Typical American species *Chilobolbina punctata* Ulrich and Bassler from the Dyer Bay dolomite (? lower Clinton), near Cabot Head, Lake Huron, Ontario, and in the Gun River and Jupiter River formations of Anticosti Island.

The Kuckers shale contains two other species that seem to belong to this genus. These also were described by Bonnema and referred by him to the genus *Primitia*. *Chilobolbina* (*Primitia*) *kuckersiana* suggests a close ally of our *Chilobolbina hartfordensis*, types of which come from the Middle Clinton, *Mastigobolbina lata* zone, in central New York. The third of the Kuckers species, *C.* (*Primitia*) *kupteyni*, also seems to have a close ally in *C. billingsi* (Jones), which is found associated on the same slabs with *C. punctata* near Cabot Head and in the Gun River and Jupiter River formations in Anticosti.

Besides the six species mentioned, there is a relatively short form of the type of *C. punctata* that is rarely observed in the *Mastigobolbina lata* zone in the vicinity of Cumberland. This is provisionally distinguished as var. *brevis*. It is interesting and perhaps stratigraphically significant to add that the three species of *Chilobolbina* so far observed in the Appalachian region are all confined to the *M. lata* zone of the Clinton.

The species now referred to *Chilobolbina* may be confidently regarded as descendants of two or more of the simply-sulcate group of Eurychilinids for which the new generic term *Coelochilina* is herein proposed. The only difference that might be considered as of greater than specific value is that the female in the derived forms develops a large and prominent brood pouch on the frill.

CHILOBOLBINA PUNCTATA n. sp.

Plate XXXVII, Figs. 10-13

Description.—Valves rather strongly convex, somewhat unsymmetrical, highest in posterior half, swung slightly backward, the anterior cardinal

[1] *Primitia dentifera* Bonnema, 1909, M. H. Min. Geol. Inst. Gröningen, vol. ii, p. 26, pl. ii, figs. 1-5.

angle sharper than the posterior; suleus median in position, short and narrow, gently curved around the anterior side of a low swelling that corresponds to the median lobe of the Beyrichiacea; surface minutely puncto-reticulate. Frill wide on ventral side, narrowing toward the cardinal angles, radially striated, concave to a sharp rim from which the surface descends abruptly into the ventral groove; pouch long, subelliptical, prominently convex, clearly defined, smooth. Length about 1.25 mm.; greatest height, excluding frill, 0.65 mm.; greatest width of frill, 0.17 mm.

This species is perhaps as near *Chilobolbina kuckersiana* (Bonnema), an Esthonian fossil, as to any other. Both have a reticulated surface and a low swelling behind the suleus, but the details of the suleus are quite different in the two species. In the Esthonian species the suleus forms a large sharply outlined pit, whereas in *C. punctata* its outline is indefinite.

Occurrence.—The types of the species were collected by Dr. M. Y. Williams in a green shale at the top of the Dyer Bay dolomite at the clay cliffs 2 miles west of Cabot Head, Lake Huron, Ontario. Specimens that we have not succeeded in distinguishing from this species were collected by Schuchert and Twenhofel in Anticosti from zone 5 of their Gun River formation and by M. Y. Williams from limestones along the southeast branch of Blanch River, north of Cobalt, Ontario.

At the Lake Huron locality the species is associated with other new and previously described ostracods two of which are figured in this work, namely, *Chilobolbina billingsi* (Jones), and *Zygobolba williamsi*. Williams originally referred the Dyer Bay dolomite to the base of the Lockport, but in his final work[1] on the concerned formations he classifies it as a part of the Cabot Head shale which he regards as representing the Cataract formation in northwestern Ontario. The Cataract, it is generally agreed, corresponds to an upper part of the Upper Medinan Albion formation of western New York. In our opinion the reference of the Dyer Bay dolomites to the Medinan is unwarranted. The problem is

[1] Williams, M. Y., The Silurian geology and faunas of Ontario Peninsula and Manitoulin and adjacent islands: Canada Dept. of Mines, Memoir 111, No. 91, Geological Series, 1919, p. 36.

complicated, and its full discussion is reserved for another occasion. Here it must suffice to say that the trend of all the evidence—physical and stratigraphic as well as the purely faunal—now available is unmistakably opposed to the reference of the Dyer Bay dolomite of the Lake Huron region and also the in part contemporaneous Mayville dolomite in eastern Wisconsin to a pre-Niagaran age. The Mayville and Dyer Bay dolomites probably belong in the Clinton group, but they certainly are neither "Alexandrian" nor Medinan in age.

Collection.—U. S. National Museum.

CHILOBOLBINA PUNCTATA var. BREVIS n. var.

Plate XXXVII, Figs. 13, 14

Description.—Two specimens found in the vicinity of Cumberland, Md., seem too near the typical form of *C. punctata* to be satisfactorily separated as a distinct species. The specimens are preserved as casts of the interior in a sandstone, the texture of which is too coarse to show the finer details of surface markings. The features that are determinable are as in the Ontario types of the species except that the valves are relatively shorter. On the basis of this difference these Maryland specimens may be provisionally designated as above. Length, with frill, 3.0 mm.; height, 2.3 mm.

Occurrence.—CLINTON. *Mastigobolbina lata* zone of the eastern slope of Wills Mountain, near Cumberland, Md.

Collection.—Maryland Geological Survey.

CHILOBOLBINA BILLINGSI (Jones)

Plate XXXVII, Figs. 4-6

Primitia billingsi Jones, 1890, Quart. Jour. Geol. Sur., London, XLVI, p. 547, pl. xxi, fig. 10.

Description.—Average length about 2.0 mm.; height, 1.25 mm. Ends subequal, the antero-cardinal angle rectangular, the posterior angle broader. Valves rather strongly convex, highest in the ventral half, with a low curved swelling on either side of the middle along the cardinal edge;

surface punctoreticulate, with a large smoothly bordered ovate and sharply outlined median pit, two-thirds of which lies within the ventral half; midway between the pit and the base of the frill is a narrow impressed line curved so as to parallel the ventral edge. Frill concave, striated, evidently wide though imperfectly preserved in all of the specimens so far observed. Brood pouch not seen in the material from Lake Huron, the collection either containing only valves of males, or if any are female, the pouch has been broken away from the frill. That the species is a true *Chilobolbina* is clearly established by collections from the Gun River and Jupiter River formations in the island of Anticosti. The pouch in these specimens is large and higher than in *C. punctata* but not so elongate.

The identification of these specimens with *Primitia billingsi* Jones is not entirely satisfactory, the figure and description given by Jones being indefinite in various particulars. His type of the species may really belong to a species of *Apatobolbina* that is not an uncommon fossil in the Gun River and Jupiter River formations.

Compared with other species, *C. billingsi* resembles two Esthonian species, *C. dentifera* (Bonnema) and *C. kapteyni* (Bonnema) from the Ordovician Kuckers shale, more closely than it does *C. punctata* with which it is associated in both Ontario and Anticosti. However, it is not the same as either of the Esthonian species. From *C. punctata* it is distinguished at once by its more nearly equal-ended, almost symmetrical carapace, more definitely outlined and wider median pit, and the curved impressed line between the pit and the base of the frill. The low swellings along the cardinal edge also are wanting in that species.

Occurrence.—The original type came from the Gun River formation west of Jupiter River, Anticosti. The specimens now referred to the species come from both the Gun River and the Jupiter River formations. The Ontario specimens figured on Plate XXXVII were found in a green clay bed at the top of the Dyer Bay dolomite, Clay Cliffs, 2 miles west of Cabot Head, Lake Huron. Finally, a cast of the interior in sandstone found in the *Mastigobolbina lata* zone of the Middle Clinton on the eastern slope of Wills Mountain, near Cumberland, Md., agrees, so far as it goes, too closely with the Ontario and Anticosti specimens of the species

to be distinguished. The same layer on Wills Mountain contains among other characteristic ostracoda of this zone also the specimens above designated as a variety of *Chilobolbina punctata*. These occurrences probably are of real significance in determining the disputed age of the Dyer Bay and Mayville dolomites of the Great Lakes region. Both of the mentioned Anticosti formations are now generally referred to the Clinton epoch.

Collection.—U. S. National Museum.

CHILOBOLBINA HARTFORDENSIS n. sp.

Plate XXXVII, Figs. 7-9

Description.—Length, without frill, 2.0 mm. or less, with frill about 2.5 mm. Shape of valves much the same as in *C. punctata* though the ventral part of the outline is not so broadly and regularly rounded. Other differences occur particularly in the median depression, which is a rather small and sharply outlined subcircular or ovate pit instead of a curved furrow. The brood pouch of the female is more elongate, with bluntly acuminate extremities and extends farther anteriorly beyond the pit. The frill is broad, slightly concave, and as usual, radially striated.

In having a median pit rather than a sulcus the species indicates alliances with the Esthonian species *C. kuckersiana* (Bonnema) and our *C. punctata*. It agrees with the former also rather well in the general outline but on closer comparison the pit proves to be larger and less rounded than in the Clinton species. Comparison with *C. punctata* shows that the outline of the valves is less symmetrical and the cardinal angles, especially the anterior, more obtuse, the pit is somewhat smaller and the ventral slope without the impressed curved line which is one of the most characteristic features of that species.

A mold of the exterior indicates that in perfect condition the surface is very minutely and closely punctate.

Occurrence.—*Mastigobolbina lata* zone, Middle Clinton, New Hartford, N. Y.

Collection.—U. S. National Museum.

Genus COELOCHILINA new genus

Proposed for the simply sulcate group of *Eurychilina* in which the node is lacking:

Genotype.—*Calochilina* (*Eurychilina*) *equalis* Ulrich.

Range.—Stones River to Richmond groups.

The described species referred to this new genus are as follows:

Eurychilina equalis Ulrich, Stones River (Lebanon) limestone, Central Tennessee.

Eurychilina dianthus Ruedemann, Mohawkian (Rysedorph conglomerate) New York.

Eurychilina jerseyensis Weller, Trenton limestone, New Jersey.

Eurychilina subequata Ulrich, Black River shale, Minnesota.

Eurychilina striatomarginata (Miller), Richmond group, Ohio Valley.

Eurychilina solida Ruedemann, Mohawkian (Rysedorph conglomerate) New York.

Eurychilina oculifera Weller, Trenton limestone, New Jersey.

Eurychilina distans Krause, Ordovician drift of Northern Germany.

Genus APATOCHILINA new genus

This new genus is proposed for the Ordovician group of Eurychilinid ostracods in which both the node and sulcus of typical *Eurychilina* are wanting, the surface of the valves being more or less evenly convex.

Genotype.—*Apatochilina* (*Eurychilina*) *obesa* Ulrich.

The described species referred to *Apatochilina* are as follows:

Eurychilina obesa Ulrich, Black River (Lowville) limestone, High Bridge, Kentucky.

Eurychilina obliqua Ruedemann, Mohawkian (Rysedorph conglomerate) New York.

Eurychilina (*Primitia*) *plana* Krause, Ordovician drift of Northern Germany.

Genus APATOBOLBINA new genus

Eurychilinid ostracods in which the median sulcus or umbilical pit and all lobes have been submerged in a more or less evenly convex surface, agreeing thus with the Ordovician genus *Apatochilina*, from which they differ in that the female carapace develops on each valve a highly protuberant oval brood pouch which covers the post-ventral half of the frill and a considerable adjacent part of the convex area.

Genotype.—*Apatobolbina granifera* n. sp., basal part of Upper Clinton in Pennsylvania and Maryland and Jupiter River formation, Anticosti.

This genus stands in essentially the same relation to *Apatochilina* as *Chilobolbina* does to *Cytochilina*. In both cases the older types differ from the younger apparently only in the fact that the females of the latter have developed brood pouches, whereas in the former females are indistinguishable from the males. The pouch in *Apatobolbina* is much like that prevailing in the Beyrichiidæ, thus being more rounded and less of it confined to the frill than in *Chilobolbina*. In the latter the pouch does not communicate with the inner part of the valves as it does in *Beyrichia*, but in *Apatobolbina* the pouch looks so much like that of *Beyrichia* and extends so far up on the slope of the ventral convexity of the valve as to suggest that in this type also it opens on the inner side of the contact margin. However, specimens retaining the pouch are as yet too few to permit determining this matter by sectioning.

Besides the genotype the genus is represented in the Gun River and Jupiter River formations in Anticosti by at least one other species. This has a more transverse carapace with produced antero-cardinal angle and longer hinge than *A. granifera*. It may be called *Apatolbolbina acuta* n. sp. The name *Apatobolbina ? appressa* is provisionally applied to a third Clinton species of which the female form has not yet been observed. The latter is figured on Plate XXXVII.

APATOBOLBINA GRANIFERA n. sp.

Plate XXXVII, Figs. 17-19

Description.—Length, with frill, 1.75 mm.; height, 1.3 mm. Valves rather strongly convex, moderately unsymmetrical highest in posterior half, oblique, the postero-cardinal angle barely distinguishable, the anterior more distinct and generally distinctly though obtusely angular; frill radially striated, moderately wide in post-ventral region, narrowing toward the cardinal angles; umbilical spot not depressed, smooth, rounded, situated a little forward and beneath middle of valve; posterior cardinal fourth with a thick undefined submarginal smooth swelling; middle and ventral slopes of valve with small and rather loosely arranged granulation. Brood pouch of female a large, very prominent oval bulb that extends

upward on the post-ventral slope and downward across and beyond the edge of the frill. On our specimen it is longitudinally traversed by fine lines.

In the Jupiter River formation of Anticosti there is a variety of this species that seems to differ only in lacking the surface granulation. The same slabs contain *A. acuta* new species which also has a smooth surface and differs further in having a longer hinge line with the antero-cardinal angle slightly produced and sharply angular.

Occurrence.—The figured types of the species were found in a thin bed of limestone lying near the base of the Upper Clinton (*Mastigobolbina typus* zone), with *Mastigobolbina triplicata* (Foerste), about 2 miles west of Hollidaysburg, Pa. Typical specimens occur in zone 9 of the Jupiter River formation at Jumpers, Anticosti. Doubtfully identified valves have been observed in shaly sandstones of the *Bonnemia rudis* zone near Flintstone, Md.

Collection.—U. S. National Museum.

APATOBOLBINA (?) APPRESSA n. sp.

Plate XXXVII, Figs. 15, 16

Description.—Length, without frill, 2.0 mm.; height, 1.1 mm. In size and general outline much the same as *A. granifera*, except that the hinge is longer and the post-cardinal angle much more distinct. Besides, the surface of the valves is smoother, less convex and lacks the subcardinal swelling. The frill also is much less gently concave, being steeply inclined to the plane of the valves. Finally, the umbilical spot lies above rather than beneath the middle of the valve.

Occurrence.—CLINTON. Top of Frankstown ore seam, one-half mile northwest of Frankstown, Pa., associated with *Zygobolba rustica* and *Mastigobolbina relifera*.

Collection.—U. S. National Museum.

Family ZYGOBOLBIDAE new family

Ostracoda with more or less distinctly lobate valves, the lobes unequal in size, normally three in number, or but two, the posterior one then being

obsolete, or four when the anterior lobe is divided as in the provisional subfamily Drepanellinæ; anterior and median lobes commonly united below, together forming a U-shaped ridge. Brood or ovarian pouch large, a simple, rarely bilobed submarginal swelling situated in varying places on the posterior or ventral slope.

Although most of the Ostracoda for which this new family is erected are now described for the first time, a considerable number of its species and two or three of its genera have been hitherto regarded as aberrant members of the family Beyrichiidæ. Both families doubtless originated in simple *Primitia*-like Ordovician forms, but there is nothing indicating that either was developed out of the other. On the contrary the oldest of the known species of either family is already definitely indicative of its particular family. Both families attained their most typical expression and greatest development during the Silurian period, the Zygobolbidæ in the early stages, the Beyrichiidæ in the later stages. Again, both families seem to have been almost confined during the Silurian period to the north middle Atlantic realm. Only one species of Beyrichiidæ is known in deposits of Silurian seas that invaded North America from the side of the Gulf of Mexico, and none at all in those that came in from the Arctic and Pacific sides. Of the Zygobolbidæ none is found in rocks of southern or western origin and only a few doubtful members in beds that invaded from the north.

The difference that distinguishes all of the Silurian genera of the two families lies in the form and position of the brood pouch. In the Beyrichiidæ this pouch forms a sharply inflated, small-based, prominent, ovoid bulb, situated over the small depression between the converging ventral extremities of the anterior and posterior lobes of the valves. The length of this bulb is approximately half that of the entire valve; and invariably at least two-thirds of it lies behind the middle of the ventral edge. In the Zygobolbidæ the corresponding pouch varies greatly in form and position. Commonly it appears as a mere inflation of the surface, and its base is never constricted. Sometimes, as in *Zygosella*, it takes the form of a narrow rounded ridge running parallel with and a short distance within the posterior border. At other times (*Mastigobolbina*) it makes a

great swelling covering the whole of the post-ventral two-fifths of the surface. In yet other cases it is of intermediate size and lies wholly within the post-ventral quarter, as in *Zygobolba* and *Kladenia;* more rarely it is bilobed as in *Zygobolbina*. Of course these characteristics are developed only on matured female shells.[1]

Male Zygobolbidæ are more or less readily distinguished from Beyrichiidæ of the same gender by differences in the lobation of their valves. If we compare only the typical genera of the two families, the differences in this respect are strikingly apparent. Thus, whereas in the typical Beyrichiidæ the valves are always distinctly trilobate and the posterior lobe not only well developed but commonly also nearly or quite as prominent as the anterior lobe, there is a generally notable tendency among the Zygobolbidæ to non-development or obsolescence of the posterior lobe and consequent bilobation. Moreover, the remaining lobes—the anterior and the median—nearly always join below so as to form a single U-shaped ridge. Though ventral confluence of these two lobes is often observable in Beyrichiidæ, particularly in the group of *Beyrichia buchiana*, the asymmetric position of the resulting loop imparts an aspect to the valve as a whole that could hardly be confused with that of typical Zygobolbidæ.

As will appear presently, this family is divisible into two subfamilies, the Zygobolbinæ and the Kloedeninæ, the former comprising carapaces having an emaciated appearance with narrow lobes and wide sulci, the latter more obese carapaces with relatively short narrow sulci and thick lobes and more strongly developed posterior lobes. Because of the last feature males of the Kloedeninæ often exhibit a greater degree of resemblance to the Beyrichiidæ. The lobation of certain species of *Mastigobolbina*, for instance, is much like that found in the groups of *Beyrichia solleriana* and *Beyrichia kladeni*. Here, then, we must depend on the differences shown by their respective female carapaces. That this depen-

[1] As shells of the younger females are not distinguishable from those of the males, all specimens that are not provided with brood pouches may for descriptive purposes be designated as males. Obviously, then, the pouchless examples of most of the species are more abundant than those recognized as females.

dence is warranted is clearly shown by two facts: First, the genetic relationship of *Mastigobolbina* to *Bonnemaia* and *Zygobolba* of the deeply sulcated types, and to *Plethobolbina*, a unisulcated genus, is undeniably established by structurally and chronologically intermediate forms; second, perfectly typical species of *Beyrichia* lived in the same seas and even earlier than the oldest of the species of *Mastigobolbina* which evidently were derived out of *Plethobolbina*.

This point being established, we proceed by similar reasoning to the inclusion of other genera in the Kloedeninæ that finally diverge to points where resemblance to either Beyrichiidæ or Zygobolbidæ is but remotely suggested. Such aberrant genera are *Plethobolbina*—an early type, which may indeed indicate a survival of the simply marked *Primitia*-like root of the whole subfamily—and the later *Kloedenia* which gave rise to *Welleria* and *Kyammodes*. In *Plethobolbina* only the median sulcus is clearly developed, and this even is uncommonly short in *P. typicalis*. The posterior sulcus is undefined and in the typical species of the genus wholly wanting. But as will be pointed out more fully later on, the genetic relation of *Plethobolbina* to *Mastigobolbina* is indubitably indicated by two of its species, namely, *P. ornata* and *P. cornigera*. The former closely simulates *Mastigobolbina punctata* whereas *Plethobolbina cornigera* has features reminding of *M. glabra*, *M. arctidimbata*, and especially, *M. trilobata*.

Assuming derivation of *Mastigobolbina* at least, if not the whole of the Zygobolbidæ, from some early species of the type of *Plethobolbina*, the evolution of the deeply grooved and sharply ridged typical exponents of the family must have been by accelerated development of features that seem to have come out much more slowly and less definitely in the lines of *Plethobolbina ornata* and *P. cornigera*.

But these evolutional speculations are seldom firmly based on facts that may not be otherwise explained. Often we cannot be sure that some kind of reversion rather than continuously progressive evolution is responsible for the observed structural similarities. In the case under discussion the posterior sulcus in the mentioned *Mastigobolbinas* may have been tending to obsolescence, the final result being forms that, like the species *ornata*

and *cornigera*, have assumed the essential characters of *Plethobolbina*. Besides, the discussion of such relations is greatly complicated by the certainty that most generic groups are variously polyphyletic in origin.

Simulating features are so often developed independently in different genetic lines that no degree of caution suffices to entirely avoid generic misassociation of genetically distinct species. Very common, too, are those simulations that are derived independently from two or more distinct species of a given genus. These divergences from type may occur either contemporaneously or at different times in the life of the genus—because of inherent tendencies in its species to vary in certain directions. Moreover, they often seem to retrace their steps so that one may be at a loss in deciding whether the stage in hand is of the progressing or the regressing series.

In the Beyrichiacea only the median pit or sulcus is constantly present and relatively stable. The other external features are less so, and the posterior lobe or ridge is the least stable. The posterior ridge may be reduced until it is lost entirely; or it may expand in width until it occupies all the space between the median lobe on the side and the outer rim of the valve on the other, the posterior sulcus then being wholly closed in the process. In the one case the reduction of the lobe is accompanied by or results in extreme emaciation of the carapace, in the other the expansion of the lobe is associated with growing obesity that finally embraces the whole of the posterior half of the carapace.

In like manner the anterior lobe may form but a narrow ridge just in front of the median sulcus, or it may expand laterally to the anterior border; in the latter condition it may be divided more or less completely by an accessory sulcus that commonly extends downward from the anterior third of the dorsal edge. But, however great the emaciation of the carapace, the anterior lobe or ridge, unlike the posterior, is never wholly effaced: and the same is true of the median ridge, for these two form the anterior and posterior boundaries of the median pit and sulcus which is always present.

In the simplest of the obese "primitian" carapaces the median sulcus defines the inner sides or slopes of areas corresponding to the anterior and

median ridges of the more definitely lobed species. Besides, even in these simple forms one or the other and commonly both of these outwardly undefined ridges are distinguished from the adjacent convex surface by a low swelling node, or spine. Their permanency is more clearly indicated in the opposite extreme of emaciation. In this condition, as illustrated by most of the species of *Zygobolbina, Zygosella* and typical *Bollia*, only these two ridges remain; and because of the contrasting depression of the surface to the front and back of them, they appear as exceptionally well developed. It is in these emaciated types also that the ventral junction of the ridges which results in forming the characteristic V- or U-shaped ridge is best developed. Between its limbs lies the median sulcus.

Now all of these modifications occur and are repeated in part or whole in quite independent lines of development. Simulation in lobation and other features, therefore, may or may not indicate truly genetic relations. The final decision must take into consideration all other available features and criteria. For practical purposes the most reliable indices are those brought out by detailed comparisons of individuals, varieties, species, and genera. Apparently it is only from such hard-won data that we may finally draw reasonably valid conclusions regarding the progress of organic evolution or mutation.

Though ever tending to reproduce itself exactly no organism ever has, for this would require absolute uniformity of environment; and environment, as we know, is forever changing. The resulting effects in changing life-forms are no less though not correspondingly varied, for they are further complicated by the workings of intellect and chance.

Obviously, then, the subject of genetic relationships is always exceedingly intricate and liable to misinterpretation. For the same reasons any classification of organisms that pretends to express natural affiliations is fraught with difficulties and loaded with inadequately determined associations. To a greater or less extent, therefore, all classifications are artificial and at best only temporary makeshifts. This is true perhaps particularly of the Ostracoda. Though the framework be largely of unassailable fact, the filling is mainly of unrecognized half-truth and frank uncertainty. Things that look unlike but really are near kin are widely

separated, whereas others that originated from distinct sources are associated in the same genus or family because they possess certain features wrongly supposed to be diagnostic. Mainly perhaps because of the absence of the soft parts, the fossil life history of every class of organisms is yet far from being understood; and as the only sure means of advancing toward a better understanding is by working out the intergradations of species, progress necessarily is slow and by small steps.

It is on such grounds that we have felt warranted in departing from preceding custom to the extent here illustrated by the reference of the distinctly trilobed and deeply bisulcated typical species of *Mastigobolbina* and the obesely bilobed and unisulcated species of *Plethobolbina* to adjacent positions in the same subfamily. The transitional relations between these two extremes is, we believe, clearly exhibited by species of the two genera here illustrated. By way of corroboration it may be added that even greater variation in the degree of lobation of the carapace is established by similar transitions observed in other families, notably in the Kloedenellidæ and Primitiidæ.

The genus *Kloedenia* is regarded as derived from either *Mastigobolbina* or *Plethobolbina*. If from the former, then it was brought about through the ventral obsolescence and consequent shortening of the sulci; if from the latter, it came through the development of the posterior sulcus which is wanting in *Plethobolbina*. The affinities of *Kloedenia* with the *Zygobolbidæ* are further indicated during the decadence of the family in the late Silurian by the ventral prolongation of the posterior sulcus and the consequent redevelopment of the U-shaped median ridge which distinguishes the derived *Zygobeyrichia* and at the same time recalls such preceding, early to middle Clinton species of *Mastigobolbina*, as *M. lata*, and more particularly the species of *Zygobolba*.

As stated above, the bulk of the Zygobolbidæ, as now conceived, seems to divide naturally into two subfamilies. These include all but two (*Drepanellina* and *Mesomphalus*) of the Silurian genera that seems to have any rights whatever to a place in the family. Numerically, the exceptions are of minor importance, comprising as they do only six relatively isolated Silurian species that so far have given no satisfactory clue to their

genetic origin. Provisionally we may add the hitherto always troublesome Ordovician genera *Drepanella* and *Scofieldia* to these doubtful Zygobolbidæ. This association does no material violence to the general conception of the family. The only real objection is the absence in the Ordovician forms of anything like the brood pouch that characterizes the matured female examples of the more typical genera.

The genera are classified, stratigraphically located, and represented by species as follows:

Family ZYGOBOLBIDAE

Subfamily ZYGOBOLBINAE

Genus Zygobolba n. gen., Clinton, 30 + species.
Genus Zygobolbina n. gen., Lower Clinton, 4 species.
Genus Zygosella n. gen., Clinton, 10 species.
? Genus Bonnemaia n. gen., Clinton (mainly Upper Clinton), 11 species.

Subfamily KLOEDENINAE

Genus Mastigobolbina n. gen., Clinton, 21 species.
Genus Plethobolbina n. gen., Clinton, possibly also Richmond, 5 species.
Genus Kloedenia Jones and Holl, Clinton to Oriskany, 25 + species.
Genus Welleria n. gen., Tonoloway, 3 species and varieties.
Genus Kyammodes Jones, Silurian, 4 species.
Genus Zygobeyrichia Ulrich, Cayugan and Helderbergian, 10 species.
Genus Steusloffia Ulrich and Bassler, Early Silurian, 5 species.

Subfamily DREPANELLINAE (provisional)

Genus Drepanellina n. gen., Upper Clinton, 6 species.
Genus Drepanella Ulrich, Stones River to Richmond, 9 species.
Genus Scofieldia Ulrich and Bassler, Upper Black River (Decorah shale), 1 species.
Genus Mesomphalus Ulrich and Bassler, Helderbergian (Keyser member), 2 species.

Subfamily ZYGOBOLBINAE new subfamily

Genus ZYGOBOLBA new genus

Carapaces 2 to 3 mm. in length (rarely smaller), more or less obliquely subovate to elongate elliptical in outline, the figure truncated on the dorsal side by the long straight hinge. Surface of valves depressed convex lobate, with the median and anterior lobes rather well developed

and surmounted by a U-shaped thin ridge or crest, the posterior arm of which commonly appears as more inflated than the anterior and ventral parts. Posterior lobe imperfectly developed, often nearly or quite obsolete; anterior lobe obscurely defined on the anterior side. Median sulcus (corresponding to the anterior sulcus of the Beyrichiidæ) deep, wide, and more or less sharply defined, commonly extending more than half across the valve; posterior sulcus usually narrow and ill-defined. Free edges of valves thick, doubly rimmed, the inner rim bordering the slight overlapping contact edges of the two valves, the outer rim or flange forming a more or less wide concave border around the anterior, ventral, and posterior sides of the exterior lobate surface of each valve. On the inner surface of the valves, hence also on casts of the interior, the flange is much less prominently developed, this being so particularly of its ventral part. In the female the brood pouch forms a large, rather well-defined, semiovate-ovate, downwardly tapering swelling. This occupies the outer two-thirds of the post-ventral quarter. Almost without exception the inflation of the posterior arm of the U-shaped crest is less than in the males. Surface of test apparently smooth or finely punctate, occasionally perhaps reticulated.

Genotype: Zygobolba (Beyrichia) decora (Billings). (See Plate XI., Figs. 11-14.)

Number of Species Known.—Thirty or more, the American species confined to formations of the Clinton group.

Generic Alliances.—The lobation and general aspect of the valves of *Zygobolba* suggest relations to *Bollia* on the one hand, and certain Beyrichiidæ on the other. The character reminding of *Bollia* is the U-shaped crest which forms the summits of the ventrally confluent anterior and median lobes. But a similarly curved and similarly located crest-like ridge is developed in certain other members of the Zygosellidæ (*e. g., Mastigobolbina incipiens*) that no one would seriously think of uniting with *Bollia*. Moreover, the union of the anterior and median lobes through confluence of their ventral portions is more or less unmistakably manifested in all of the Zygobolbidæ. It is, therefore, to be viewed as a characteristic of this family as well as of *Bollia*. Besides, it is well developed in

other ostracods, as for instance the Ordovician genus *Jonesella*, which are so different in other respects that their classification in the same family even with either *Bollia* or any of the Zygosellidæ seems highly questionable. We must conclude, therefore, that the common possession of a U-shaped ridge is not of itself conclusively indicative of a closeness of genetic relationship.

Taking other features into consideration *Zygobolba* is at once distinguished from typical *Bollia* by the often feeble though yet unmistakable development of a posterior lobe. However, a more conspicuous and probably important difference is that the valves of the female carapace of *Zygobolba* and its immediate allies are provided with large brood pouches. Nothing of the kind has been observed on any of the numerous Ordovician and Silurian species of *Bollia*. It may be added that the average size of the carapace is decidedly greater in *Zygobolba* than in typical species of *Bollia*.

Compared with *Beyrichia*—excluding the groups of *B. interrupta* and *B. linnarssoni*[1] which seem more properly referable to the family Zygobolbidæ—the male carapace in the present genus is distinguished by the relatively inferior development of its posterior lobe. Also by the greater continuity and evenness and the relative narrowness of the U-shaped loop. The latter in fact suggests a structure superposed on the lobes which without it, as may be seen when casts of the interior of *Zygobolba* are compared with exteriors of *Beyrichia*, would be much less unlike in the two genera. The chief difference in lobation, aside from the disparity in their respective posterior lobes already mentioned, is that the anterior lobe in *Beyrichia* is always a more definitely outlined and more broadly prominent feature than in *Zygobolba* in which the definition of the anterior side of the lobe is commonly so obscure that its slope may be described as merging imperceptibly into the more or less wide marginal concavity. Another difference is that the indentation of the surface of the bases of the posterior and median lobes, which is as a rule clearly observable in *Beyrichia*, is wanting or but obscurely determinable in species of *Zygobolba*.

[1] Ulrich, E. O., and Bassler, R. S., Proc. U. S. Nat. Mus., vol. xxxv, pp. 295-300, 1908.

A more important difference is noted in comparing female carapaces of the two genera, namely, in the form of their respective brood pouches. Though occupying somewhat similar positions on the valves, the pouch in *Beyrichia* always is more prominent, more regularly oval, and particularly, more sharply outlined.

All of the differences mentioned as distinguishing *Zygobolba* from typical *Beyrichia* are invalidated when the comparison is extended to at least certain members of the groups of *Beyrichia interrupta* and *Beyrichia linnarssoni* (op. cit.). The species of the first group especially referred to here is the *Beyrichia damesi* Krause found in early Silurian erratics in the Baltic region. The carapace of both the male and the female forms of this species remind so strongly of *Z. williamsi* that no reasonable doubt of their congeneric relations is to be entertained. Though similar affinities are less clearly exhibited by *B. interrupta* Jones and the other two species which constitute the remainder of its group, namely, *B. granulifera* Ulrich and Bassler (*Bollia granulosa* Krause) and *B. v-scripta* (Krause) —all three of which were removed in 1908 by Ulrich and Bassler from *Bollia* to *Beyrichia*—it yet seems certain that the whole group is more truly related to *Zygobolba* and its immediate allies than to typical *Beyrichia*. Unfortunately, the female form has been observed in this group only in *B. damesi* so that we are as yet unable to decide finally that the species *interrupta*, *granulifera*, and *v-scripta* belong in *Zygobolba* and not to some other genus or subgenus of the Zygobolbidæ. Of the three the species *interrupta* seems the most likely to prove congeneric with *Z. damesi* and *Z. williamsi* and thus to belong to the genus *Zygobolba* as now understood.

The second group of *Beyrichia* above mentioned as probably more closely allied to the Zygobolbidæ than to typical *Beyrichia*, namely, the group of *B. linnarssoni* for which Ulrich and Bassler in 1908 proposed the subgeneric term *Steusloffia*, is distinguished by having one to four usually connected thin ribs coursing over the summits and sides of the lobes. Aside from these superposed ribs, the valves of *Steusloffia* resemble those of *Mastigobolbina* more than those of *Zygobolba*. In fact, pending the discovery or recognition of the female forms of the five known species of

Steusloffia, the superficial ribs afford perhaps the only really valid reason for the erection of *Mastigobolbina*.

Another rather closely simulating generic type is *Zygobeyrichia* Ulrich,[1] a genus recently established for late Silurian and early Devonian species that now seem to have been derived out of *Kloedenia* rather than *Beyrichia* as was believed before the present, more thorough studies were undertaken. Like *Zygobolba* so also is *Zygobeyrichia* distinguished from *Beyrichia* by the definitely U-shaped form of its ventrally confluent median and anterior lobes. But, as intimated above, this feature is shared by genetically very distinct ostracods. It is more or less distinctly developed in *Zygosella*, *Zygobolba*, *Zygobolbina*, and *Zygobeyrichia*, all genera of the family *Zygobolbidæ*, and equally as well or even better in such otherwise very distinct genera as *Bollia*, *Dizygopleura*, and *Jonesella*. In itself, therefore, the U-shaped ridge is not particularly characteristic of any of these genera.

Except in the latter three cases, which reduces our comparisons to groups of species recognized in the family Zygobolbidæ, hardly any characters of the kind and grade of importance of those hitherto employed in discriminating fossil genera of Ostracoda are available for the purpose of classifying the numerous species into clearly definable genera. The necessities of the case, therefore, demand that features hitherto neglected, also relatively small differences in others, should be promoted to a grade of importance beyond that previously credited to them. After all, the only practical means of determining the systematic value of a character is by observing its relative persistence in nature. However trivial its known biological significance, the presence of some particular character in many species that have other characters in common makes it a valuable aid in classifying organisms.

Of greater, indeed primary, importance in building any classification that pretends to a natural basis, is the determination, so far as possible, of the genetic origin and development of the objects to be classified. Therefore, giving due weight to this principle and though fully cognizant

[1] Williams, H. S., Fauna of the Chapman sandstone of Maine: U. S. Geol. Survey Prof. Paper 89, p. 290, 1917.

of the general resemblance existing between male carapaces of *Zygobolba* and *Zygobeyrichia*, we must not yield to the temptation to unite the two groups of species in one genus. They were not developed out of the same genetic roots. When *Zygobeyrichia* was proposed the belief prevailed that its species were derived from typical *Beyrichia*. This view was based on comparisons of forms having similarly well-developed lobes. However, the present more extensive investigation seems to establish beyond question that *Zygobeyrichia* was differentiated from *Klædenia* by accentuating features initiated in species like *Z. ventricornis*. The process may be imagined as one of emaciation that brought the location of internal organs into clear relief on the outer surface of the valves. *Zygobolba*, on the other hand, was derived from some other stock—most probably *Drepanella*—at a time when real *Klædenias* were not yet in existence.

Being convinced, then, of the genetic distinctness of *Zygobolba* and *Zygobeyrichia*, we may pass on to the consideration of possible structural differences. Critical comparisons show that even the male carapaces of the two groups of species are not entirely alike. So far as known, the anterior lobe in *Zygobeyrichia* has a broader and anteriorly fuller base than in *Zygobolba*. The dorsal part of its median lobe is also more roundly inflated and commonly more prominent. Similarly, the ventral part of the confluent median and anterior lobes is thicker, more elevated, steeper, and as a rule closer to the border of the valves. Finally, the marginal rim is narrower and flatter.

Comparisons with *Zygobolbina*, *Zygosella*, *Bonnemaia*, and *Mastigobolbina* will be found on following pages devoted to their description.

Geographic and Stratigraphic Distribution of Species.—Thirty different forms of this genus are known from American and Canadian localities in eastern North America. Many of these are described and illustrated for the first time in this work. Two or three additional forms are represented by unique specimens in collections from the Jupiter River and Gun River formations on the Island of Anticosti. Besides, as above mentioned in discussing the generic alliances, a group of four European species now referred to *Beyrichia* may belong here.

Because of its bearing on questions of stratigraphic correlation it is important to note that nine of the Appalachian species are found also in

Anticosti. Five of these are associated on the same slabs of limestone taken from the highest zone (No. 5 of Twenhofel's classification) of the Gun River formation in Anticosti, and are similarly found together on slabs of shale procured from the middle part of the Clinton as developed at Hagans, in southwestern Virginia; and four of the five were found in the "Williamson" shale member of the Lower Clinton at Rochester, N. Y. In all of these places the Ostracoda occur with numerous specimens of the same variety of *Anaplotheca hemispherica* that is one of the most characteristic brachiopods of this zone in the Appalachian region.

The stratigraphic significance of these occurrences becomes more clearly determinative when we add that the five species of *Zygobolba* common to the localities at Rochester, N. Y., and Hagans, Va., comprise all the species of the genus known from the former place. Also that only two others, or seven in all, have been found at Hagans; also that the total number of species of *Zygobolba* found in the Gun River formation in Anticosti is seven, of which four occur also at Rochester and five (including the four common to all three places) at Hagans. Finally, the collections from all of these places include specimens of certain perhaps less diagnostic species of *Parachmina* and *Bythocypris*.

Though introducing some difficult problems of paleogeography, the direct evidence of the presence of these closely discriminated fossils seems to point indubitably to the conclusion that the beds holding them in Anticosti, New York, and southwestern Virginia are practically contemporaneous.

Z. williamsi is from the Dyer Bay dolomite in western Ontario. Williams[1] refers this dolomite to the Cataract formation but in our opinion it represents a part of the Clinton group. The other American species are all confined to beds known to be Lower Clinton in age, and most of them to localities in the Appalachian region between central Pennsylvania and the southwestern extremity of Virginia. As stated above, nine are common to the Appalachian Valley and Anticosti whereas four are known as yet only from the latter island. So far the genus is wholly unknown to the south of northeastern Tennessee.

[1] Williams, M. Y., Silurian Geology and Faunas of Ontario Peninsula, etc. Mem. 111, Geological Series 91, Geological Survey of Canada, p. 18.

ZYGOBOLBA DECORA (Billings)

Plate XXXIX, Figs. 15-22; Plate XL, Figs. 11-14; Plate LXIV, Figs. 21-25

Beyrichia decora and *B. venusta* Billings, 1866, Geol. Survey Canada, Cat. Silurian Fossils Anticosti, pp. 68, 69.

Description.—Length of an average carapace of the male form about 2 mm.; height of same 1.27 mm. Dimensions of largest male valve observed 2.75 mm. by 1.75 mm. Females commonly exceed males in size, the length of the largest seen about 3.10 mm.

Billings did not illustrate specimens of this species *Beyrichia decora* and *B. venusta*, nor is it known that he marked any specimens as types of them. Under the circumstances we are compelled to depend solely upon his descriptions in identifying the forms referred to by him in material collected at the same places as those from which the specimens described by Billings were procured. It should be said further that in determining which of a number of congeneric forms found together at East Cliff and The Jumpers, Anticosti, localities particularly mentioned by Billings as affording specimens of his species, is the most likely to be the same as the one mainly used by him in writing the descriptions of *B. decora* and *venusta* would be the one found in greatest abundance at the places mentioned. The selection then was made in accordance with this probability.

In studying the descriptions of *Beyrichia decora* and *B. venusta* it soon appeared that the former was founded on valves of females, the latter on those of males of the same species. At the time Billings wrote these descriptions the discrimination of the sexes in specimens of Beyrichiacea was not appreciated as at present and as the two commonly look very unlike no particular blame attaches to Billings on account of his failure to recognize the specific identity of the two forms described by him. However, as may be seen by comparing the numerous figures, including both sexes, on Plates XXXIX and LXIV, and aside from the fact that in the mature female the brood pouch covers most of the post-ventral quarter of the valve whereas in the male this pouch is wanting, the valves in the two sexes are practically alike.

The specimens illustrated on Plates XXXIX and LXIV show not only typical examples but also the extremes of variation so far observed. The

figures on Plate LXIV are reproduced from practically untouched photographs of right and left valves of seven males and two right valves of females selected almost at random from thousands of excellently preserved specimens of this species that occur on thin slabs of highly fossiliferous limestone collected at the same localities in Anticosti at which the material described by Billings was procured. The figures credited to this species on Plate XXXIX represent gutta percha squeezes of nine valves of males and three of females, right and left valves of both sexes being included. These were selected to show the variations observed among hundreds of examples preserved as molds of the exterior and interior which largely cover the bedding planes of a fine-grained ferruginous sandstone of Middle Clinton age found in southwestern Virginia. Among them we distinguish two varieties, the commoner of the two being indistinguishable from average Anticosti specimens of the species, the other a shorter-hinged form with more obtuse anterior dorsal angle. If a name is desirable for this rounder local variety it might be called variety *portalis*.

As the many figures of this species herein given show practically every feature, further description seems unnecessary. It may be well, however, to direct attention to the exceeding constancy in size, form, and details of lobation displayed by these specimens. We may add that a like degree of fidelity to type is maintained by all the other species of which many specimens have been collected. This statement, supported as it is by the testimony of photographic illustrations, is perhaps required to convince those paleontologists who have not made extensive studies of fossil Ostracoda that their separation into numerous species and the subsequent recognition of the latter is a practicable undertaking.

Occurrence.—The types of the species are from the Jupiter River formation of the Island of Anticosti. It should occur in Maryland and Pennsylvania, but so far it has been observed in the Appalachian Valley region only in the gap at Gate City, Va. Here it is found in great numbers holding a thin zone of ferruginous, soft, fine-grained sandstone occurring approximately 200 feet above the base of the formation. Associated with it are occasional specimens of other ostracoda, among them *Zygobolba arcta* and *Zygobolbina emaciata*. Also numerous specimens of

Anoplotheca subrotunda Ulrich and a small species of *Tentaculites* 10 mm. or less in length. Both of these fossils are similarly characteristic of the *Z. decora* zone, which is placed near the top of the Lower Clinton.

Collection.—U. S. National Museum.

ZYGOBOLBA ARCTA n. sp.

Plate XXXIX, Figs. 10-14

Description.—Length and height of four valves, respectively 1.8 by 1.12 mm., 1.63 by 1.09 mm., 1.62 by 1.06 mm., and 1.58 by 1.06 mm. Species based on six specimens.

This species differs but little in outline from *Z. cristata* with which it is sometimes associated, but it is readily distinguished by its much narrower border. The lobes and in fact the whole area within the border are also fuller, giving the valves a much less emaciated aspect than pertains to its more prolific contemporary. As a matter of detail it may be added that the U-shaped crest is thinner and in part less sharply defined, the ventral portion of the loop especially being inclined to obsolescence. Also that the dorsal angles are slightly more angular and the average size somewhat less than in *Z. cristata.*

Occurrence.—CLINTON. Near the boundary between the Lower and Middle Clinton (probably in both *Zygobolba decora* and *Zygobolbina emaciata* zones) at Gate City, Va., about 200 feet above the base of the Clinton and 8 miles south of Big Stone Gap, Va., it occurred about 50 feet beneath the iron ore bed in association with a larger and relatively more elongate variety. Also in the Middle Clinton (*Mastigobolbina lata* zone) at Cumberland, Md., 173 feet above the Tuscarora sandstone. So far as known the species seems very rare.

Collection.—U. S. National Museum.

ZYGOBOLBA ERECTA n. sp.

Plate XXXIX, Figs. 1-4

Description.—Length and height of the right valve of a male of average size, respectively, 2 by 1.63 mm.; of a smaller left valve, 1.75 by 1.50 mm.;

of a large left valve of the female form, 3.30 by 2.60 mm. Species based on four specimens.

Though doubtless closely related to and in some respects intermediate in character between *Z. cristata* and *Z. arcta*, this species is easily distinguished by its relatively greater height. The concave border is not as wide as and the convexity of the lobate inner area of the valves is appreciably greater than in the former whereas the opposite condition in both respects is observed when critically compared with the latter. Proportionately the height of the carapace is greater than in any other species of the genus and family. This fact, in connection with the approximate bilateral symmetry of the valves, especially those of the male form, gives them an uncommonly erect appearance.

Occurrence.—So far this species has been observed only in soft, red sandstone taken out of a tunnel in the east slope of Tussey Mountain, 1½ miles southwest of Cherrytown, Pa. The position of the bed is said by Mr. Charles Butts, the collector, to be near the base of the Clinton. A number of other Ostracoda are associated on the same piece with *Z. erecta*, among which *Z. carinifera*, *Z. reversa*, *Z. elongata*, and *Z. limbata* are likewise so far known only from this bed and locality. Evidently the zone (*Zygobolba erecta* zone) is distinct from and older than any of the Clinton ostracod zones observed in the section at Cumberland, Md.

Collection.—U. S. National Museum.

ZYGOBOLBA CARINIFERA n. sp.

Plate XXXIX, Figs. 5, 6

Description.—Length and height of a rather large right valve (male), respectively, 2.75 and 1.87 mm. Species based on five specimens.

This species is found with *Z. erecta* and evidently is closely allied to it. Males only have been seen, and these are somewhat larger than the males of that species though still inferior in size to the female. Critically compared *Z. carinifera* is found to be proportionately longer, its outline oblique, and the junction of the anterior and dorsal edges rectangular. The post-dorsal angle is more obtusely angular or narrowly rounded. The oblique form and rectangular anterior extremity of the hinge serves

equally well in distinguishing the species from *Z. arcta* and *Z. cristata*. Comparison of the figures discloses other small differences.

Occurrence.—Near the base of the Clinton, on the east slope of Tussey Mountain, 1½ miles southwest of Cherrytown, Pa., where it is associated with *Z. arcta*. The species probably is abundant here as the types—comprising valves of five individuals—were all contained in 3 or 4 cubic inches of rock.

Collection.—U. S. National Museum.

ZYGOBOLBA REVERSA n. sp.

Plate XXXIX, Figs. 7-9

Description.—Length of large right valve 2.31 mm., height of same 1.34 mm.; length of rather small left valve 1.81 mm., height of same 1.12 mm. Species founded on seven specimens, all males.

The main characteristics of this species are (1) that the greatest height of the valves lies in front of the middle instead of behind, and (2) that the oblique "swing" of the outline and lobes is forward from the dorsum instead of backward. In consequence the anterior side of the carapace is likely to be taken for the posterior. As these extraordinary peculiarities have not resulted through distorting pressure, the specimens so marked must be viewed as representing a species by themselves despite the fact that in other respects they closely simulate the preceding *Z. carinifera*. However, even those features that are most nearly alike in the two forms are yet not entirely the same. Most of them differ in proportion as they are affected by not only the differences in outline and swing mentioned but also by the decidedly greater relative length of the valves of *Z. reversa*. As a matter of detail concerning their respective outlines it is worth mentioning that in *Z. reversa* the posterior part of the border is much more narrowly rounded and that the lower part of the anterior edge curves more sharply into the ventral part, whereas its straight upper part trends decidedly backward in its course to the angular extremity of the hinge. Further, it should be observed that the transverse lower part of the U-shaped crest is sharply defined also on its ventral side so that it forms

a thin elevated rib along the upper edge of the wide sloping ventral part of the loop. Finally, judging from the material in hand the average dimensions of *Z. carinifera* exceed those of *Z. reversa*.

Compared with other species described on preceding pages, *Z. erecta* is found to be relatively higher, more equal-ended, and more erect in general aspect. In *Z. arcta* the border is narrower, the general form more nearly bilaterally symmetrical, and the contour of its valves more convex. The more V- than U-shaped form of the crest in *Z. cristata*, combined with the emaciated appearance of its valves and broad concave border, renders confusion with it highly improbable.

Occurrence.—Same as *Z. carinata* and *Z. erecta*.

Collection.—U. S. National Museum.

ZYGOBOLBA ELONGATA n. sp.

Plate XL, Figs. 15-17

Description.—Length of a male left valve 3.25 mm., greatest height of same 1.56 mm., length of hinge line 2.68 mm. Similar measurements of the right valve of a female gave, respectively, 3.75 and 2.03 mm. Species based on two specimens, a male and a female.

This is a large and extraordinarily elongate species, the proportionate length being greater than in any other now known. In outline the valves of the male are straight along the hinge, very greatly convex on the ventral side, with the anterior end but little narrower than the posterior; but the large pouch of the female overhangs the ventral edge sufficiently to cause its posterior half to appear considerably higher than the anterior half. Though thin, the crest is fairly distinct and sharply ridged on the exterior, but on casts of the interior, as shown in the illustrations, it is but obscurely indicated. In gutta-percha squeezes taken from the empty molds of the exterior, the anterior and median lobes and the crest are not materially different from the same parts in *Z. limbata* (see Pl. XL, Fig. 15), but the posterior lobe is thicker below, more nearly obsolete above, and more oblique in trend. The anterior lobe is thick, its anterior limits indefinite, and the slope in that direction rather gently convex. The concave border,

though shallow, is fairly wide on the ends but narrow in the middle part of the ventral side. The dorsal angles are sharp but both are wider than a right angle.

The great length of its carapace and valves will at once distinguish this species from all previously described forms. Species thought to be nearer relatives are *Z. limbata*, *Z. buttsi*, *Z. parifinita*, and *Z. bimuralis*. Descriptions and comparisons with these appear on following pages.

Occurrence.—Same as the preceding *Z. carinata* and *Z. erecta*.

Collection.—U. S. National Museum.

ZYGOBOLBA PARIFINITA n. sp.

Plate XLI, Fig. 27

Description.—Length and height of the holotype, a right valve of the male form, respectively, 2.27 and 1.25 mm.; length of hinge line of same 2.20 mm.

This species, though probably inferior in size, reminds greatly of *Z. elongata* with which, besides, it is found and with which it was at first confused. Later, more careful comparison, however, convinced the authors that it is perhaps no less like *Z. pulchella*—with which, moreover, it agrees much better in dimensions—and that it represents another of the many specific modifications into which these Clinton Ostracoda are divisible. Compared with *Z. elongata* it is found to be somewhat less drawn out, the greatest height in that species being appreciably less than half the length whereas in *Z. parifinita* the length is distinctly less than twice the height. The hinge line, on the contrary, is proportionately longer in the latter, a condition resulting from its more nearly rectangular dorsal angles. Further, the two ends are even more nearly equal in size and form than are those in *Z. elongata*. When it comes to the form and disposition of the lobes, especially as they appear in casts of the interior, the two species differ in little that would not naturally follow a general reduction of the length of the carapace. The only observed exception is that the U-shaped crest is less clearly recognizable in *Z. parifinita*,

the difference being in the direction of conditions prevailing in *Z. pulchella*.

Occurrence.—Same as the preceding *Z. carinata*, *Z. erecta*, and *Z. elongata*.

Collection.—U. S. National Museum.

ZYGOBOLBA LIMBATA n. sp.

Plate XLI, Figs. 12, 13

Description.—Length of a left valve (male) 3.34 mm., height of same 1.64 mm. Species based on five specimens.

In size and general form this species resembles *Z. elongata* but detailed comparisons show important and, in part, conspicuous differences. Of the latter the great development of the flange and concave marginal area—especially notable on the posterior end—imparts a strikingly different aspect to similar views of the two species. This may be seen by comparing Figs. 12 and 13 in Plate XLI.[1] At the anterior side the rim is more prominently and abruptly elevated and the front edge consequently more flatly thickened in views of the dorsal or ventral edges than in *Z. elongata*. The posterior lobe also differs in being narrower, less oblique, continuous to the dorsal edge, and so disposed that its rather sharp summit runs parallel with and closer to the edge of the bulbous median lobe. The posterior sulcus, therefore, differs correspondingly in being narrower and better defined in its dorsal half. Other less important differences may be noted in comparing the illustrations.

None of the other species here described seems near enough to require unusual care in distinguishing them. Only *Z. reversa*, which is found in the same pieces of sandstone and is thought to be even more truly related to *Z. limbata* than *Z. elongata*, may give any trouble. However, as *Z. reversa* commonly does not greatly exceed half the size of *Z. limbata* and

[1] The distinctness of these two illustrations is due in only small part to the fact that the former represents the *exterior* of the one whereas the latter is taken from a cast of the *interior* of the other. Interior casts of *Z. limbata* differ from reproductions of the exterior of the same individuals only in that the sharpness of the features is somewhat subdued.

proportionately is a distinctly shorter form, their separation has so far proved comparatively easy.

Occurrence.—CLINTON. East slope of Tussey Mt., 1½ mi. southwest of Cherrytown, Pa.

Collection.—U. S. National Museum.

ZYGOBOLBA BUTTSI n. sp.

Plate XLI, Figs. 16-24

Description.—In three casts of the interior, all of males, and showing the extremes of variation observed, measurements of greatest length and height gave 1.71 by 1 mm., 1.75 by 0.98 mm., and 1.87 by 1 mm. In a testiferous left valve, preserving the wide outer border, the same measurements give 1.87 by 1.15 mm.; and in a cast of the interior of a left valve of a female 2.27 by 1.40 mm.

Ferruginous pseudomorphs of this neat species occur by the thousand, together with other Ostracoda, in a thin layer of iron ore lying about 8 feet above the main seam of the Frankstown (Pa.) ore bed. The fossiliferous ore was collected in quantity by Mr. Charles Butts, of the U. S. Geological Survey, after whom we take pleasure in naming the species. Its characters are clearly brought out by the photographic illustrations in Plate XLI. Besides indicating their essential constancy, the figures also show the strikingly different appearances of casts of the interior, on the one hand, and testiferous examples, on the other. In the latter the concave border is very wide and the lobate area within it falsely seems less convex than in the interior casts which, moreover, when freed from the matrix give no adequate indication of the actual width of the border on perfect shells.

The interior casts, in which condition all but a few of the specimens in hand are preserved, are elongate. Compared with preceding species their general form and lobation suggests affinities with *Z. elongata*, but on account of their constantly smaller dimensions one soon reaches the conclusion that the two are specifically distinct. Critically compared their ends are found to be less nearly equal in height, the anterior being not only

distinctly inferior to the posterior but also different in form. Thus, whereas the posterior half of *Z. buttsi* may be justly described as a diminutive replica of the equivalent part in *Z. elongata*, the anterior half obviously is not, because (1) its height tapers forward, (2) the antero-ventral part of the outline is more gently curved, and (3) the anterior edge more nearly vertical, its junction with the hinge line forming practically a right angle. The length of the cast also is proportionately less, the height being greater than half the length, whereas it is less than half in *Z. elongata*.

When it comes to exteriors, the two species are found to be really very different. With the wide border intact, the smaller *Z. buttsi* is so much shorter and the general aspect so different that near affiliations with *Z. elongata* would scarcely be suspected. Turning to other possible allies the choice soon narrows to *Z. cristata* as the nearest known relative. In fact there is little besides the angularity of the dorsal angles to distinguish perfect specimens of *Z. buttsi* from similar examples (or corresponding gutta-percha impressions of the exterior) of *Z. cristata*. In the latter, as shown in Plate XLI, these angles are somewhat rounded or at least more obtusely angular. Among other small differences it may be observed that the curvature of the antero-ventral half of the edge of the border is more gentle and the edge itself thinner and less erect than in *Z. cristata*. Casts of the interior are more easily distinguished, those of *Z. buttsi* appearing relatively more elongate and more distinctly tapering toward the front. Such casts when left in the surrounding matrix commonly retain an impression of the inner surface of the flange (outer border) and give an idea of its width and of the extent to which it projects beyond the contact edge (see Pl. XLI, Fig. 16). Finally, the brood pouch of the female of *Z. buttsi* is more prominent, relatively larger, and its axis more nearly horizontal than in *Z. cristata*. As a rule, too, the elevation of its summit is emphasized at its widest part of a low tubercle, the like of which has not been observed in *Z. cristata*.

Occurrence.—Very abundant in a thin bed of soft, porous, fossiliferous iron ore lying about 8 feet above the main ore bed one-half mile northwest of Frankstown, Pennsylvania. The stratigraphic position of the bed

seems to be not far from the top of the Lower Clinton and possibly falls into the base of the *Zygobolbina emaciata* zone of the Middle Clinton. It has not been recognized in the Clinton sections in Maryland, where, as for instance at Cumberland, it should be looked for in the hitherto apparently barren or insufficiently searched 60-foot interval between the two known ostracod beds which lie about 57 and 120 feet above the base of the formation in the sections on Wills Creek. The higher of these beds contains *Mastigobolbina lata*, *Zygobolbina conradi* and other species commonly found in the *M. lata* zone. The Frankstown bed is exceedingly rich in remains of Ostracoda, all of the 12 species except one so far collected from it being unknown elsewhere.

Collection.—U. S. National Museum.

ZYGOBOLBA RUSTICA n. sp.

Plate XLI, Figs. 28, 29

Description.—Length of the cast of the interior of a left valve 2.66 mm., height of same (across the median lobe, hence behind the midlength) 1.50 mm. Similar measurements of another cast of a left valve gave a length of 2.70 mm. and a height of 1.56 mm.

This species is closely allied to *Z. buttsi* and is found with it though much less abundantly. Except for its much greater size, it would be difficult to distinguish them. However, certain small differences in structure assist in assuring their distinction. Thus, the anterior dorsal angle is slightly wider, the hollow of the outer border somewhat narrower and deeper, and its edge correspondingly more erect and slightly thicker. Other differences also are to be noted in comparing the lobate areas within the border. The convexity of this is on the whole proportionately somewhat greater in *Z. rustica*. Besides, in casts of the interior, the ventral prolongation of the posterior lobe, which is otherwise similar in the two species, is commonly more distinct and the summit of the median lobe more uniformly convex in *Z. rustica*. Finally, the inner part of the anterior lobe (corresponding to the anterior arm of the U-shaped exterior crest) is thicker and never raised into a distinct ridge as commonly happens in *Z. buttsi*.

None of the other foregoing species is sufficiently like *Z. rustica* to require comparison.

Occurrence.—CLINTON. Near Frankstown, Pa., with *Z. buttsi*, which see for details.

Collection.—U. S. National Museum.

ZYGOBOLBA PULCHELLA n. sp.

Plate XLI, Figs. 25, 26

Description.—Length of a left valve of a male specimen 2.37 mm., greatest height of same 1.36 mm.

This also appears to be a close ally of *Z. buttsi*, agreeing in some respects even better with that species than does *Z. rustica*. Excepting that it is larger and the height proportionately somewhat greater, the outline is almost the same as in the former. The only other difference in outline observed in comparing casts of the interior is that the posterior edge is on the whole more nearly vertical. Judging from the remains of the border it seems to have been narrower than is the same feature on the two mentioned allies. Comparing casts of the three species, the rim, especially on the posterior side, is thicker, and the furrow between it and the contact edge shallower, in *Z. pulchella* than in the other two species. But the peculiarities chiefly relied on in differentiating *Z. pulchella* lie in the lobate area. The first of these concerns the median lobe which exhibits no suggestion of carination and is much less prominent than in the others. The anterior lobe also is less prominent and neither rigid nor particularly thickened in the part adjacent to the main sulcus. The latter, too, is shallower. Again, the post-ventrally curved lower extremity of the anterior lobe forms a low swelling beneath the median lobe that is fuller and causes a more distinct depression under the adjacent terminus of the posterior lobe than is commonly observable in either *Z. buttsi* or *Z. rustica*. Finally, the posterior lobe is less clearly defined and less prominent in its lower half but, on the contrary, as well or better developed in its dorsal extension.

Only a single valve of a female that may possibly belong to this species has been found. This, contrary to the rule prevailing in this family, is a

trifle smaller than the males referred to the species. Its dimensions are approximately the same as those of the females of *Z. buttsi*, one of which is illustrated in Plate XLI, directly above the figure of the specimen under consideration. The latter, as may be seen by comparing Fig. 20 first with Fig. 18 and then with Fig. 19, agrees in size and form fairly well with the female of *Z. buttsi* but differs decidedly in its much less distinct lobes and smaller as well as more rounded brood pouch. On the other hand its characters, aside from the matter of size, are precisely such as might be expected in the female of *Z. pulchella*.

Except the allies above mentioned, and perhaps *Z. obsoleta* a discussion of which follows, no other species referred to this genus is at all likely to be confused with *Z. pulchella*. Species of two other Clinton genera, however, might sometimes give a little trouble. Thus, casts of the male form of *Montigonellina vanuxemi* and *Zygonella vallata* occasionally resemble not only similar casts of *Z. pulchella* but also of *Z. rustica* and *Z. buttsi*. But the exteriors of these several species are so different and the form and position of the ovarian pouches in their respective females so at variance that this mere mention of possible confusion should suffice in averting it.

Occurrence.—CLINTON. Near Frankstown, Pa. Associated with *Z. buttsi*, which see for details.

Collection.—U. S. National Museum.

ZYGONOLBA OBSOLETA n. sp.

Plate XLI, Figs. 14, 15

Description.—Of this small species only two specimens, both left valves, have been found. In one of these the length is 1.66 mm., the height 0.88 mm.; in the other similar measurements gave 1.77 mm. and 1 mm.

The size and outline, likewise the contour of the surface of the anterior half, are practically the same as in casts of the interior of the associated *Z. buttsi*. But it is not certain that these specimens are merely casts of the interior. On at least one, if not both, the marginal portions retain what seem remnants of a ferruginous pseudomorph of the test. If so, then the interior surface of the carapace must be quite different in the two species. However, waiving this point, real differences are noted in com-

paring their posterior and median parts. The median lobe, for instance, is practically obsolete. The posterior sulcus, and consequently the posterior lobe, are both exceedingly obscure in one of the specimens and wholly unrecognizable in the other. Obviously, therefore, the approximately even convexity of the posterior wider half of the surface looks very different from the corresponding part of the valves of *Z. buttsi*.

These peculiarities being repeated in a second specimen, the probability of the suggestion that they might be due to some abnormality in development became too remote to be longer entertained. However, there yet remains a suspicion that the described appearances are caused by some as yet unappreciated physical peculiarity of preservation.

Occurrence.—CLINTON. Near Frankstown, Pa. It is there associated with many other Ostracoda, among them *Z. buttsi*, which see for further particulars.

Collection.—U. S. National Museum.

ZYGOBOLBA WILLIAMSI n. sp.

Plate XLI, Figs. 1-9

Description.—Measurements of greatest length and height in two typical males gave, respectively, 1.50 by 0.94 mm. for the right valve, and 1.59 by 0.95 for the left valve. Similar measurements of the two right valves shown in Figs. 2 and 7, and which are to be regarded as typical female examples of the species, gave 1.52 by 1.02 mm., and 1.54 by 1.09 mm. The original of Fig. 3 is more acuminate anteriorly and uncommonly high posteriorly, therefore more triangular in outline than is the typical form. Its length is 1.62 mm., its height 1.20 mm. Figs. 4 and 5 represent two varieties both with blunter antero-dorsal angles but otherwise departing in opposite directions from the typical form, the proportionate height being considerably less in the former whereas it is greater in the latter. Length and height in the two are, respectively, 1.62 by 0.91 mm., and 1.72 by 1.25 mm.

As above indicated, the material in hand is divisible into three varieties. A great majority of the specimens are of the form designated as typical. The low, relatively elongated variety is rare but the large and proportion-

ately short form is not uncommon. It is the last that reminds most of the previously described Anticosti species *Z. decora*, published by Billings under two names, the male form being called *Beyrichia venusta*, the female *Beyrichia decora*.

In the typical form of *Z. williamsi* the outline is dorsally truncated, acuminate-ovate, the anterior end tapering forward with a broadly convex curve beginning a short distance in advance of the middle of the ventral side and terminating at the sharply angular extremity of the straight hinge line. The ventral part of the outline is neatly rounded, the curve being somewhat accelerated as it passes into the posterior side. The posterior dorsal angle also is sharply defined but blunter than the anterior, the junction with the hinge line being a few degrees wider than a rectangle. Carried to extremes we have the form shown in Fig. 6 in which the outline has become more triangular through increased straightening of the curve in the antero-ventral third.

The form and other characters of the U-shaped crest, the slightly swollen median lobe, the small curved dorsal ridges, the border of the male carapaces, and the brood pouch of the females are all shown by the illustrations as well or better than they can be described. It will therefore suffice to point out some of the peculiarities which distinguish the species from others here described. Chiefly notable among these are the small curved ridges close to the dorsal edge. Something of this kind occurs in certain Anticosti species of the genus, like *Z. rectangula* and *Z. inflata*, but it is not so clearly developed. Still, such ridges do occur in a small early Silurian group of European species hitherto referred to *Beyrichia*, namely, the *Beyrichia interrupta* group of Ulrich and Bassler.[1]

The next important peculiarity is the acumination of the anterior end which is carried to an extreme in the typical variety of *Z. williamsi* far beyond that attained by any other species now referred to the genus. The nearest approximation in this respect is found in *Zygobolba buttsi* and *Zygobolbina emaciata* but, disregarding the distorted examples of the latter figured in Plate XLII, the differences are too obvious to cause

[1] Ulrich, E. O., and Bassler, R. S., Proc. U. S. Nat. Mus., vol. xxxv, p. 293, 1908.

difficulty in their discrimination. But this distinction does not hold good for the two varieties of *Z. williamsi* represented by Figs. 7 and 8 in which the anterior extremities are relatively blunt. The separation of these from species like *Z. buttsi* must, therefore, depend on comparison of other features.

A third peculiarity that greatly assists in distinguishing all three varieties of *Z. williamsi* from other species is the thin ridge or crest which forms the summit of the ovarian pouch of the females.

As the fourth characteristic we may count the rather general presence of small, irregularly distributed nodes on the outer slopes of the convex inner area of the valves. Their occasional apparent absence seems due to abrasion or imperfect preservation rather than to original non-development.

As above suggested near relatives of *Z. williamsi* seem to be among the members of the "group of *Beyrichia interrupta*." Of these *Beyrichia damesi* Krause,[1] an early Silurian species in the Baltic region, is the nearest of the European species. From this the present species is at once distinguished by its much more distinct border, thinner and more definitely U-shaped crest, and the in general lesser convexity of the lobate area of the valves. In consequence the valves of the American species suggest a degree of emaciation altogether wanting in its European ally.

Occurrence.—Found in great abundance in a green shale forming the top of the Dyer Bay dolomite at Clay Cliffs, about 2 miles west of Cabot Head, Ontario shore of Lake Huron, and in limestones along the southeast branch of Blanch River, north of Cobalt, Ontario. The specimens were submitted for determination by the collector, Dr. M. Y. Williams, and the species named for him in recognition of the excellent stratigraphic work being done by him in the Silurian rocks in Ontario and adjacent areas in the United States. Dr. Williams's Cabot Head collection includes four other species of Ostracoda which together are expected to have an important bearing on correlation problems now under active discussion in America.

Collection.—U. S. National Museum.

[1] Krause, Zeit. d. d. geol. Gesell., vol. xliii, 1891, p. 502, pl. 32, figs. 1-3.

ZYGOBOLBA (?) MINIMA n. sp.

Plate XLI, Figs. 10, 11

Description.—Length of left valve 1.07 mm.; height 0.70 mm. Only a few specimens of this species have been seen. These were found with remains of other Ostracoda in a thin bed of sandy shale about 57 feet above the base of the Clinton at Cumberland, Maryland. All the specimens are flattened by pressure and have their features yet further obscured by the sandy constituent of the matrix. They would scarcely be worth describing were it not that in Maryland fossils of any kind are rare in the lower 75 feet or so of the formation. In southern Pennsylvania, however, at least two if not three ostracod zones are indicated in the Lower Clinton beneath the horizon of *Mastigobolba lata*, and it was the hope of identifying one of these that persuaded the writers to work up the material from this lowest zone in the Cumberland section. Although this hope proved futile there has been some compensation in the discovery of evidence strongly indicating that the first of the Clinton deposits at Cumberland is considerably younger than are the lowest beds of the formation in certain much thicker Clinton sections in central Pennsylvania.

So far as may be determined from the material in hand *Z. minima*, though much smaller, appears to be rather closely related to *Z. williamsi*. This relation is suggested by the form of the U-shaped crest, by the characters of the border, and by faint indications of thin curved dorsal ridges. Apparently the flattening of the specimens has had no appreciable effect in the way of distorting the original outline. Assuming that the outline is still essentially normal, comparison with *Z. williamsi* shows that it is widely different. Considering the right side of the specimen, from which Figs. 9 and 10 were prepared, as posterior, it will be seen to be of less height than the anterior. Very much the opposite condition obtains in *Z. williamsi*. Even should the narrower end be the anterior, the differences in their respective outlines would still be more than obvious. But it is reasonably certain that the left half of this specimen corresponds to that part of the carapace and valves of all Zygobolbidæ and Beyrichiidæ that

has been consistently and unhesitatingly recognized as the anterior. It is unmistakably indicated: (1) by the identification of the more swollen or bulbous of the two arms of the U-shaped loop as the median lobe which lies, without exception, in these families precisely as in this specimen, that is, immediately *behind* the main sulcus; (2) by the identification of the posterior lobe in the low narrow ridge that runs nearly parallel with the right-hand border and between it and the median lobe—making a posterior lobe comparable in development to that found in species of *Zygosella*, like *Z. postica*, *Z. mimica*, and *Z. brevis*, in which the ends are so nearly alike in outline and lobation that their discrimination is determined chiefly by the position of the brood pouch; and (3) by the fact that the sharper of the two dorsal angles, which as a rule is the anterior, is on the left side of the specimen. On these grounds, therefore, it is decided to be a left valve.

Except *Z. williamsi* no other species now referred to *Zygobolba* seems near enough to *Z. minima* to require detailed comparisons. Its relatively small size together with the peculiarities in form and marking shown in the illustrations doubtless will suffice in distinguishing it.

Regarding its generic assignment some doubt must remain until female examples are discovered. These may show it to belong to *Zygosella*, the male forms of certain species of which it resembles quite as much as those of *Zygobolba*. Pending such possible discoveries it has seemed advisable to accord the greater weight to its apparent alliance with *Zygobolba williamsi*.

Occurrence.—CLINTON, in a bed of shaly sandstone lying 57 feet above the top of the underlying Tuscarora sandstone, in the section along Wills Creek at Cumberland, Md. Associated with it are *Beyrichia emaciata* n. sp. and *Plethobolbina cribraria* n. sp. As none of these species has been found elsewhere we cannot say precisely what the relations of this bed may be to the three main ostracod zones of the Lower Clinton. However,

the apparent probabilities suggest that it represents a sub-zone lying somewhere between the *Z. erecta* and *Z. anticostiensis* zones.

Collection.—U. S. National Museum.

ZYGOBOLBA BIMURALIS n. sp.

Plate XL, Figs. 1-10

Description.—Enlarged photographs of 20 specimens, including besides the types some doubtfully referred to the species, are reproduced. All of them are separated valves, half of the number being left valves, the others right, and half, again, of males, the others of females. These figured specimens include all the variations in form and size observed on the slabs containing the types and show practically all that is known of the species. Gutta-percha impressions representing the exterior of typical males are shown in Figs. 1 and 2. Also casts of the interior of three other typical examples of the male form are shown, one of them in Fig. 4 and two in Fig. 8 which includes also casts of right and left valves of females. A typical female right valve is shown in Fig. 4.

Figure 3 is of a possible variety that can be only doubtfully referred to the species because the U-shaped crest is too thin. It probably belongs to *Zygosella mimica* and would have been referred to that species if the more characteristic females of that type had been found with it.

There is some doubt also concerning the propriety of referring all the remaining nineteen specimens to one and the same species or at least without some nomenclatural qualification. In several of the figured specimens, notably the upper and lower of the three casts included in Fig. 6, the outline differs from that of the form regarded as typical of the species. The difference occurs chiefly in the antero-dorsal quarter, the hinge line being longer and its junction with the anterior margin sharply rectangular, and sometimes even narrower, instead of rounded or obtusely angular. Such specimens, particularly the males, closely simulate *Zygobolbina conradi*, there being considerable danger of confusion between them. Females of the two, however, are more easily separated, the brood pouch being on the whole larger and much less distinctly bilobed than in *Z.*

conradi. In fact the ventral extremity of the pouch is acuminate and does not merge with the base of the median lobe. Nor is it at all clearly separated by constriction from the main part behind it.

Were perfect specimens of these difficult fossils available for study sufficient grounds for specific distinction doubtless would be found. For the present perhaps the desires of the systematist may be satisfied by distinguishing the form in question as *Zygobolba bimuralis* var. *transitans*.

The average length of the male form of *Z. bimuralis* is about 2.3 mm. Only very rarely it is as much as 2.8 mm. The female form is larger, ranging in length from 2.9 to 3.5 mm.

In its general aspect the male of the typical form reminds greatly of such good species of *Zygosella* as *Z. postica* and *Z. mimica*, but considering the widely different locations and forms of the ventral pouches of their respective females it seems unlikely that the suggested affinities can be very close. On the other hand, neither the male nor the female of *Z. bimuralis* offers any valid reason for doubting its alliance with *Zygobolba*. Removal from this genus would be justified only to the extent of placing it into the genus *Zygobolbina*, a suggestion, or incipient development, of the bilobation of the brood pouch that alone distinguishes the species of that genus being as a rule readily discernible in *Z. bimuralis*.

The incipient bilobation of the brood pouch, the very slight development of the posterior lobe, the downward tapering of the median lobe making a sag in the U-shaped crest (best seen in casts of the interior), the flattening of the higher parts of the summit of the crest, and the thick border, together with various small peculiarities in outline and surface contour give a combination of characters that cannot be readily confused with any other species of the genus. Comparisons with species of *Zygobolbina* are given on following pages.

Occurrence.—CLINTON. One hundred and seventy-three feet above the Tuscarora sandstone at Cumberland, Md. Rare associates here are *Z. arcta*, *Zygobolbina conradi* and its variety *latimarginata*. Other localities are Cove Gap in Tuscarora Mountain 4½ miles northwest of Mercersburg, Pa., near Warm Springs, Va., and Cumberland Gap, Tenn.

Collection.—U. S. National Museum.

ZYGOBOLBA CURTA n. sp.[1]

Plate LXIV, Figs. 1, 2, Plate LXV, Fig. 27

Description.—Characterized by the short, truncated subcircular outline, rectangular antero-dorsal angle, the rather flat border and the relatively thin lobes.

Occurrence.—CLINTON. *Zygobolba anticostiensis* zone, Hagans, Virginia, where it is associated with some of the following species.

Collection.—U. S. National Museum.

ZYGOBOLBA ANTICOSTIENSIS n. sp.

Plate LXIV, Figs. 3-7

Description.—A widely distributed and usually abundant species, with somewhat longer valves, thicker and more prominent lobes, thicker and higher rim, and deeper concave border than *Z. curta*. Also related to *Z. decora* (Billings), the most common and characteristic of the species of the overlying Jupiter River ostracod zone, but differing in its shorter form, less unequal ends, longer posterior lobe and deeper as well as longer median sulcus.

Occurrence.—GUN RIVER FORMATION. Island of Anticosti, and in corresponding beds of the Lower Clinton at Cumberland, Maryland, and Hagans, Virginia.

Collection.—U. S. National Museum.

ZYGOBOLBA EXCAVATA n. sp.

Plate LXIV, Figs. 8-13; Plate LXV, Fig. 6 (?)

Description.—The extraordinarily wide and deeply excavated border and the steepness and evenness of the anterior slope are characteristic.

[1] The following brief descriptions of species from Anticosti Island, New York, and southwestern Virginia are added partly for the sake of completeness and to show the wide geographic distribution of these fossils, but mainly because of their decisive bearing on the correlation of the Maryland formations and zones of the Clinton group with the zones of the typical Clinton in New York.

These features, together with its larger size, the more broadly curved ventral part of the loop and longer posterior lobe and sulcus distinguish the species from the associated and supposedly nearest relative *Z. anticostiensis*.

The female form of the species has not been observed unless as we strongly suspect the specimen doubtfully referred to *Z. twenhofeli* (see Pl. LXV, Fig. 6) actually belongs here.

Occurrence.—GUN RIVER FORMATION. Island of Anticosti. CLINTON. *Zygobolba anticostiensis* zone, Cumberland, Maryland, Hagans, Virginia and also in the correlated Williamson shale, at Rochester, New York.

Collection.—Maryland Geological Survey.

ZYGOBOLBA PROLIXA n. sp.

Plate LXIV, Figs. 14-17

Description.—Easily distinguished from all other species of its zone by its large size, elongate outline, projecting antero-cardinal extremity, rather thin loop, and the low and broad swelling of the anterior slope. The brood pouch of the female is uncommonly small for a species of its size and situated wholly within the base of the elevated marginal rim. The latter is thinner and narrower and the outline different from that of the similarly large and otherwise allied *Z. robusta* of the overlying *Z. decora* zone (lower part of the Jupiter River formation). Other close allies are *Z. oblonga*, *Z. rectangula* and *Z. twenhofeli*.

Occurrence.—CLINTON. *Zygobolba anticostiensis* zone, Hagans, Virginia, Rochester, New York (Williamson shale).

Collection.—U. S. National Museum.

ZYGOBOLBA ROBUSTA n. sp.

Plate LXIV, Figs. 18, 19

Description.—Allied to *Z. prolixa* but has higher valves, thicker and more bulbous median lobe, the anterior limb of the loop more erect, a wider border and a much deeper and wider depression between the posterior lobe and the elevated border. In some of these respects the species

resembles *Z. excavata*, a Gun River species, but is readily distinguished by its larger size, more oblong shape, more convex anterior slope, and less carinate loop. Other closely related species are *Z. rectangula* which differs in outline and in having a longer loop, and *Z. twenhofeli* which has a thinner and narrower rim, more diverging loop and ventrally fuller posterior lobe.

Occurrence.—JUPITER RIVER FORMATION. Island of Anticosti.

Collection.—U. S. National Museum.

ZYGOMOLBA INTERMEDIA n. sp.

Plate LXIV, Fig. 20

Description.—This form is intermediate in most of its characters between *Z. excavata* and *Z. robusta*. However, it is somewhat shorter than either, the limbs of the loop are more nearly parallel and their passage into the connecting ventral part is more abrupt. Further, the ventral part of the outline is more convex and the anterior slope steeper and not broadly convex as in *Z. robusta*. In the latter respects it is like *Z. excavata* but the posterior lobe and sulcus are both narrower and the submarginal excavation is neither so broad nor so deep as in that species.

As *Z. intermedia* occurs associated with *Z. decora* at the two places where it has been found, collectors will be more concerned with its separation from that exceedingly abundant species than from the really closer allies with which it has been compared. In the collections now available *Z. intermedia* is much less common than *Z. decora*. The former also is a trifle larger. But the main and most constant as well as the most striking differences between them are in the shapes of their valves, the rate of divergence of the limbs of the loop and the strength and elevation of the rim. Thus in *Z. intermedia* the valves are relatively shorter and the loop longer, the limbs of the loop are more erect and subparallel and never diverge so much as in *Z. decora*, in which the loop commonly is more V-shaped than U-shaped, the ends of the valves are more nearly equal in height and the anterior end is never distinctly narrower than the posterior and the rim, especially on the ventral side, is not so thick nor so high as in *Z. decora*.

Occurrence.—JUPITER RIVER FORMATION, Island of Anticosti; CLINTON, *Zygobolba decora* zone near Alton, New York.

Collection.—U. S. National Museum.

ZYGOBOLBA RECTANGULA n. sp.

Plate LXV, Figs. 1-4

Description.—This species is characterized particularly by the length and vertical disposition of the limbs of the loop, the nearness of the base of the loop to the ventral border, the rectangular and strong antero-dorsal angle, thickness of the rim, the relatively strong inflation of the posterior limb of the loop and the unusual fulness of the ventral third of the anterior lobe. These characters will serve in distinguishing the species from *Z. robusta* in which also the depression between the posterior lobe and the elevated rim is larger. But *Z. twenhofeli* with which *Z. rectangula* is found in Anticosti is not so easily separated. The difficulty is occasioned mainly by the fact that there are two intermediate varieties one (Pl. LXV, Figs. 8, 9) having the antero-dorsal angle sharp and rectangular as in this species, whereas the other characters are as they should be in *Z. twenhofeli;* the other (Pl. LXV, Fig. 7) resembling *Z. rectangula* in the ventral reduction of the posterior lobe. In typical examples of *Z. twenhofeli* the anterior extremity of the hinge is somewhat obtusely angular, the rim is rather thin and the loop on the whole is thinner and its lower end farther removed from the ventral edge and the lower third or half of the posterior lobe further than in *T. rectangula.* The female form of the species has not been positively identified.

Occurrence.—GUN RIVER FORMATION, Island of Anticosti; WILLIAMSON SHALE. Rochester, New York; CLINTON. *Zygobolba anticostiensis* zone, Hagans, Virginia.

Collection.—U. S. National Museum.

ZYGOBOLBA TWENHOFELI n. sp.

Plate LXV, Figs. 5, 7-9 (?)

Description.—This species is approximately of the same size, associated with, and structurally most closely related to *Z. rectangula.* The two

exceed in size the average for the genus and are larger than all others of the family found in Anticosti. Its recognition on slabs of Gun River limestone therefore requires unusual care only in distinguishing it from *Z. rectangula* which commonly is found with it. Typical specimens of *Z. twenhofeli* are easily separated by the relative thinness of their rims, the inferior inflation of the posterior limb of the loop and the unusual fulness of the ventral third of the posterior lobe. As a rule, too, the limbs of the loop diverge more, the anterior limb especially being less nearly vertical than in *Z. rectangula*. The loop is also somewhat shorter and its ventral extremity farther removed from the edge of the valve. Unfortunately, the slabs containing the types of the two species also exhibit occasional specimens that fail in one or more respects to maintain the normal distinctions between the two. Three of these intermediate examples are figured in Plate LXV. In one (Fig. 7) the specimen is normal for *Z. twenhofeli* in every respect except that the ventral part of the posterior lobe lacks the fulness that it should have. The other two specimens are normal in this and all other respects except that the antero-dorsal angle is too sharp thus reminding of *Z. rectangula*. However, when specimens are many and all are conscientiously compared such departures from type are to be expected.

There is considerable doubt regarding the specific relations of the valve shown in Plate LXV, Fig. 6. Instead of its belonging to a female of this species as was believed when the plates were arranged, we are now strongly inclined to refer it to *Z. excavata* instead. The anterior slope in this valve is too steep for *Z. twenhofeli* and the outline in general also compares better with that of the male of *Z. excavata* than with this species. This doubt, considered in connection with the fact that the brood pouch in *Z. prolixa* and the following *Z. oblonga* is much smaller than usual in the genus, suggests that what is above referred to as the typical form of *Z. twenhofeli* (Pl. LXV, Fig. 5), may really be the female of the first variety (Pl. LXV, Fig. 7) which in that case would be the male of the typical form. It would mean only that the disparity between the valves of the two sexes is reduced to a minimum in this species.

Occurrence.—CLINTON. *Zygobolba anticostiensis* zone, GUN RIVER FORMATION. Island of Anticosti.

Collection.—U. S. National Museum.

ZYGOBOLBA OBLONGA n. sp.

Plate LXV, Figs. 10, 11

Description.—This species is very liable to confusion with *Z. prolixa*, both being large, nearly equal in size, and similar in general expression. However, when the outline is perfectly preserved it will be found that the antero-dorsal angle is less acute and the curve on either end of the ventral edge is more abrupt, the outline on the whole therefore being more oblong and relatively shorter than in *Z. prolixa*. But there is besides another difference that is mainly relied on in distinguishing the two species. Namely, in *Z. oblonga* the posterior lobe forms a thinner, less curved ridge that, moreover, is farther removed from the posterior limb of the loop. The two limbs of the loop also do not diverge so much, the anterior limb particularly appearing as more nearly vertical than in that species. Finally, the brood pouch is even smaller, scarcely exceeding half the size of the pouch on females of *Z. prolixa*. However closely allied, the two are not the same and with a little practice may be readily distinguished.

Occurrence.—CLINTON. *Zygobolba anticostiensis* zone, Hagans, Virginia, and Cumberland, Maryland.

Collection.—U. S. National Museum.

ZYGOBOLBA INFLATA n. sp. and variety RECURVA n. var.

Plate LXV, Figs. 12-27

Description.—This is a rather variable and usually small species the characterization of which seemed the more easily accomplished by profuse photographic illustrations of specimens than by detailed description. The holotype of the species is the large left valve shown in Plate LXV, Fig. 22. This shows it to be more closely allied to *Z. rectangula* than to any of the other species described in this work. Both have rectangular antero-cardinal extremities, a long loop with only slightly diverging limbs

and rather strongly inflated posterior limb, and broadly sloping anterior lobe. But the two certainly are not the same species, *Z. inflata* being constantly smaller, more delicate and emaciated in appearance, with thinner though high rim and ventrally less convex body. Longish specimens are represented by Figs. 19, 21, 24, 25 and 27; shorter examples by Figs. 12-14. Figure 26 is of the holotype of the var. *recurva* which differs from the typical form of the species in the lesser prominence of the dorsal angles. Other specimens of this variety are shown in Figs. 14-17 and 21. It should be observed also that, as is usually the case, the ridges appear thinner and sharper in the specimens that are preserved in shale than in the testiferous examples.

Occurrence.—GUN RIVER FORMATION. Island of Anticosti; CLINTON. Hagans, Virginia; WILLIAMSON SHALE, Rochester, New York.

Collection.—U. S. National Museum.

Genus ZYGOBOLBINA new genus

Beyrichia, part, and *Bollia* part, of authors.

This generic group is proposed for species conforming in general aspect, especially as regards the males, with *Zygobolba*. The only constant difference lies in the brood pouch of the female. This instead of forming a prominent and continuous semiovate or acuminate-ovate swelling covering the outer two-thirds of the post-ventral quarter of the valves, is unequally bilobed, the ventral part, which looks like a continuation of the post-median lobe, being more or less completely divided from the larger posterior part by prolongation of the posterior sulcus. The valves of the female carapace therefore have a distinctly different appearance from those of *Zygobolba*.

Genotype.—*Zygobolbina conradi* n. sp.

Only four species and one good variety having the required kind of brood pouch in combination with the lobation of the carapace prevailing in *Zygobolba* are as yet known. Of these the genotype, along with its variety *latimarginata* and *Z. emaciata*, occur in Middle Clinton zones. The other two, *Z. carinata* and *Z. panda* are from the Frankstown ore bed

in central Pennsylvania. The stratigraphic position of this bed is not certainly determined. It may lie either a little above or beneath the boundary between the Lower and Middle Clinton.

ZYGOBOLBINA CONRADI n. sp.

Plate XLIII, Figs. 1-11

Description.—Length 2.6 mm.; height, 1.75 mm. This is a rather large clearly defined species, the outline somewhat oblique but varying in this respect, the hinge straight, terminating at distinct angles, the anterior side dropping off vertically, the posterior outline more rounded, the ventral side broadly convex. The U-shaped ridge is thick and prominent, usually with a descending prolongation below that connects it with the strong marginal rim; the dorsal halves of its limbs project slightly beyond the hinge line and are slightly swollen this being so especially of the posterior limb. The posterior lobe is practically obsolete. Usually the females are larger than the males. The brood pouch is divided as it should be by prolongation of the posterior sulcus into a moderately prominent ovoid post-ventral lobe and a smaller swelling that looks like a ventral continuation of the posterior limb of the U-shaped ridge. The specimens found at Gate City, Virginia and at Arnuchee, Georgia, are smaller than the average for the species as found at localities in Maryland, Pennsylvania and New York. In other respects, however, there is no appreciable difference.

Valves of this species were figured and included with the same species as *Mastigobolbina* (*Agnostus*) *lata* by Hall in 1852. More recently Ulrich and Bassler having observed that Hall had included two quite distinct ostracods under the name "lata" provisionally referred to the second as *Bollia lata*. The facts in the case are fully discussed under our remarks on *Mastigobolbina lata* to which the reader is referred. Here it suffices to say that because of confusion likely to result from a second and altogether different usage of the term *lata* in this connection we have decided to propose the new name above employed.

Occurrence.—CLINTON, New Hartford, New York, localities in Pennsylvania, Cumberland, Maryland (120 feet above the Tuscarora sandstone), Gate City, Virginia, and Armuchee, Georgia. At most localities it is associated with *Mastigobolbina lata* and other species that like it seem to be confined to the zone to which the latter name has been applied.

Collection.—U. S. National Museum.

ZYGOBOLBINA CONRADI LATIMARGINATA n. var.

Plate XLIII, Figs. 12-19; Plate XLII, Fig. 1

Description.—The average size is somewhat greater in this variety than in typical *Z. conradi*. Besides there are various small but constant differences in structural details that probably would have warranted full specific separation. Of these differences the most striking and perhaps important is the greater width and deeper excavation of the hollow anterior and posterior borders. However, this feature is very notable only in molds of the exterior (*e. g.*, Pl. XLII, Fig. 1). On casts of the interior the height and extent of the border is not fully indicated so that these commonly resemble typical *Z. conradi* in greater degree. The outline, further, is relatively longer and more oblong, and the curve in the post-ventral part sharper and more produced. Finally, the U-shaped ridge is somewhat thinner and less prominent.

Occurrence.—Associated with and nearly as abundant as the typical form of the species at most of the localities in New York, Pennsylvania, Maryland and Virginia where the latter has been found. The best specimens were collected at New Hartford, New York, Reedsville, Pennsylvania and Cumberland, Maryland (120 feet above the Tuscarora sandstone). Two casts of the interior of left valves found in the Frankstown ore bed are doubtfully referred to this variety. The specimens are imperfect at their margins and in the absence of their counterparts in the matrix which would give us a more satisfactory conception of the outer surface of their shells it is impossible to decide positively whether they belong to this variety or not.

Collection.—U. S. National Museum.

ZYGOBOLBINA PANDA n. sp.

Plate XLIII, Figs. 20-22

Description.—Length 2.6 mm.; height, 2.0 mm. This species is characterized by its relatively short form, wide and rather shallow, undefined concave border and thin rather low but sharply crested U-shaped ridge. These features distinguish it, at once from *Z. conradi* which may be designated as its nearest relative. It certainly is farther removed from both *Z. conradi latimarginata* and *Z. emaciata*. The valves of the following *Z. carinata* with which it is associated at Frankstown, Pennsylvania, resemble it in that the U-shaped ridge is sharply crested but differs so greatly in its outline, erect border and much better developed posterior lobe that confusion between them seems quite unlikely.

Occurrence.—In the Frankstown ore bed, which lies near or at the top of the Lower Clinton one-half mile northwest of Frankstown, Pennsylvania. It is associated here with other species of ostracoda described in this volume.

Collection.—U. S. National Museum.

ZYGOBOLBINA CARINATA n. sp.

Plate XLII, Figs. 11-20

Description.—Length 2.6 mm.; height, 1.75 mm. Somewhat smaller than *Z. conradi* which it resembles in general outline though not exactly, its two ends more nearly equal. On critical comparison, however, it is found to differ in many respects. In the first place the posterior lobe is better developed in the male than in that or any other species now referred to the genus. Next, the U-shaped ridge is much thinner and surmounted by a thin crest of which no sign has been observed in *Z. conradi*. Something like this crest occurs in the associated *Z. panda* but that species differs so decidedly in other respects that further comparison between them is unnecessary. Another peculiarity of this species is the relative minuteness of the anterior division of the brood pouch. The larger division also differs from that of the other species of the genus in seemingly involving the whole of the posterior lobe in its swelling.

Many specimens of the species are before us. Each looks more or less different from the other, the variations depending upon the state of preservation. The more striking of these apparent differences are shown by the nine valves—five left valves, four right—figured on Plate XLII. The different appearances result from varying degrees in which the shell is wanting. In most of them the thin and highly elevated border is at least partly broken away. Three of them retain considerable parts of it. In most of the others the shell is wanting completely and only one retains the greater part. The last shows the crested character of the lobes.

Occurrence.—Frankstone ore bed, at or near the top of the Lower Clinton, one-half mile northwest of Frankstown, Pennsylvania.

Collection.—U. S. National Museum.

ZYGOBOLBINA EMACIATA n. sp.

Plate XLII, Figs. 2-10

Description.—Length, 2.75 mm.; height, 2.00 mm. Apparently a close ally of *Z. conradi* but easily distinguished by its thinner U-shaped ridge and generally more emaciated appearance. Separated valves occur in great abundance on certain bedding planes rather low in the Middle Clinton near the tollgate on the Cove Gap road from Mercersburg to McConnelsburg, Pennsylvania. Unfortunately the outline in nearly all of these specimens is more or less distorted by horizontal compression of the rock. As shown by the illustrations some are shortened, others lengthened, relatively, with every conceivable variation in form according to the ever varying angle at which the direction of pressure crossed the valves. The original form of the valves must have been something almost exactly between that of Figs. 2 or 6 on the one hand and Fig. 3 on the other. Accordingly, the outline must have been more oblique and the posterior end relatively wider than in typical *Z. conradi*.

Occurrence.—Lower part of Middle Clinton (*Zygobolbina emaciata* zone), near tollgate, Cove Gap, Tuscarora Mountain, 4½ miles northwest of Mercersburg, Pennsylvania. Also at Gate City and near Big Stone Gap, Va., and Cumberland, Md. Specimens doubtfully referred to the

species occur in the Frankstown ore bed near the top of the Lower Clinton, one-half mile northwest of Frankstown, Pa., and in the *Zygobolba erecta* zone of the Lower Clinton, 1½ miles southeast of Cherrytown, Pa.

Collection.—Maryland Geological Survey, U. S. National Museum.

Genus ZYGOSELLA new genus

The carapace of the male is essentially the same as in *Zygobolba* and *Zygobolbina*, but that of the female differs in the shape and position of the brood pouch. This forms a narrow ridge-like elevation lying on or closely paralleling the posterior border which it follows from the dorsal to the ventral edge. The posterior limb of the U-shaped lobe is always the straighter and more nearly vertical of the two, and it is by this means that the almost equal-ended valves may be determined as the right or left as the case may be.

Genotype.—*Zygosella vallata* n. sp.

Nine species and one variety of the genotype are known of this generic type. All occur in the Clinton deposits of the Appalachian region and all are described and illustrated in this volume. *Z. vallata* and its variety, *nodifera*, *Z. alta*, *Z. macra*, and *Z. cristata* occur in the lower half of the Upper Clinton; the others are found in various beds of the Middle Clinton.

In general aspect the valves of the males in this genus closely resemble those of species of *Bollia*. However, in *Bollia*, so far as known, the sexes are not distinguishable by characters showing on the exterior surface of the carapace. In *Zygosella*, on the contrary, the two sexes are conspicuously differentiated by the long and narrowly crescentic brood pouch on the posterior edge of the valves in the female form.

Zygosella is divisible into two groups, the one including *Z. vallata* n. sp. with one variety, *nodifera*, *Z. alta*, *Z. macra* n. sp., and *Z. cristata*, the other comprising *Z. postica* n. sp., *Z. gracilis* n. sp., *Z. limula* n. sp., *Z. minuta* n. sp., and *Z. brevis* n. sp. The two groups differ structurally in the form and width of the brood pouch, this feature being thinner and dorsally more incurved in the former than in the latter group. The two sets of species also hold different stratigraphic ranges, the *Z. vallata* group so far having been found only in Upper Clinton zones whereas the group

of *Z. postica* seems to be confined to Middle Clinton zones. Finally, the species of the older group are all smaller than those of the younger *Z. vallata* group.

ZYGOBELLA VALLATA n. sp.

Plate XLV, Figs. 1-3

Description.—Length, 3.00 mm.; height, 1.5 mm. In this species the two limbs of the V-shaped ridge are keeled and diverge considerably in dorsal direction, the outline is distinctly narrower in front than behind, the border is high, broad, and thick, and the median parts of the valves are largely sunken beneath its level. Casts of the interior which often retain little indicating the height and width of the flange-like border may look quite different from the exterior of the perfect shell. In these the V-shaped ridge also is much less prominent than on the outside of the valve, the slightly bulbous posterior limb alone standing out as a conspicuous elevation. The brood pouch forms a thin, narrow ridge on the inner slope of the raised border. As it nears the dorsal edge it curves forward until it approaches or quite reaches the dorsal extremity of the posterior limb of the yoke.

Occurrence.—Lower part of Upper Clinton. Though perfect valves of this species are not easily procurable it must yet be regarded as one of the most common and widely distributed ostracods of the *Mastigobolbina typus* zone. It has been found at Great Cacapon, W. Va., where it occurs about 20 feet beneath the Keefer sandstone. Also at Six Mile House and Stone Cabin Gap, Md., Hollidaysburg, Pa., Williamsville, Va., and other places where its zone has been searched for fossils.

Collection.—U. S. National Museum.

ZYGOBELLA VALLATA NODIFERA n. var.

Plate XLV, Figs. 7-10

Description.—Approximately of the same size as the typical form of the species, from which it differs mainly in having two or three small nodes

on, but near the base of, the inner slope of the anterior ridge. Of other small differences that may be observed on critical comparison of the illustrations it may be pointed out (1) that the limbs of the U-shaped ridge diverge in lesser degree, (2) that the brood pouch of the female is thinner, and (3) the dorsal angles are sharper than in the typical form of the species.

As this form seems to be confined to a lower zone than that in which typical *Z. vallata* is found and its peculiarities appear to be reasonably constant, we would perhaps have been warranted in describing it as a distinct species. However, we feel convinced of its ancestral relations to *Z. vallata* and for this reason believe it provisionally advisable to adopt the above classification.

Occurrence.—CLINTON. *Bonnemaia rudis* zone, near Six Mile House, Md., where it was found about 120 feet beneath the Keefer sandstone and at Williamsville, Va. Also with millions of *Bonnemaia rudis* at Mulberry Gap, Powell Mountain, 5 miles northwest of Sneedville, Tenn.

Collection.—U. S. National Museum.

ZYGOBELLA ALTA n. sp.

Plate XLV, Fig. 11

Description.—Length (male valve), 2.75 mm.; height, 1.75 mm. This species attains somewhat greater dimensions than any of its congeners. It was found with *Z. vallata nodifera*, with which it agrees in having two or three small nodes on the anterior slope of the depressed space between the limbs of the U-shaped ridge. However, in other respects the two forms are widely different. In fact the present species differs notably from all of its allies in the greater convexity of its valves and more prominent crested ridges. The posterior lobe, especially in the female, also is better developed than in other species excepting perhaps *Z. macra*. Further, the outline is more nearly elliptical and equal-ended and the border more erect and steeper on its inner slope. The brood pouch is thicker than in *Z. vallata* and its variety, this feature again being more as in *Z. macra*. After all, however, the characteristic that will be found the most service-

able in recognizing *Z. alta* is the uncommonly great thickness of its carapace.

Occurrence.—So far found only at Big Stone Gap in southwestern Virginia and on Powell Mountain (5 miles northwest of Sneedville) in northeastern Tennessee. At both places it is associated with *Bonnemaia rudis* less than 50 feet beneath the more or less eroded top of the Clinton. In this part of the Appalachian Valley the overlying *Mastigobolbina typus* zone commonly is either wanting entirely or retained only in part. The Keefer sandstone may be represented in a few places, but the *Drepanellina clarki* zone probably never so far down the valley.

Collection.—U. S. National Museum.

ZYGOBELLA MAGNA n. sp.

Plate XLV, Figs. 1, 4-6

Description.—Length (female), 3.1 mm.; height, 2.00 mm. This species is easily distinguished from *Z. vallata*, with which it occurs, by its slightly larger average size, more equal ends, the anterior being relatively higher, much less diverging limbs of the U-shaped ridge, more convex median areas and thinner border, the former appearing less sunken beneath the level of the latter. Further, the lowly convex areas on either side of the U-shaped ridge are fuller and the posterior one is wider. In most of these respects the species agrees better with *Z. alta*, but the maximum thickness of the carapace and valves is considerably less than in that species and the space between the limbs of the yoke much narrower. Moreover, the border does not rise so steeply as in that species. Finally, so far as observed, there are no such nodes on the anterior slope of the median sulcus as in *Z. alta* and *Z. vallata nodifera*.

Occurrence.—CLINTON. Found in considerable abundance associated on the same slabs with *Z. vallata* and *Mastigobolbina typus* at Williamsville, Va. Doubtless it occurs in this zone (*M. typus* zone) also in Maryland.

Collection.—U. S. National Museum.

ZYGOSELLA CRISTATA n. sp.

Plate XLV, Figs. 12-14.

Description.—Length, 2.5 mm.; height, 1.6 mm. This is a rare fossil but when found may be distinguished at once by its rather low but angular ridges and relatively short form. The ends are more unequal in height and the posterior half relatively higher than in any other species of its group. The limbs of the yoke diverge very slightly and are not very prominent, but the median areas generally are quite as convex as in *Z. macra*. The border is wide and broadly hollowed, particularly on the posterior side. But the feature on which we mainly rely in distinguishing the species from others of its group is the curved angulation or ridging of the surface of the incipiently developed posterior lobe. This low ridge joins the posterior limb of the yoke and between them outline a gently concave semi-elliptical space.

Occurrence.—CLINTON (*Mastigobolbina typus* zone), 29 feet beneath the Keefer sandstone, near Six Mile House, Md.

Collection.—Maryland Geological Survey.

ZYGOSELLA POSTICA n. sp.

Plate XLIV, Figs. 1-10

Description.—Length, 2.4 mm.; height, 1.4 mm. The males of this, like the other species of its group, might readily be mistaken for a species of *Bollia*. The outline is slightly oblique, the upper two-thirds of the posterior side sloping backward to a point where the outline turns rapidly forward into the broadly yet distinctly convex ventral side. On the anterior side the most prominent point is above the midheight. The U-shaped ridge is well formed and clearly defined, its posterior limb more nearly vertical and less curved than the anterior limb. The dorsal extremities are rather obtusely angular though clearly indicated, the rim is thick, moderately high and clearly defined. The brood pouch suggests an added ridge somewhat thicker and longer than the limbs of the median yoke. It extends upward to the post-dorsal angle from which its longi-

tudinal axis trends with slight anterior curve to and slightly beyond the post-ventral edge.

There is practically no danger of confusion between this and any of the previously described species. The disparity in size alone would prevent it.

Occurrence.—CLINTON. *Zygosella postica* zone, at Narrows, Va., Cumberland, Md., and other localities exposing its zone. Identified also from the *Zygobolbina emaciata* zone at Cove Gap, 4½ miles northwest of Mercersburg, Pa.

Collection.—U. S. National Museum.

ZYGOSELLA GRACILIS n. sp.

Plate XLIV, Figs. 11-14

Description.—Length, 2.75 mm.; height, 1.5 mm. This is associated with *Z. postica* at Narrows, Va., and was at first mistaken for its young, but closer examination revealed larger specimens and sufficient structural differences to soon establish its distinctness. The male valves always are more elongate, that is, comparing specimens of equal length the height in these is quite obviously less than in those. The ventral side of the outline also is straighter or rather less convex. In the female the axis of the brood pouch is more diagonal with respect to the long axis of the valve. It is also straighter and more sharply angulated on its inner side.

Occurrence.—CLINTON. New River, 1 mile west of Narrows, Va. (*Zygosella postica* zone) and at Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa. (*Zygosella emaciata* zone).

Collection.—U. S. National Museum.

ZYGOSELLA BREVIS n. sp.

Plate XLIV, Figs. 21-25

Description.—Length, 2.4 mm.; height, 1.6 mm. This doubtless is closely allied to *Z. postica* though showing decided relations also to the following *Z. mimica* and *Z. timula*. Its outline is relatively shorter than

in any of these and the convex curve of the ventral part is more pronounced. It is a rare fossil at all places except Cove Gap, Pa., where, however, all the fossils in the beds containing it have suffered more or less distortion by rock pressure. The supposed original outline is retained by a single right valve found at Cumberland, Md., on a bedding plane showing thousands of individuals of *Zygobolba bimuralis*. In this as in the Cove Gap specimens the posterior lobe is barely indicated by a low and narrow ridge lying close to the base of the posterior limb of the U-shaped ridge. It is more clearly indicated than in *Z. postica* but not so well as in *Z. limula* and *Z. mimica*.

Occurrence.—CLINTON. *Zygobolbina emaciata* zone near the tollgate in Cove Gap of Tuscarora Mountain, 4½ miles northwest of Mercersburg, Pa. A specimen occurring with *Zygobolba bimuralis* probably comes from a different though nearby zone at Cumberland, Md.

Collection.—U. S. National Museum.

ZYGOBELLA MIMICA n. sp.

Plate XLIV, Figs. 18-20

Description.—Length, 2.25 mm.; height, 1.37 mm. Another ally of *Z. postica* from which it differs in its outline, this being less oblique and less convex in the ventral part. On the whole, too, the form is relatively a little shorter or higher. A more important difference, visible, however, only in the males, is the much stronger and more definite development of the posterior lobe. This lobe is more strongly indicated than in any other species of the genus. In the female the brood pouch is larger than in *Z. postica* and its axis, except in its basal incurved and projecting part, almost perfectly vertical. The rim is well developed though not so thick as in *Z. postica*.

The next following species, *Z. limula*, probably is a closer relative of *Z. mimica* than the one with which we have compared it.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, Gap, 1½ miles northwest of Warm Springs, Va.

Collection.—U. S. National Museum.

ZYGOSELLA LIMULA n. sp.

Plate XLIV, Figs. 15-17

Description.—Length, 2.5 mm.; height, 1.5 mm. The specimens referred to under this designation indicate a species that seems more closely related to *Z. mimica* than to any of the others now known. However, it is distinguished readily enough from that species by its more ovate outline and more deeply and more broadly excavated border. In these features it reminds of *Z. alta* and *Z. macra*, but its dimensions are far inferior to either of those later species, whereas the thickness of its carapace is relatively much less than in the former and the excavation of the surface of the valves outside of the U-shaped ridge is much greater than in *Z. macra*. The brood pouch is of the type prevailing in the group of *Z. postica* and not like that marking the group of *Z. rallata*.

Occurrence.—CLINTON (*Zygobolbina emaciata* zone), Cove Gap, 4½ miles northwest of Mercersburg, Pa.

Collection.—U. S. National Museum.

Genus BONNEMAIA new genus

Very large Zygobolbinæ, commonly 4.0 to 6.0 mm. in length, the U-shaped ridge thick, its posterior limb often divided in its upper half by a short posterior sulcus, the anterior lobe usually crowned with a more or less sigmoidally curved angular crest. The development of the posterior lobe varies greatly in different species. In some, as in *B. obliqua* and *B. perlonga*, it is wanting entirely; in others, *B. celsa* for example, it is represented almost solely by a short spur trending downward from the post-dorsal quarter of the elevated border, or as in *B. rudis* and *B. longa*, by a barely perceptible elevation in the wide depression of the surface between the post-median lobe and the posterior part of the border. In yet others, like *B. crassa* and *B. oblonga*, it is present in full width in the convex inner area of the valves, leaving only a relatively narrow, deep excavation between it and the posterior border, but in these cases the lobe is only partly or indefinitely separated from the post-median lobe. Finally, as in *B. fissa* and *B. transita*, the posterior lobe is rather well

developed and clearly defined on its inner side by deepening and extension of the posterior sulcus to a length nearly equalling that of the larger and always well-developed median sulcus. Brood pouch essentially as in *Zygobolba*.

Genotype.—Bonnemaia celsa n. sp.

With the exception of *B. notha*, which was found in the *Mastigobolbina lata* zone of the middle Clinton, all the species referred to this genus are confined to the lower and middle parts—*Bonnemaia rudis* and *Mastigobolbina typus* zones, respectively—of the Upper Clinton. All of the eleven species and two varieties are new and described for the first time. So far the genus has been observed only in the Appalachian region, in which it ranges southward from Clinton, in central New York, through Pennsylvania, Maryland, West Virginia and southwestern Virginia into northeastern Tennessee. In this narrow but long area one or more of its species abounds at every locality that exposes the particular beds of the Clinton in which they occur. The several species therefore are to be counted among the most valuable of guide fossils. It is an interesting fact, the significance of which is not fully understood, that not a single specimen of this genus or indeed any member of its family has rewarded careful search in supposedly contemporaneous Red Mountain Clinton deposits in Alabama. The probable explanation of this absence is that the Upper Clinton of Pennsylvania and Maryland is not represented by marine deposits in that State.

The naming of this interesting and for various reasons highly important new genus after Dr. J. H. Bonnema of the University of Groningen is intended as a manifestation of our high regard for the quality of his work on Paleozoic ostracods of the Baltic region. As to differences of opinion between us regarding the proper orientation of the valves of Beyrichiaceæ we can only regret that they still exist.[3]

[3] The argument advanced by us in 1908 in our Revision of the Beyrichiidæ in support of our contention respecting the determination of which of the two valves is the right and which the left, or as to which end of the carapace is the anterior and which the posterior, seems no less valid to-day than then. Our argument was founded primarily on a natural assumption regarding the position of the brood pouch of the female in certain genera and deductions

The relations, systematic and genetic, of *Bonnemaia* to other genera are involved and difficult to express in words. Probably we can make no better start of the discussion than by stating our conviction that *Bonnemaia* is a possibly composite culminating expression of one or more closely originating subparallel lines of contemporary development out of species of *Zygobolba*. The genus thrived at a time when, and in a sea wherein other groups of the family, to wit, *Mastigobolbina* and *Plethobolbina*, also assumed larger proportions and developed certain features in common. Among the latter is the sigmoidally curved crest of the anterior lobe in *Bonnemaia* which is the homologue of the "whip-lash" of the Upper Clinton species of *Mastigobolbina* and *Plethobolbina cornigera*. But the carving of the crest commonly fails to reach the stage attained by the "whip-lash" and in some does not proceed beyond the stage reached by such of the Middle Clinton species of *Mastigobolbina* as *M. lata*. Another tendency, variously expressed in *Bonnemaia* but followed in common though along wholly separate paths with the last group *Mastigobol-*

based on correlations of corresponding parts in genera and species in which the two sexes are not similarly distinguished but some of which have an unquestionable eye spot that proves the anteriority of the end containing it. Regarding the pouch we held that it must be posterior in position and not anterior as it would be if Dr. Bonnema's view were the correct one.

In the course of the present investigations we have discovered and asserted the feminine sex of such pouch-bearing individuals of many different kinds of ostracods. Indeed, we found these pouches to be among the most reliable of generic characters and have therefore made extensive use of them in the systematic classification of the species. They occur in almost perfectly simple forms, like *Apetobolbina*, as well as in the complexly lobed types of which pouched individuals have been known a long time. In this connection it is important to note the fact that their position on the valves is maintained with gratifying constancy not only within the limits of each species, but also throughout the confines of large genera. Of yet greater significance is the fact established by thousands of observations that the whole or at least the greater part of the pouch lies in every instance to one and the same side of the middle of the valve; and this side is the one that on other grounds we have regarded as the posterior.

If this pouch has anything whatever to do with the generation or rearing of the young it is hardly conceivable that it could be developed on the anterior border or side of the valve. Yet this would have to be so for *Zygosella* and *Mastigobolbina*, in both of which it lies wholly within that half of the carapace that according to Dr. Bonnema's view would be the anterior.

bina, namely the group of *M. trilobata*, is the expansion of the lobes at the expense of the sulci and marginal furrow. One phase of this thickening of the lobes is shown in *B. transita*, other in *B. oblonga*, *B. crassa*, and *B. perlonga*.

That the species of *Bonnemaia* were derived out of *Zygobolba* and probably, at least in part, separately—meaning by this that the genus comprises the terminals of two or more subparallel lines of descent and not merely the rapidly established subdivisions of a single branch—is suggested by various facts. In the first place little argument is required to show the reasonable probability of the asserted development of *B. notha* out of *Zygobolba*. Aside from the considerable size of this species, a fact that helped materially in deciding our reference of it to *Bonnemaia* instead of *Zygobolba*, we need only to direct the attention of the reader to the similarities in structure that it exhibits to several fairly typical species of the latter genus. These are most clearly indicated by comparison of interior casts. Compare, for instance, the three casts—right and left male and a right female valve—shown in Fig. 7 on Plate XLVIII with similar casts of *Z. buttsi* figured on Plate XLII, and those of *Z. binuralis* given on Plate XLI. In essentials the lobing of the valves is practically the same in the interior casts of these three species. The features requiring particular emphasis in this connection are the elongate elliptical outline of the post-median lobe and the ventral decline or sagging of the summit of its neck-like lower extremity before it joins the ventral part of the U-shaped loop. But all the lobes are thicker in *B. notha* than in the species of *Zygobolba* with which we are comparing it; and therein lies the main reason for our conclusion that *B. notha* represents an early and possibly the first recognizable though as yet incompletely established introduction of the *Bonnemaia* type of structure developed out of a *Zygobolba* like those mentioned. Other reasons for the adopted generic assignment of *B. notha* are given in the specific discussion.

The next step in the evolution of *B. notha* might very well be that which we have called *B. obliqua*. At about the same time its line may have split to give rise to a form like *B. transita grandis*; and by departure in somewhat different directions it may have produced forms like *B. oblonga*

or even *B. crassa*. But species like *B. rudis*, *B. fissa*, and *B. putchella* seem to us as having rooted in other species of *Zygobolba* than the one out of which *B. natha* was developed.

The relations to *Mastigobolbina*, which may seem clear enough when we take into consideration mainly such forms as *B. fissa* and *B. transita*, are in fact much less clear than they appear at first. It was this first impression that suggested the latter name for the species that seemed most clearly to indicate some kind of transition from the more typical species of *Bonnemaia* to those of *Mastigobolbina*. In fact, that first impression was so strong that if of the considerable group of species that we have brought together under the generic term *Bonnemaia* all the others had remained undiscovered, we would have experienced no misgivings in referring the species *transita* without question to *Mastigobolbina*. However, the discovery of these other species disclosed alliances that without them could not have been suspected. With them we reach a point where we are almost ready to deny that the apparently close relations of *B. transita* to certain of the known species of *Mastigobolbina* are in any wise direct or orthogenetic.

Taking only such typical species of *Mastigobolbina* and *Bonnemaia*, as *M. typus*, *M. arguta*, and *M. intermedia* and *B. celsa*, *B. rudis*, *B. longa*, and *B. oblonga*, none could doubt the absolute generic distinctness of both the male and female forms of the two types. But we distinguish and refer to *Mastigobolbina* no less than 23 species and named varieties and to *Bonnemaia* 11 species and 2 varieties. Naturally these numbers include, particularly among the earlier ones, a few too many species of each that differ more or less decidedly from their respective genotypes; and among these again there are some that judged empirically would probably be given a different generic position from that assigned to them by us. *B. transita* may be cited as one of such species. The only difference of possibly generic significance between it and such a species of *Mastigobolbina* as *M. trilobata*, or even *M. tripticata*, is the relative shortness of the sulci, especially the posterior one. In all species referred to *Mastigobolbina* the posterior lobe, whether narrow or wide, is a persistent feature and the posterior sulcus is sharply defined and long and either divides the

posterior lobe completely from the confluent bases of the median and anterior lobes or it leaves only a narrow ventral contact with the other lobes. In species of *Bonnemaia*, on the contrary, the posterior lobe varies greatly in development. In some species (*e. g.*, *B. obliqua* and *B. perlonga*) it is quite obsolete; in others only its middle and lower parts are wanting (*e. g.*, *B. celsa*); in yet others it is obsolete and the posterior sulcus, if it is distinguishable at all, never extends as a well-impressed furrow beyond the mid-height of the valve. In two otherwise very different species, namely, *B. pulchella* and *B. oblonga*, a very shallow continuation of the sulcus extends downward to or slightly beyond the lower extremity of the median sulcus.

In deciding the generic assignments in the several instances we have been guided, of course, primarily by the characters of the specimens. But in a considerable number of cases this basis alone failed to lead to satisfactory conclusions. In these then we depended mainly on obvious or more or less probable genetic alliances as indicated by detailed comparisons of particular and general characters. Thus, for instance, in determining the generic position of *B. transita*, *B. pulchella*, and *B. fissa*—the first of which reminds in general aspect of species of *Mastigobolbina* like *M. trilobata*, the second in some respects of species like *M. declivis* and *M. lata*, in others like *M. intermedia*, the third also of species like *M. intermedia*—we found that each could be brought by transitional forms into closer relations to typical species of *Bonnemaia* than to the species of *Mastigobolbina* with which they might otherwise have been associated.

The closeness of the relations of *B. transita* to *B. pulchella* and of the latter to *B. celsa*, the genotype of *Bonnemaia*, will, we believe, be appreciated at once. It is indicated not only by similarity in general aspect but also by comparison of details of the lobing of their respective valves. At least it must be admitted that the relations between the mentioned three species are more conclusively indicative of actually genetic affiliations than are those that suggest alliance of *B. transita* and *B. pulchella* with *Mastigobolbina trilobata* and *M. declivis*, respectively.

In like manner we find that the simulation of *Bonnemaia fissa* and *Mastigobolbina intermedia* is more apparent than genetically real. The flattening of the surface of the lobes that obtains in the former but not at all in the latter is a feature more commonly pertaining to species of *Bonnemaia* than of *Mastigobolbina*. In the latter genus it is markedly developed only in *M. lata* and *M. declivis*—both of them rather untypical species—whereas in *Bonnemaia* it is well developed in *B. celsa*, *B. crassa*, *B. longa*, and *B. oblonga* besides *B. fissa*. Then one has only to try to separate many specimens of *B. fissa* and *B. rudis*, the latter an unquestionable *Bonnemaia*, to realize that these two species are congeneric and in fact more closely allied than one may think from comparison of figures only. In other directions also the generic alliance of *B. fissa* with more typical species of *Bonnemaia* is clear. Compare it, for instance, with *B. longa* figured on the same plate and with *B. oblonga* on Plate XLVIII.

Finally, as regards *B. pulchella*, we are thoroughly convinced that its simulation of *M. declivis* and *M. trilobata* is to be viewed as a relatively fortuitous family resemblance rather than as indicating true genetic relations and that it is overbalanced in systematic significance by the resemblance it bears to so typical a species of *Bonnemaia* as *B. longa*.

BONNEMAIA CELSA n. sp.

Plate XLVI, Figs. 1-6

Description.—Length, 3.5 mm.; height, 2.4 mm.; greatest thickness (through anterior edge of anterior lobe), 1.4 mm. Outline slightly oblique, the posterior half usually a little wider than the anterior, the hinge straight but rather short, the dorsal outline more or less broken by projecting lobes, the cardinal extremities obtusely angular, the ends and ventral side distinctly convex; border thick and high. The median sulcus is deep, rather narrow and extends half across the valves. The U-shaped median lobe is thick, obliquely flat-topped, very high and angular on the anterior side which drops off abruptly into the depression between it and the elevated border. This depression is widest near the middle of the posterior half and above its widest part is constricted by a vertical spur-like projection from the inner side of the elevated border.

This spur represents the sole remnant of the posterior lobe of Beyrichiacea. The sharp-edged summit of the anterior lobe makes a broad anterior curve —somewhat more sharply arcuate than the anterior outline—but as it nears the dorsal edge the direction of the curve is reversed so that the ridge here points directly across the transverse axis. The resulting slightly sigmoid crest represents the flagellum of *Mastigobolbina*.

The nearest allies of this species are *B. crassa* and *B. obliqua*, which see for comparisons.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, Flintstone, Md., 32 feet beneath base of Keefer sandstone; Cumberland, Six Mile House, and Stone Cabin Gap, Md., 1½ miles east of Great Cacapon, W. Va., where it is found 23 feet beneath the Keefer; also at Williamsville and Big Stone Gap, Virginia.

Collection.—Maryland Geological Survey, U. S. National Museum.

BONNEMAIA CRASSA n. sp.

Plate XLVI, Figs. 7-9, and Plate XLVIII, Fig. 19 (?)

Description.—Length of average specimen, 3.0 mm.; height, 2.0 mm.; greatest thickness of single valve, 1.15 mm. A close ally of *B. celsa* with which it is associated but readily distinguished by its smaller size and structural differences. The general outline and border are much the same in the two species, but the lobed inner area is so extensive in *B. crassa* that it leaves relatively a much narrower depressed zone between it and the border. The posterior ridge instead of forming a mere spur on the border is joined to the median swelling from which it is partly separated by a sharply defined short cleft in the post-dorsal quarter. The median sulcus is a trifle shorter, appears more oblique and flares more, especially on the posterior side, as it opens on the dorsal edge. Finally, the anterior lobe, though thick and high, lacks the sharp crest which bounds its anterior side in *B. celsa*. In consequence the surface of the anterior lobe lacks also the characteristic flatly sloping top. The difference in the latter respects are clearly notable in comparing ventral views of the two species (*e. g.*, Pl. XLVI, Figs. 5 and 9). Of the following species *B. oblonga* may be classified as intermediate between *B. crassa* and *B. celsa*.

it has the crested anterior lobe of the latter but in all other respects agrees better with the former.

The specimen represented by Fig. 19 on Plate XLVIII is doubtfully referred to this species. It is unusually large and in some of its features suggests *B. oblonga* rather than *B. crassa*. Such a feature is the crest on the anterior lobe, but this is not prominent enough for either *B. oblonga* or *B. celsa*. The ventral three-fifths of the posterior lobe also is somewhat thick and thus reminds of *B. oblonga*. But the complete coalescence of this part with the lower half of the median lobe points so obviously to *B. crassa* that taken in connection with the other similarly trending features we cannot deny its close and probably conspecific relations to *B. crassa*.

Occurrence.—CLINTON. (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1¼ miles east of Great Cacapon, W. Va., and at Stone Cabin Gap, and Cumberland, Md.; also at Big Stone Gap, Va.

Collection.—Maryland Geological Survey.

BONNEMAIA OBLONGA n. sp.

Plate XLVIII, Figs. 14-18

Description.—Length of average left valve of male of typical form (Figs. 14 and 15), 3.9 mm.; height of same, 2.5 mm. The female is larger, attaining a length of 4.75 mm. The outline is more oblong, less equal-ended, and less convex on the ventral side than in *B. crassa* and *B. celsa*, both of which—the former, however, much more than the latter—resemble *B. oblonga* in the characters of the lobed inner area. Compared more critically with *B. crassa* the present species is found to differ in several parts of the lobed area. The anterior lobe, for instance, is more distinctly carinated—somewhat as in *B. celsa*, only not so prominently. The lower part of the median lobe also is more clearly indicated and defined by a shallow depression from the posterior lobe, the lower half of which forms a rather prominent and wide swelling or plateau even in the male. In the female the shallow depression mentioned is largely obscured by encroachment of the brood pouch. The median lobe is somewhat irregularly pyriform in outline, the irregularity being mainly in the middle

part of the posterior side where the deeply impressed dorsal half of the posterior sulcus ceases and thence passes into its shallower ventral continuation.

The outline of the valves of *B. oblonga* is not greatly different from that prevailing in *B. obliqua*, but, as is pointed out in discussing that species, the bases of the lobes are broader than in that species. Other rather close allies are *B. transila*, *B. fissa*, and *B. longa*.

Occurrence.—CLINTON (*Mastigobolbina typus* zone), 29 feet beneath Keefer Sandstone, Sir Johns Run, Md., one mile southeast of Big Stone Gap, Va.

Collection.—Maryland Geological Survey.

BONNEMAIA OBLIQUA n. sp.

Plate XLVI, Figs. 10-13

Description.—Length, 4.75 mm.; greatest height, 3.25 mm. The outline in this species is somewhat obliquely oblong and usually not materially different from that commonly found in *B. oblonga*, which may be set down as its closest known ally. There is, however, a tendency to increase both the degree of obliquity and the inequality in height of the ends over the average in these respects observed in that species. As a rule therefore the post-ventral quarter of the outline is slightly more produced in *B. obliqua* than in *B. oblonga*.

However, more constant and also more important differences are found in comparing the lobes of the two species. To begin with, the ventrally confluent lobes are not so broadly based so that the depressed or rather the concave area lying between their summits and the base of the elevated margin is wider than in that species. Further, there is no clearly defined posterior sulcus and consequently no convex part of the surface that may be confidently correlated with the rather well-developed posterior lobe of *B. oblonga*. Finally, the median sulcus is narrower and more nearly parallel-sided, and the median lobe is correspondingly more erect. In fact, its axis intersects the hinge line at practically a right angle. Because of these distinctions profiles of the valves of the two species are notably different. Other close allies are *B. fissa* and *B. longa*.

Occurrence.—CLINTON. *Bonnemaia rudis* zone at Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn., Wills Creek, Cumberland, Md., and state line east of Rickard Mt., Williamsport quadrangle, Md.

Collection.—U. S. National Museum.

BONNEMAIA FISSA n. sp.

Plate XLVII, Figs. 7-9

Description.—Length of average male, 3.0 mm.; height, 2.13 mm. This is a smaller species than *B. oblonga*, *B. obliqua*, *B. transita*, and *B. rudis*, to each of which it exhibits close alliance in one or another respect. It agrees with the first in having a well-defined deep posterior sulcus, but this sulcus is longer than in that species, extending nearly as far across the valves as does the median one. The general outline also is much the same in the two, though the ventral edge commonly is less convex in *B. oblonga* than in the present species. Even more striking differences are noted in comparing the lobes. In *B. oblonga* these have such wide bases that they occupy a much greater proportion of the area lying within the elevated border. In *B. fissa* the lobes are relatively much thinner and the angular crest of the anterior lobe curves more strongly forward as it turns upward from its ventral part and then recurves so as to make a distinct sinus in its course to the dorsal edge. Further, the lower half of the posterior lobe is much narrower and the depressed area behind it much wider than in *B. oblonga*. In view of these many and in part conspicuous differences it seems quite unlikely that anyone will experience much trouble in separating these two species. Valves of their females are similarly and on the whole hardly less different than the males.

The main lobes are as narrow in *B. obliqua* as in *B. fissa*, but the lack of anything like a well-developed posterior lobe or a posterior sulcus in the former is a sufficiently striking difference to distinguish the two at a glance. Detailed comparisons of course reveal other differences.

Discriminating comparisons with *B. rudis*, *B. transita*, and *B. pulchella* will be found on following pages devoted particularly to their several discussions.

Occurrence.—CLINTON. *Bonnemaia rudis* zone, Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.

Collection.—U. S. National Museum.

BONNEMAIA RUDIS n. sp.

Plate XLVII, Figs. 1-6

Description.—Length, 3.5 mm.; height, 2.6 mm. The male valves of this species remind somewhat of *B. celsa*, on the one hand, and *B. fissa* on the other. They are distinguished from the former at once by their much thinner and less prominent lobes and correspondingly wider and longer median sulcus. The constancy of these differences is attested by comparisons of many specimens of each and the fact that none of either suggests any sort of transition between them. The exceeding abundance of specimens of *B. rudis* is clearly indicated by the small part of a slab shown in Fig. 5.

B. fissa occurs less abundantly on the same slabs with *B. rudis*. The separation of the two is not always easily accomplished for the reason that their respective peculiarities often are obscured by breakage or imperfect separation of the interior casts from their exterior molds. The matrix is a soft sandstone and the space formerly occupied by the shell itself is now filled with a more or less rotted ferruginous pseudomorph. Therefore, in splitting the slabs the plane of cleavage may pass through or along either the inner or outer surface of the filling. When clean and perfect molds of the exterior are available and good impressions of these have been made in gutta percha or clay the difficulties of accurate separation of the two species have been largely overcome. Comparison of such impressions (see Plate XLVII, Figs. 1 and 3 on the one hand and 7 and 9 on the other) shows that the main structural difference between the two lies in the fact that whereas in *B. fissa* both the posterior sulcus and the posterior ridge are clearly defined and uncommonly well developed for the genus neither is clearly indicated in *B. rudis*. Moreover, in the latter the lobes commonly show irregularities suggesting a rough unfinished appearance that is quite foreign to the more neatly constructed

B. fissa. As a rule, too, the height of the valves in the present species is relatively greater, the lobes are more prominent and more convex and without the notable flattening of their summits and the sharpness of their sides that pertains to *B. fissa*. Finally, the average size of the males is appreciably greater than in that species.

B. rudis is related also to *B. obliqua* but never attains the size of that species. This together with obvious differences in their respective outlines and in the position of the anterior lobe with respect to the anterior edge of the valve makes the task of separating these two species uncommonly easy.

Occurrence.—CLINTON. *Bonnemaia rudis* zone, Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn., and at Big Stone Gap, Va.

Collection.—U. S. National Museum.

BONNEMAIA PULCHELLA n. sp.

Plate XLVIII, Figs. 1–4

Description.—Dimensions of the holotype, a right valve: length, 3.5 mm.; greatest height, 2.5 mm. The valves in this neat species are shorter and, except on the straight dorsal side, more rounded in outline than in any other species of the genus. The cardinal angles are sharp and slightly produced, the sigmoid crest of the anterior lobe is well defined and hooks forward as it approaches the dorsal edge, the anterior slope is gently convex but on the whole descends steeply, the border is wide and clearly defined, the depression within it distinct, narrow on the anterior and ventral sides and much wider but not so sharply defined on the posterior side. The median sulcus is deep, rather long and of moderate width, the post-median lobe is prominently convex, elliptical in outline, narrowing distinctly in its ventral part, the posterior sulcus just behind it is a shallow, the posterior ridge low, not well defined in the middle of its straight posterior side but more clearly limited below and again above where it joins the elevated border which here curves forward toward the dorsal extremity of the post-median lobe, passing well within the produced dorsal angle.

This species doubtless is closely allied to *B. transita* and perhaps less intimately also to *B. fissa*. As all three of these species often occur associated on the same slabs some care is required in distinguishing them. *B. pulchella* differs from the other two in its more rounded outline and more prominent dorsal angles. Further comparison with *B. transita* will be found in following descriptive notes on that species. Regarding its relations to *B. fissa* we may add here that the outline is not only more rounded but the height is relatively much greater and the height of the two halves more nearly equal. A more important difference concerns the posterior sulcus which is much deeper and better defined in that species but ceases abruptly before attaining the length of the median sulcus. In *B. pulchella*, on the contrary, it extends in its characteristically shallow manner to beyond the terminus of the median sulcus. Further, the surface of the lobes is less convex in that species and the course of the crest of the anterior lobe is materially different. Namely, in *B. fissa* it does not form a sigmoid curve, the dorsal half of its extent being almost straight. Moreover, the lower curve of the crest occurs farther down and is sharper.

B. rudis also is associated with this species and like it has uncommonly short valves. Still the two are so different in other respects that, providing good specimens are at hand, confusion between them seems altogether unlikely.

Occurrence.—CLINTON. *Bonnemaia rudis* zone, Wills Creek, Cumberland, Md. Somewhat smaller specimens were found in the same zone in Mulberry Gap, Powell Mountain, 5 miles northwest of Sneedville, Tenn. At this place the *B. rudis* zone lies at the top of the Clinton section.

Collection.—U. S. National Museum.

BONNEMAIA TRANSITA n. sp.

Typical variety, Plate XLVIII, Figs. 8-11; var. *grandis*, Plate XLVIII, Figs. 12, 13; var. *transversa*, Plate XLVII, Fig. 13

Description.—Length of right valve of typical form, 2.5 mm.; greatest height of same, 1.75 mm.; length of another right valve of typical form in which the height of the anterior and posterior halves is more

nearly equal, 2.6 mm.; greatest height of same, 1.75 mm.; length of left valve of var. *transversa*, 3.13 mm.; height of same, 1.75 mm.; length and height of a right valve of var. *grandis*, 4.6 mm. and 3.13 mm., respectively.

We distinguish three forms of this species. First the typical form represented by Fig. 9. With it we include some slightly longer specimens like Fig. 10. The latter approaches the var. *transversa* in which the length is relatively greater, the anterior part of the outline less convex and the median sulcus somewhat wider than in the typical variety. The third variety, for which the subordinate designation *grandis* is provisionally proposed, occurs in a higher zone than the others. It differs from them in its much greater size, narrower posterior sulcus, wider post-median lobe and the higher position of the anteriorly curved part of the crest of the anterior lobe. If these peculiarities prove reasonably constant it would be well to raise its rank to that of a distinct species.

In the following discussion the references to *B. transita* are mainly concerned with the typical variety of the species.

The close relations of this species to *B. pulchella* was mentioned in the preceding description of that species. As a rule the valves of the present species are smaller than those. Their height also is proportionally inferior. However, the difference mainly relied on in distinguishing the two lies in the posterior lobe as developed in males. In *B. transita*, namely, the posterior lobe is more definitely separated from the post-median lobe, this being brought about by greater depth of the posterior sulcus. Moreover, the posterior lobe is thicker, especially in its lower half, is more clearly defined on its posterior side, and occupies much more of the space between the post-median lobe and the elevated posterior border. Besides, it extends through to the dorsal edge and does not, as in *B. pulchella*, join the elevated border at some considerable distance beneath the dorsal edge. In consequence of these facts the furrow between the posterior lobe and the elevated border is not only narrower and deeper but extends as a narrowing channel quite to the dorsal edge. Finally, the posterior dorsal angle is not produced, as in *B. pulchella*, beyond the incurving post-dorsal extension of the elevated border. In all other respects the two species are practically the same.

In certain features *B. transita* occupies an intermediate position between *B. oblonga* and *B. fissa*. This is true particularly of the relative development of the posterior sulcus. In *B. transita* this sulcus is moderately deep and nearly as long as the median sulcus, in *B. fissa* it is deeper and, because of the flattened tops of the adjoining lobes, its sides are sharper. In *B. oblonga*, on the other hand, this sulcus is moderately deep only in its upper third, the middle and lower parts, the latter of which, moreover, extends beyond the lower end of the median sulcus, being very shallow. On further comparison with *B. oblonga* we find that the outlines of the valves of *B. transita* are more rounded, the hinge-line being shorter, the dorsal angles less prominent, and the border around the ventral half more uniformly curved. Further, the surface of the lobes is more convex with scarcely a suggestion of the broad flattening of their summits that pertains to *B. oblonga*. The course of the crest of the anterior lobe also is decidedly more curved, while the furrow between the posterior lobe and the border is not only less sharply defined and shallower but also it runs through above to the dorsal edge instead of being cut off as in *B. oblonga* by confluence of the posterior lobe with the elevated border. Various other differences may be observed in critical comparisons of figures of the two species.

The female forms of *B. fissa* and *B. pulchella* have not been recognized. Hence, comparisons of these with that of *B. transita* cannot as yet be made. The pouch of the female regarded as belonging to *B. transita* presents the almost unknown feature in both *Bonnemaia* and *Mastigobolbina* of failing to extend outwardly across the border. A narrow groove divides its outer limits from the top of the elevated border. The pouch forms a large depressed hemispheric inflation of the posterior half of the valve, reaching well up toward the dorsal angle, though falling short of it, and looking so that it is liable to be mistaken for a large posterior lobe. A similar brood pouch has been observed only in the otherwise peculiar species to which we have applied the name *Mastigobolbina ? bifida*. Though widely different in other respects it is of interest to note that the two species in which this kind of pouch occurs are associated in the same bed in northeast Tennessee.

Further comparisons with *B. fissa* might be desirable only because it is found in the same zone. However, the differences between them, particularly as regards the form and details of structure of the lobes and furrows, are so clearly indicated in the illustrations on Plates XLVII and XLVIII that they are believed unnecessary.

As stated in the preceding generic discussion this species was given the name *transita* because it seems to us to combine in a marked degree the characters of *Bonnemaia* and *Mastigobolbina*. In that discussion we have set forth the reasons that induced us to refer it and certain other species to *Bonnemaia* rather than *Mastigobolbina*.

Occurrence.—CLINTON. The typical variety is found rather abundantly in the *Bonnemaia rudis* zone in Mulberry Gap of Powell Mountain, 5 miles northwest of Sneedville, Tenn. The variety *transversa* occurs in the same bed and place but seems a rarer fossil. The variety *grandis* was found associated with *B. oblonga* in the *Mastigobolbina typus* zone of the upper Clinton, 29 feet beneath the Keefer sandstone at Sir Johns Run (Devils Nose), Md.

Collection.—U. S. National Museum.

BONNEMAIA LONGA n. sp.

Plate XLVII, Figs. 10 and 11, 12 (?)

Description.—Dimensions of holotype, a right male valve: Length, 4.13 mm.; height, 2.5 mm. Good exteriors of the male form show that this is a well-marked and fairly typical species of *Bonnemaia* with rather close though not very obvious relations to *B. celsa* and *B. obliqua* on the one hand and *B. perlonga* on the other. Compared with *B. celsa* the outline of the valves is so distinctly more elongate and more nearly equal-ended that one sets them apart on the first casual glance. This conclusion is substantiated when further comparison discloses many other differences, among them the more decidedly sigmoid course of the angular crest of the anterior lobe. This crest, namely, turns rather sharply forward as it nears the dorsal edge and more broadly though even farther

forward in the opposite—ventral—direction; and it is nearly or quite as high and the surface descends in anterior direction no less abruptly than in *B. celsa*. In fact, the anterior slope of this lobe is more concave than in that species. The posterior sulcus and lobe are both very imperfectly developed. Even the spur-like projection from the dorsal quarter of the posterior border that constitutes the main representative of the posterior lobe in *B. celsa* is practically absent in *B. longa*.

B. longa is further removed from *B. obliqua* in which the posterior half of the valves is relatively much higher and the outline on the whole therefore much more oblique. The lobes in that species also are narrower, the median sulcus is correspondingly wider and the concave spaces of the surface both fore and aft of the lobes are more depressed and usually appear wider.

The relations to *B. perlonga* are discussed in the following notes on that species. The real types of *B. longa* were found along Wills Creek in the city of Cumberland, Md. A few specimens of the same or a but slightly different form were observed in the *B. celsa* zone on Powell Mountain near Sneedville, Tenn. Two of these, a male and a female, are included in the small part of the surface of a slab shown in quadruple magnification on Plate XLVII, Fig. 5. Unfortunately, none of these Tennessee specimens show the exterior surface so that we cannot decide positively whether they are strictly conspecific with the Maryland types of the species or not.

Other specimens that may belong to this species were found in a higher zone of the Upper Clinton at Sir Johns Run, Md. These, too, we regret to say, are not in satisfactory condition, the valves being more or less distorted and crushed in the shaly matrix. One of these specimens—the left valve of a female—is shown on Plate XLVII, Figs. 11 and 12. These figures differ enough from that of the holotype, Fig. 10, the right valve of a male, to warrant hesitancy in declaring their specific identity. Indeed, the apparent tenuity of the rim and certain peculiarities about the median and posterior sulci suggest the possibility that the Sir Johns Run specimens represent quite a different species.

Occurrence.—CLINTON. The typical specimens are from the *Bonnemaia rudis* zone along Wills Creek in Cumberland, Md. Specimens doubtfully referred to the species occur in the same zone on Powell Mt. 5 miles northwest of Sneedville, Tenn., and also in the upper Clinton at Sir Johns Run, one mile west of Stone Cabin Gap, Md., and Williamsville, Va.

Collection.—U. S. National Museum.

BONNEMAIA PERLONGA n. sp.

Plate XLVI, Figs. 16-18

Description.—Length of typical male left valve, 5.25 mm.; greatest height of same, 2.62 mm. The most striking of the peculiarities of this species is the extraordinary length of the carapace that has suggested the specific name *perlonga*. Otherwise it is comparable with the preceding *B. longa* without, however, being strictly like that species in any respect. Critically compared with the typical form of *B. longa* (see Plate XLVII, Fig. 10) the elevated border in the present form is thicker, the postmedian lobe also is thicker and shorter and its dorsal extremity more rounded, and both the median sulcus and the crescentic posterior depressed area are wider. Another important difference is in the course and position of the angular crest of the anterior lobe. The sigmoid curvature of the crest is similar in the two species, but whereas in *B. longa* its dorsal part maintains a median position with respect to the anterior and posterior sides of the lobe in *B. perlonga* on the contrary it turns so far backward that it forms the precipitous dorsal third or more of the anterior boundary of the median sulcus.

None of the other species now referred to this genus is sufficiently like *B. perlonga* to require detailed comparison.

Occurrence.—CLINTON. (*Mastigobolbina typus* zone) 1 mile west of Stone Cabin Gap, Bear Pond Mountains, Williamsport quadrangle, Md., and one mile west of Narrows, Va.

Collection.—U. S. National Museum.

BONNEMAIA NOTHA n. sp.

Plate XLVIII, Figs. 5-7

Description.—Length of a left valve, 3.0 mm.; greatest height of same, 2.0 mm. A larger valve, retaining all of the upturned thin border but otherwise like the preceding specimen, has a length of 3.25 mm. and height of 2.25 mm. This species differs from all of the preceding species of the genus in the greater segregation and relative prominence of the post-median lobe. This is notable mainly in casts of the interior. These resemble interior casts of *Zygobolba* and *Zygobolbina* in which also the ventrally confluent parts of the lobes seem abnormally low or at least are not so clearly separated from the border (compare Plate XLIII, Fig. 9, and Plate XL, Figs. 8, 9, 16, and 17 with Plate XLVIII, Fig. 7). The females of the species agree further with those of *Zygobolba* in the form and low position of the brood pouch. However, this fact has little significance in determining the generic relations of *B. notha* because the brood pouch in all of the unquestionable species of *Bonnemaia* of which the female is known holds a similarly low position and differs from that of *Zygobolba* only in its inferior convexity and prominence. (Compare Plate XLVII, Figs. 4 and 6 with Plate XL, Figs. 5, 6, and 8.)

We have referred *B. notha* to *Bonnemaia* because of general and particular resemblances it bears to such other less doubtful species of the genus as *B. obliqua*. The rather notably great thickness of the anterior lobe indicates this genus and not *Zygobolba*. However, we miss the curved angular crest that is so commonly found on this lobe in *Bonnemaia*. The border, however, though wide enough, is thinner than usual in this genus. On the other hand, the post-median lobe is broad and defined behind by a short though narrow posterior sulcus so that the whole of the post-dorsal quarter is sufficiently like the same quarter in such, in part typical, species of *Bonnemaia* as *B. transita grandis*, *B. crassa*, and *B. oblonga* to encourage the conviction that *B. notha* is at least nearer the genus in which we have placed it than it is like any other now recognized.

The features mentioned together with the fact that its valves are much larger than those of any known species of either *Zygobolba* or *Zygobolbina* will probably suffice in distinguishing *B. notha* from species of those

genera. The fact that *B. notha* occurs in a lower zone than the other species of *Bonnemaia* and also that its zone holds many species of Zygobolbinæ may explain its synthetic combination of characters. At the same time these facts tend to substantiate our conviction that *Bonnemaia* is the culminating expression of the Zygobolbinæ and not, as some of its species may suggest, an aberrant member of the Kloedeninæ.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, Gate City Gap, Va.

Collection.—U. S. National Museum.

Subfamily KLŒDENINAE new subfamily

Genus MASTIGOBOLBINA new genus

Rather large trilobate Zygobolbidæ, typically with a narrow posterior lobe, a much larger and irregularly shaped anterior lobe and a pyriform median lobe, the latter tapering below and passing into a whip-lash-like raised extension (the "flagellum") that turns obliquely forward and upward and then backward again across the anterior lobe. From these typical species, constituting the group of *M. typus*, we pass by easy gradations (1) to the group of *M. trilobata* in which the posterior lobe is large and broadly convex like the anterior lobe and the flagellum tends to become entirely obsolete; (2) to the group of *M. lata* in which the flagellum is either obsolete or more commonly forms a merely angular gently curved crest on the anterior side of the anterior lobe; (3) to the group of *M. incipiens* in which the anterior and posterior lobes are wide (as in the group of *M. trilobata*) and the flagellum forms a thin ridge along the posterior edge of the anterior. Finally, in the small group of *M. bifida*, which differs from the others mainly in characters pertaining to the brood pouch of the female, the anterior lobe is divided vertically by a narrow pit or furrow.

The female form has been determined for 15 of the 20 odd species here distinguished and assigned to the genus. Most of the exceptions are accounted for by the five species comprising the group of *M. trilobata*. In 13 of the 15 species of which the female form is known the distinguishing brood pouch is essentially of the same type. In these the pouch is large, a quarter-sphere in form, wholly posterior in position, more or

less sharply defined on its inner side, extends from about the middle of the ventral border to a point near the post-dorsal angle, and covers the posterior lobe completely on its straight or slightly concave inner side and the posterior half of the elevated border on its outer side. In *M. bifida* and *M. ultima* the pouch holds the same position but is smaller, its outer limit being at the inner base of the elevated border which therefore is continued around it.

Genotype.—*Mastigobolbina typus* new species.

So far as known the species of this genus are confined to deposits of Clinton age in the Appalachian region. In this they range from the vicinity of Clinton in central New York through Pennsylvania, Maryland, and the Virginias into northeastern Tennessee. The type seems to be entirely unrepresented in the large ostracodal faunas of similar age on the Island of Anticosti. And in the opposite direction, in Alabama, where the Clinton is well represented in the Red Mountain formation and in places is highly fossiliferous, no ostracoda of any kind have been found. However, nearby, in northwestern Georgia—where Middle Clinton sandstone, containing an ostracod fauna comparable to that found in beds of corresponding age in Virginia, Maryland and New York, occurs at the north end of Lavender Mountain near Rome—a few specimens of *M. lata* have been found together with an abundance of *Zygobolbina conradi*. Except this occurrence in Georgia the geographic range of *Mastigobolbina* thus appears to be practically the same as that of *Bonnemaia*.

The stratigraphic range of *Mastigobolbina*, however, is wider than that of *Bonnemaia*. But even in this respect there is agreement between them in so far as the 15 species and varieties of the groups of *M. typus*, *M. trilobata*, and *M. bifida* are concerned. Namely, all but one of the 15 are found in the two Upper Clinton *B. rudis* and *M. typus* zones beneath the Keefer sandstone. The exception in both cases is a Middle Clinton species. As regards the remaining species, the 6 comprised in the group of *M. lata* all occur only in Middle Clinton zones, whereas the three of the group of *M. incipiens* are found in a lower bed that is referred provisionally to the top of the Lower Clinton or the base of the Middle Clinton.

TABLE SHOWING STRATIGRAPHIC DISTRIBUTION AND CLASSIFICATION OF THE SPECIES OF MASTIGOBOLBINA

	Lower Clinton	Middle Clinton			Upper Clinton	
	Z. Z. decora zone	Z. emaciata zone	M. lata zone	Z. pontina zone	S. rudis zone	M. typus zone
I. Group of *Mastigobolbina typus*. Posterior lobe small, flagellum well developed and so curved that it extends first forward and then backward across the anterior lobe; brood pouch covering posterior half of border.						
M. typus n. sp.	....	....	....	....	....	X
M. typus angulata n. var.	....	....	....	....	....	X
M. typus prænuntia n. var.	....	....	....	....	X	....
M. triplicata (Foerste)	....	...	....	....	....	X
M. argula n. sp.	....	....	....	....	....	X
M. intermedia n. sp.	....	....	....	....	....	X
M. rotunda n. sp.	....	....	....	....	....	X
M. modesta n. sp.	....	....	X	....	....	....
II. Group of *Mastigobolbina trilobata*. Posterior lobe nearly as large as the anterior, both extending to the submarginal furrow; flagellum imperfectly developed or wanting.						
M. trilobata n. sp.	....	....	....	....	....	X
M. aretilimbata n. sp.	....	....	....	....	....	X
M. glabra n. sp.	....	....	...	....	....	X
M. punctata n. sp.	....	....	....	....	....	X
M. micula n. sp.	....	....	....	....	X	....
III. Group of *Mastigobolbina bifida*. Posterior lobe narrow, anterior lobe divided vertically by a furrow, brood pouch confined to space within the elevated border.						
M. bifida n. sp.	....	....	...	....	X	....
M. ultima n. sp.	....	....	....	....	X	....
IV. Group of *Mastigobolbina lata*. Posterior lobe narrow, flagellum represented by a but slightly curved crest extending to the dorsal edge or more or less obsolete.						
M. lata (Hall)	....	....	X	....	....	....
M. lata nana n. var.	....	....	X	....	....	....
M. vanuxemi n. sp.	....	....	X	....	....	....
M. clarkei n. sp.	....	....	X	....	....	....
M. declivis n. sp.	....	....	X	....	....	....
M. virginia n. sp.	....	....	....	....	X	....
V. Group of *Mastigobolbina incipiens*. Posterior and anterior lobes large, posterior sulcus narrow and shallow, flagellum running along inner edge of anterior lobe to the dorsal edge where it turns sharply forward and ends on the anterior slope.						
M. incipiens n. sp.	....	X	....	....	....	....
M. producta n. sp.	....	X	....	....	....	....
M. retifera n. sp.	....	X	....	....	....	....

The most interesting peculiarity, which has suggested the name *Mastigobolbina* and marks particularly the typical section of the genus, is the lash-like anterior extension of the ventral extremity of the median lobe, usually referred to in these pages as the flagellum. This forms a thin, usually sharply defined, low to high, recurved ridge traversing the outer surface of the thick lower and median parts of the anterior lobe. It is somewhat less clearly indicated also on the inner surface of the valves, though here it appears as a groove; and in corresponding manner as a low recurved ridge on clean casts of the interior. The flagellum may be analogous to the ribs traversing the surface of the valves in *Steusloffia*,[1] a genus of Ostracoda established some years ago by the writers for certain Baltic species previously assigned to *Beyrichia* and now regarded as probable members of the Zygobolbidæ. However, the arrangement of the ribs in *Steusloffia* is so different from that of the flagellum in the majority of the species of *Mastigobolbina* that one is disposed to doubt that the two are structurally analogous. Apparently there may be or perhaps is good ground for that belief only in the case of the group of *M. incipiens*. But the three species of that group are the oldest of the genus and seem either not yet to have acquired the characters that mark the more typical sections of the genus or they represent an early independent line that may have led to *Steusloffia* or to some other at present unrecognized or unknown ancestor.

Without speculating as to what future investigations may establish it is clear enough at present that *M. incipiens* and its immediate allies are not wholly unquestionable members of the genus *Mastigobolbina*. It is clear also that their particular combination of characters is synthetic in suggesting relations not only to *Steusloffia* and *Mastigobolbina* but also to such other members of its family as *Kloedenia*, *Zygobeyrichia*, *Welleria*, and *Plethobolbina*. However, these relations are suggested in most cases by merely generalized similarity in the males that may be interpreted equally well in two or more ways. But this is not so of the females, the brood pouch in the group of *M. incipiens* being precisely the same in form

[1] Ulrich, E. O., and Bassler, R. S., Preliminary Revision of the Beyrichiidæ: Proc. U. S. Nat. Mus., vol. xxxv, 1908.

and position as in otherwise more typical species of *Mastigobolbina* and not as in the other genera mentioned in this connection.

On casual comparison one would hardly suspect that *Plethobolbina typicalis* really can be linked very closely to typical *Mastigobolbina* by a chain of intermediate species. Nevertheless, it is true at least in so far as the valves of male specimens can show relationships. Indeed, the transition from the one to the other becomes so obvious and convincing that we cannot doubt that such widely differing species as *Mastigobolbina typus* on the one extreme of the chain and *Plethobolbina typicalis* on the other are in fact closely allied genetically. To realize the closeness of the links of this chain one needs but to compare *M. typus* with *M. triplicata* and then in order the stages to which we have applied the names *M. argula, M. intermedia, M. trilobata, M. glabra, M. punctata, Plethobolbina ornata, P. cornigera* and finally *P. typicalis*. If there is any real break in this chain we have failed to detect it. The only element of uncertainty in the matter is that the latter half of the chain, with the possible exception of *P. typicalis*, is based solely on specimens believed to be males.

It should be observed that a brood pouch has not been positively recognized in *Plethobolbina*. In four of the five species of *Plethobolbina* this failure may be accounted for on the ground of insufficient material, only a few specimens of each being known. But this explanation seems inadequate in the case of the relatively abundant *P. typicalis*. However, study of many specimens of the latter suggests that the two sexes are distinguishable but much less different in appearance than is the case in species of *Mastigobolbina*. Critical comparisons seem to establish that some specimens of *P. typicalis* (see Plate LIII, Figs. 32 and 33) are slightly fuller in the post-ventral part than the others. Probably these slightly more ventricose examples are female individuals of the species.

Definitely recognizable females of at least five of the following species of *Mastigobolbina* also have not been observed. However, this conclusion may be at least partly in error because the great brood pouch covers that part of the valves on which the more conspicuous of the specific peculiarities are found and in consequence of which the females of the several species of *Mastigobolbina* are much more difficult to distinguish than

are the males. It is possible therefore that the female of *M. glabra*, for instance, may have been referred to the closely related *M. trilobata* which is found in the same beds. However, such possible errors in identification seem less likely in the cases of *M. arctilimbata* and *M. punctata*, because these two species are marked by peculiarities that should be recognized almost as readily in the female as in the male.

As the specimens referred to *M. arctilimbata* and *M. punctata* have larger and fuller posterior lobes than do *M. typus*, *M. triplicata*, *M. modesta* and other species of their type, two thoughts are suggested: (1) that *M. arctilimbata* and *M. punctata* are based on female individuals and not males, and (2) that the sexes in these species are either not distinguishable externally or that they are united in the same individual. But none of these possibilities seem at all probable, strong doubt being warranted by the fact that, although the male carapace of *M. trilobata* possesses a posterior lobe nearly as large as those found in *M. arctilimbata* and *M. punctata*, the brood pouch in the female of *M. trilobata* is about as large and otherwise practically the same as in *M. typus*. That the type specimens of *M. arctilimbata* and *M. punctata* are actually males and not females is further indicated if not completely established by the fact that in these specimens the concave border is developed on the posterior side about as well or better than on the anterior, whereas in all the species of the genus of which both males and females are known the brood pouch of the latter entirely covers the area occupied in the male by the widest part of the submarginal furrow.

The relations of *Mastigobolbina* to *Bonnemaia* are discussed at length in remarks following the description of that genus. As to *Kladenia*, *Zygobeyrichia*, and *Welleria* it hardly seems necessary to spend much time in showing wherein they differ. The male carapaces in those genera are always sufficiently characteristic to leave no doubt regarding their distinctness from those of *Mastigobolbina*; and when it comes to their female forms there is even less excuse for confusion with the present genus. In *Mastigobolbina* the brood pouch is large and wholly posterior in position, in *Kladenia*, *Zygobeyrichia*, and *Welleria* it lies mainly on the ventral side.

As will be noted on comparing the illustrations of species of the two genera herein published, *Mastigobolbina* presents a general resemblance to *Beyrichia*. In fact, the previously described species of the former have hitherto been referred to *Beyrichia*. But with the material and information now in hand the new genus is easily distinguished from the older.

The peculiarities mainly relied on in separating *Mastigobolbina* from *Beyrichia* concern the position, form, and size of the brood pouch. In *Beyrichia* this pouch lies on, or rather covers, the post-ventral quarter of the valves and consequently permits the dorsal half of the posterior lobe to remain visible as in the male. Its form and prominence may be described as egg-shaped or subglobular (see Plate LXIII, Figs. 24 and 30). In *Mastigobolbina* the brood pouch is relatively much larger, obliquely quarter-globular in form without constriction of its base, hence, not so sharply outlined; and it covers all of the posterior third or more of the valve, so that nothing of the posterior lobe remains visible in the valves of the female.

Among other differences of probably inferior physiological importance the most striking peculiarity of *Mastigobolbina* is the whip-lash-like prolongation of the ventral extremity of the median lobe that we usually refer to under the term flagellum. This peculiar feature is suggested in the groups of *Beyrichia clavata* and *Beyrichia interrupta*.[1] Nothing of the kind is seen in the more typical sections of *Beyrichia*. Of the less typical groups mentioned that of *B. clavata* is provided with a brood pouch like that prevailing in typical *Beyrichia*, hence, generic alliance with *Mastigobolbina* is out of the question. As to the "group of *B. interrupta*," its relations to *Mastigobolbina* are not so easily determined because, so far as known to the writers, their female forms have not been described except in one instance, *B. dumesi* Krause. In this Silurian species the brood pouch resembles those of *Kladenia* and *Zygobolba* rather more than those of either typical *Beyrichia* on the one extreme and *Mastigobolbina* on the other. In the other species of this doubtful group of *Beyrichia* the female

[1] Ulrich, E. O., and Bassler, R. S., Preliminary Revision of the Beyrichiidæ: Proc. U. S. Nat. Mus., vol. xxxv, 1908, pp. 295-300.

carapace may not be distinguishable from the male, a possibility rendered rather probable by the fact that they are credited to the Ordovician in which age pouch-bearing Ostracoda are very uncommon. If a brood pouch was not developed in them then they should be regarded as generically distinct not only from *Mastigobolbina* but also from *Beyrichia*. Pending the discovery of further evidence on this matter *Mastigobolbina* may be distinguished from the group of *Beyrichia interrupta* by the greater development of the median lobe in *Mastigobolbina*, especially in the direction of the dorsal edge. In *Beyrichia interrupta* and its immediate allies the median lobe is small and located near the middle of the valves or at least a considerable distance beneath their dorsal edges.

The genetic derivation of *Mastigobolbina* is in doubt. Of Ordovician types only *Drepanella* seems an at all likely ancestor, not only of the present genus but of the whole family. As possible links in this line of descent *Drepanella richardsoni* (Miller) and *Ctenobolbina ? lunula* Ulrich, both Richmond fossils, should be mentioned. On another occasion the latter species was referred by the writers to *Beyrichia*. Subsequent study leads to the conclusion that it is not a true *Beyrichia*. It has been thought of in connection with *Drepanella* and also as an incipient member of either *Mastigobolbina* or *Bonnemaia*, but it fits poorly wherever we try to locate it, so that any change in its classification at this time would be of doubtful advantage.

I. Group of *Mastigobolbina typus*

MASTIGOBOLBINA TYPUS n. sp.

Plate XLIX, Figs. 1-6; Plate L, Fig. 5

Description.—Carapace large, the male shell usually 3.5 to 4.5 mm. in length, the female 4.5 to 5.0 mm., the height about two-thirds of the length, the greatest thickness perhaps one-fourth less than the height.

Typical form.—Valves of the male subovate in outline, the greatest length slightly beneath the midheight, the ends rounded, the anterior side more strongly curved in the ventral half than in the dorsal half, the curvature of the latter part being slight. Dorsal edge straight, considerably

shorter than the greatest length of the ventral half of the valve, the junction with the curved outlines of the ends sharply angular, often forming a blunt spine at each extremity. Ventral part of outline gently convex, sometimes almost straight in the middle third. Border wide, especially on the posterior and ventral sides, strongly elevated at the outer edge, sloping rapidly inward to the base of the lobe-bearing part of the surface. The post-dorsal part of this elevated border does not terminate at the extremity of the hinge but continues forward within the angle till finally it joins the dorsal extremity of the median lobe. Posterior lobe small, low and narrow, usually crowned with a row of small nodes, the wide space behind it appearing depressed and usually smooth. Median lobe thickly fusiform in shape, its most prominent part rounded, smooth or obscurely nodulose, occasionally with a thin rib running down from the nodose area over the tapering ventral part which turns forward and joins the ventral part of the anterior lobe. In the typical form of the species this thin secondary ridge increases slowly in strength downward and yet more as it turns forward to the summit of the anterior lobe. Here it turns rather sharply backward and finally terminates at the inner edge of the anterior lobe and very near the exact middle of the valve. Considered in connection with the median lobe it may be said to resemble the lash of a thick-handled whip. The anterior lobe is large, subtriangular in outline, prominent, obtusely pointed, more or less irregularly tuberculated in its dorsal half, and more sparsely nodose or almost smooth on the steep anterior and ventral slopes. Of the two sulci the anterior one is much the wider and deeper. It lies near the middle of the valves and divides them vertically into approximately equal parts. At the dorsal edge it flares widely, whereas the lower end in certain lights appears as though it bent anteriorly into the narrow loop of the lash. The posterior sulcus is narrow and shallow, though distinct enough, thus corresponding to the weak development of the posterior lobe.

Valves of the female larger and otherwise conspicuously different from those of the male. However, the differences are confined to the posterior third or half, the anterior parts, including the median and anterior lobes, being essentially the same in both. The ventral turn of

the flagellum as in Plate XLIX, Fig. 9, sometimes is more broadly curved than in the male. The posterior sulcus appears deeper, wider, and longer than in the males, being clearly defined from the post-dorsal rim to the ventral edge. Behind it the remainder of the valve is entirely occupied by the great brood pouch which is smoothly inflated almost to the form of a quarter-section of a globe. Its inner boundary is sharp, slightly concave, and oblique with respect to the hinge line, its ventral extremity lying directly beneath the middle of the median lobe.

In edge views the broad border appears as a thick concave rim, the inner edge of which is finely denticulated. Within the denticles the inner surface of the rim (see Fig. 8) is fluted parallel to the edge, the purpose of the grooves and ridges evidently being to insure secure locking of the valves when closed. So far as known the two valves overlapped very little (or not at all) at their ventral contact.

The distinctive characters of this fine species are so clearly marked that detailed comparisons, except perhaps with the next following species, *M. triplicata* (Foerste), are scarcely necessary. However this may be, the desire to avoid too much repetition is thought a sufficient excuse to defer all necessary comparisons to the descriptive comments on those of the following species that seem near enough to render confusion at all likely. Conforming to the plan followed throughout these descriptions the species of each genus are compared in their turn only with preceding congeners. But when the relations to a species described on a succeeding page are particularly close anticipatory statements directing attention to the fact will be introduced.

The subordinate name *Mastigobolbina typus* var. *angulata* is proposed for a form that differs from the typical variety of the species in the lesser convexity of its valves and in the elbow-like angulation of the ventral extremity of the flagellum. In both these respects var. *angulata* suggests *M. triplicata* and *M. argula*. However, the posterior lobe is small as in *M. typus*, therefore not as well developed as in those species. The anterior recurved extremity of the flagellum also is as in *M. typus*, making a narrower loop than it does in *M. triplicata* and *M. argula*.

Occurrence.—The typical form of the species is rather common and widely distributed in the lower part of the limy upper division of the Clinton. At the railroad cut 1½ miles east of Great Cacapon, West Virginia, it is found in crystalline limestone 23 feet beneath the Keefer sandstone; in the "section near Six Mile House" it occurs abundantly as excellent casts of the interior and exterior in leached argillaceous and finely siliceous limestone 29 feet beneath the Keefer. The species has not been observed in collections made at Cumberland, but as its common associates in other places also have not been found at Cumberland the deduction that the bed itself is absent there may perhaps be warranted. In Virginia it has been noted at Williamsville and at Gate City. In Pennsylvania *M. typus* is not uncommon in the lower part of the Upper Clinton at and in the vicinity of Hollidaysburg. It has been found also at Clinton, New York, where it occurs in the *Palaeocyclus rotuloides* zone in the upper Clinton a few feet above the oolitic ore bed. Finally, a few specimens that in their usual state of preservation are not easily distinguishable from *M. typus* and especially *M. typus angulata* were detected among thousands of *Bonnemaia rudis* on leached calcareous sandstone occurring near the top of the Clinton as developed on Powell Mountain, about 5 miles northwest of Sneedville, Tenn. These older specimens probably represent a small variety that may be distinguished provisionally as *M. typus pramuntia*. The variety *angulata* occurs in association with the typical variety in the section near Six Mile House, Md.

Collection.—U. S. National Museum.

MASTIGOBOLBINA TRIPLICATA (Foerste)

Plate I., Figs. 1-4

Beyrichia lata—triplicata (part) **Foerste, Bull. Geol. Survey Kentucky, vii, p. 329, 1906; Jour. Cincinnati Soc. Nat. Hist., xxi, p. 31, pl. i, fig. 4, 1909.**

Description.—As noted above Foerste distinguished this species as a variety from *Beyrichia lata* Hall or *Mastigobolbina lata* (Hall) as it should now be called. Unfortunately, Foerste's types of his variety in-

clude specimens of two distinct species, both of which are represented in the U. S. National Museum by good gutta-percha squeezes prepared by the writers about 15 years ago from the originals in the Foerste collection. On comparison both of these forms proved to be represented by indistinguishable though much better preserved specimens in the collections from Maryland and Pennsylvania. In order to recognize Foerste's name *triplicata* it became necessary to redefine and restrict its application to one of the two. Accordingly, the form looking most like the rather poor and evidently generalized figure published by Foerste was selected as typical of the form that should hereafter bear the name. At the same time the "variety" is promoted to the rank of a species. Being a fairly typical species of the genus under consideration it may hereafter be known as *Mastigobolbina triplicata* (Foerste). The other species included in the "variety" by Foerste is next described under the name *Mastigobolbina argula* new species.

The length in mature examples of the male form of this species varies but little from 2.0 mm. The height of same is about 1.62 mm. In female individuals the length is greater, the average being a trifle under 3.0 mm.

Isolated individuals of this species might easily be mistaken for young examples of *M. typus*, with which indeed it is stratigraphically associated. But after finding numerous specimens, all agreeing in size and structure, it became evident that they belonged to a distinct species. Comparison of the three male valves figured on Plate I can leave no doubt concerning the constancy of the structural peculiarities by which it may be distinguished from *M. typus*. Comparing males of the two species the posterior lobe in *M. triplicata* is found to be relatively larger, with two rows of small nodes instead of one. Besides, the depressed area behind this lobe has more of a slope and carries small pustules that are wanting in *M. typus* and its varieties. Proceeding, the junction of the "lash" and the base of the median lobe is much less curved, appearing, in fact, angular as in *M. typus* var. *angulata*. The posterior outline of the constricted ventral half of the median lobe thus is not convexly curved as in *M. typus* but straight. It also is longer, extending quite to the marginal furrow.

For the same reasons the ventral part of the lash is straight instead of curved. Following the lash anteriorly it is noted further that the recurvature of its end makes a much wider curve, and this distinguishes it particularly from the var. *angulata* of that species. The dorsal extremity of the anterior lobe exhibits commonly still another difference in that it usually terminates in a relatively smooth cone instead of a tuberculose protuberance. Finally, the valves as a whole seem to be deeper, so that the exterior view presents a less emaciated appearance than pertains to the larger species. This is especially so when compared with the variety *angulata*. All of these differences are observable also in comparing the females of the two species except those relating to the posterior lobe, which, of course, is covered in these by the brood pouch. The latter is practically the same in the two species. The same may be said of the border, the agreement in this feature being particularly noteworthy because these two species differ from all the others in that the post-dorsal part of the border does not terminate at or just in front of the dorsal angle but passes within it to the median lobe.

After the genotype, *M. triplicata* should be compared with *M. intermedia* and *M. argula*.

Occurrence.—CLINTON. *Mastigobolbina typus* zone. Not uncommonly found in association with *M. typus*, at Hollidaysburg and Lakemont in central Pennsylvania. The original types of the species came from a supposedly corresponding horizon at the top of the Alger formation, in Lewis County, Kentucky.

Collection.—U. S. National Museum.

MASTIGOBOLBINA ARGUTA n. sp.

Plate I, Figs. 6-10

Beyrichia lata—triplicata Foerste, Bull. Geol. Survey Kentucky, vii, p. 329, 1906; Jour. Cincinnati Soc. Nat. Hist., xxi, p. 31, not pl. i, fig. 4, 1909.

Description.—As stated in the introduction to the foregoing description of *Mastigobolbina triplicata* specimens found in Maryland, West Virginia, and central Pennsylvania proved to be conspecific with the second of the two forms on which Foerste based his supposed variety of

M. lata. As the two are clearly distinct and also different from *M. lata* a new name must be applied to the form remaining after the preceding restriction of *M. triplicata*. Accordingly, the name *Mastigobolbina arguta* is proposed.

This species agrees rather closely with *M. typus* and *M. triplicata*. In size it is inferior to the former and superior to the latter, the length of mature males being 2.9 mm. to 3.3 mm., that of the largest female in the collections being 3.85 mm. The relative height varies considerably in different specimens, the height and length in three specimens, comprising the extremes so far observed, being 2.2 mm. by 3.4 mm., 2.9 mm. by 3.0 mm., and 1.46 mm. by 2.50 mm. The first and second of these may be regarded as representing the typical form of the species, the third is a relatively elongated variety.

In addition to the matter of size already mentioned the male form of *M. arguta* differs from *M. typus* and *M. triplicata* chiefly in the relative strength and disposition of features lying behind the median lobe. The most important of these differences concerns the posterior lobe. This is much stronger and more definitely outlined, and its crest is located further away from the median lobe, in *M. arguta*. Moreover, its crest is smooth and the nodes on its outer slope are less conspicuous and sometimes wanting entirely. In definiteness, relative narrowness and height of the posterior lobe and in the width and depth of the posterior sulcus *M. arguta* excels all other species now referred to the genus.

Comparing median lobes the rectangular turn below contrasts obviously with the corresponding part in typical *M. typus;* but a second look may be required to show that it is not exactly the same as in *M. triplicata*. In the latter the ventral extremity of this lobe is high, the descent from it to the marginal furrow being sheer. In *M. arguta*, on the contrary, the surface slopes toward the extremity, reducing its altitude by a half and causing a decided difference in the profiles of the concerned parts. Further, the median lobe as a whole is more erect and relatively less inflated in the present species, agreeing with this feature much better with *M. typus;* likewise in the occasional carination of the crest of the lobe.

The crest does not follow the middle of the lobe but lies near the posterior side.

Regarding the anterior lobe, the facts are again in closer agreement with *M. triplicata* than *M. typus*. This is shown in the general shape and relative prominence of the lobe, in its simple, broadly conical dorsal termination, and in the course of the lash-like extension of the crest of the median lobe. On the other hand the outline of the inner side of the anterior lobe is oblique as in *M. typus* and not vertical as in *M. triplicata*. Finally, the anterior (median) sulcus is appreciably wider and the curvature of the outline of the valves slightly more convex in the ventral part and more broadly arcuate in the antero- and postero-ventral parts.

As the more striking of the above distinctions pertain to the posterior lobe the recognition of the female form of the species, in which this part of the valve is covered by the brood pouch, is not so easily accomplished. Considerable difficulty therefore may be experienced in distinguishing such specimens from those of *M. triplicata* and *M. typus*. Apparently, the only reliable differences are those pertaining to the anterior or median sulcus, which opens more broadly at the dorsal edge in *M. arguta* and the post-dorsal extremity of the elevated border which does not recurve to contact with the median lobe. The female valve is even more difficult to distinguish from that of *M. intermedia*.

Occurrence.—CLINTON. *Mastigobolbina typus* zone. Usually found in association with *M. typus* and *M. triplicata* at localities in the vicinity of Great Cacapon, West Virginia, and Hollidaysburg, Pennsylvania. One and one-half miles east of Great Cacapon its horizon lies 23 feet beneath the Keefer sandstone. Gate City Gap, Virginia, and other localities in Virginia expose its horizon. In Lewis County, Kentucky, it is found in association with *M. triplicata* at the top of the Alger formation.

Collection.—U. S. National Museum.

MASTIGOBOLBINA INTERMEDIA n. sp.

Plate L, Figs. 12-15

Description.—This species is very closely allied to *M. triplicata* with which also it is associated at Lakemont, Pennsylvania. The two agree

approximately in size but the present species is constantly shorter so that its outline is correspondingly more rounded, the greater convexity of the ventral side being especially notable. A more important difference is in the posterior lobe. The anteriorly situated crest of this lobe separated from the rather steeply sloping area behind it by only a shallow groove. In fact, when a valve is viewed in unfavorable lighting, the whole area between the posterior sulcus and the bottom of the groove that separates it from the base of the elevated border may appear as constituting a single thick lobe. We have therefore a clearly intermediate condition between that obtaining in *M. typus*, *M. arguta* and *M. triplicata*, in which only the thin crest of the posterior lobe stands out prominently, and that marking the group of species comprising *M. trilobata*, *M. glabra* and *M. punctata*, in which the posterior lobe is wide and actually does occupy the whole of the convex area behind the posterior sulcus. Another difference between *M. intermedia* and *M. triplicata* is that in the former the inner crest-like ridge of the posterior lobe passes above without break into the incurving dorsal part of the elevated border, so that the latter appears to fork. In the latter, on the contrary the upper extremity of the posterior lobe barely reaches the base of the border with its summit distinctly beneath the level of the border. Besides, the incurving end of the border does not quite reach the tip of the median lobe. Finally, the curve of the flagellum over the middle part of the anterior lobe is sharper than in *M. triplicata*.

Occurrence.—CLINTON. *Mastigobolbina typus* zone at localities in the vicinity of Hollidaysburg, Pennsylvania.

Collection.—U. S. National Museum.

MASTIGOBOLBINA ROTUNDA n. sp.

Plate L, Fig. 11

Description.—This seems to be a rare species, only one specimen, and that injured on the front border in cleaning, being known. The length of this is approximately 2.13 mm., the height 1.62 mm. Except for the straight but short dorsal edge and projecting cardinal angles the outline is subcircular. The lobation of the valve and the border are essentially

as in *M. arguta*, the fusiform lobe being decidedly inflated in the dorsal half and constricted to a narrow, anteriorly curving neck below, the anterior lobe, though narrower and relatively much more prominent, carries a gently curved ridge which represents the more strongly recurved "lash" of the other species, the posterior lobe is thin, low, and ridge-like, the two sulci deep and long, the marginal furrow, especially on the posterior side, wide and deep, and the outermost edge thin and highly elevated. Compared with *M. arguta* the differences in the lobes, sulci, and marginal furrow are such as would naturally result from a shortening of the carapace.

Mechanically shortened valves of *M. lata* and its variety *nana* as for instance those illustrated in Plate LI, Figs. 12 and 13, sometimes appear much like *M. rotunda*. Critically compared, however, differences in the lobes and margin will be observed that satisfactorily demonstrate their specific distinctness.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, 23 feet beneath the Keefer sandstone, at the railroad cut 1½ miles east of Great Cacapon, West Virginia. The same bed contains *M. typus*, *M. arguta*, *M. trilobata*, and other ostracods.

Collection.—U. S. National Museum.

MASTIGOBOLBINA MODESTA n. sp.

Plate LII, Figs. 11-16

Description.—Length 2.4 mm., height 1.5 mm. These dimensions were taken from an adult right valve. In hundreds of examples none varies from it in length by more than 0.2 mm. Most of them are only 0.1 mm. or so shorter. Except that it is much smaller this species resembles rather closely the *M. triplicata* and *M. arguta* of the upper Clinton fauna. The flagellum is similarly curved but extends upward to the tip of the anterior lobe. The posterior lobe is narrow and the rather widely crescentic space behind it is flat, giving much the same appearance to this part as in *M. arguta*. However, this upper end of this lobe is thinner than in that species; and the depressed space behind the lobe lacks, as does

also the lobe itself, the pustules that occur on these parts in *M. triplicata*. But a more important difference than those mentioned is that the upper two-thirds of the median lobe is more strongly inflated and the constricted lower third thinner than in either of those species. Unfortunately, the preservation of the specimens in a moderately coarse grained sandstone renders more detailed comparisons with these and other species impossible. *M. modesta* is of interest mainly in establishing the existence of the *M. typus* group of species in the Middle Clinton. The strongly sigmoid curvature of the flagellum distinguishes it readily enough from all other species of the genus found in its zone.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, 1 mile west of Narrows and in the gap 1½ miles northwest of Warm Springs, Virginia.

Collection.—U. S. National Museum.

II. Group of *Mastigobolbina trilobata*

MASTIGOBOLBINA TRILOBATA n. sp.

Plate 1, Figs. 16, 17

Description.—As usual with these Ostracoda the specimens of this species so far observed differ only very little in size and proportions. The length in males it about 2.65 mm., the height about 1.75 mm. The female is somewhat larger, the length in one being 3.5 mm., the height 2.3 mm. The outline of the valves is rather regularly ovate, truncated on the dorsal side, the hinge uncommonly short, its extremities obtusely angular. Except the two deep sulci the surface of the valves is rather uniformly convex, the fusiform median lobe even being somewhat flattened in its widest part. The anterior lobe is large, extending laterally with little change in convexity from its sharply defined inner side to the bottom of the furrow which marks off the relatively narrow anterior part of the border. The posterior lobe is broad, taking in all the space between the posterior sulcus and the base of the moderately wide posterior part of the concave border. The anterior sulcus is deep, nearly vertical, flares dorsally, and extends about two-thirds across the convex part of the valve. The posterior sulcus is narrow, more uniform in width, and longer but

does not reach the concave border. Of the flagellum only the semicircular terminal part which lies on the most prominent part of the anterior lobe is developed as a distinctly elevated crest. Otherwise the surface of the lobes is quite smooth.

This species is distinguished from *M. typus*, *M. triplicata*, *M. arguta* and *M. intermedia* by its short hinge, more regularly ovate outline and much broader posterior lobe. On further comparison each of the mentioned species is found to differ in one or more additional respects. Doubtless the following *M. arctilimbata* and *M. glabra* are to be counted as nearer allies.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, 1½ miles east of Great Cacapon, West Virginia, and at Lakemont, near Altoona, Pennsylvania. Also in the soft shale above the oolitic ore at Clinton, New York.

Collection.—U. S. National Museum.

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MASTIGOBOLBINA ARCTILIMBATA n. sp.

Plate I, Figs. 18-20

Description.—This seems to be a close relative of *M. trilobata*. At first the possibility that it might be the female form of that species was considered but more critical comparisons revealed differences that could not be reconciled with that view; and it was entirely abandoned when the real female of *M. trilobata* was discovered. In some respects the present species is even more like the following *M. glabra*, which see for comparisons. In the matter of size and general form there is no essential difference between these three species, the length and height of a mature example of *M. arctilimbata* being, respectively, 2.5 mm. and 1.67 mm.

Compared with male valves of *M. trilobata* the two species are found to differ in the width of the border, in the size of the posterior lobe, and in the direction of the sulci. Thus, the border is flatter and narrower all around the free edges and narrowest on the posterior side, which is the direct opposite of the condition obtaining in all of the species described on preceding pages. Next the posterior lobe is even wider than in *M. trilobata*, being broadly crescentic in outline—in fact nearly semicircular or,

more properly, approximately a quarter globe in form. Finally, the posterior sulcus is less curved and more nearly ventrical in direction, the anterior sulcus, on the contrary, being more oblique and its anterior side less curved. To these differences is to be added the fact that the flagellum is entirely lost, not a vestige of it being discernible on either the ventral slope or on the median part of the great anterior lobe.

The female form of the species has not been observed. Probably this is to be ascribed to the rarity of the species, only two specimens having so far been seen.

Occurrence.—CLINTON. *Mastigobolbina typus* zone, 23 feet beneath the Keefer sandstone, at the railroad cut 1½ miles east of Great Cacapon, West Virginia. Here it was found associated with *M. typus*, *M. triplicata* and other Ostracoda marking this zone. Another specimen, smaller and supposedly immature, was found in corresponding beds at Lakemont, Pennsylvania.

Collection.—U. S. National Museum.

MASTIGOBOLBINA GLABRA n. sp.

Plate L, Fig. 21

Description.—Length 3.17 mm., greatest height 2.98 mm. Valves subovate with rather short hinge, the anterior side strongly rounded in lower half but oblique and straight in upper half, the antero-cardinal angle sharp, about 120°, the post-cardinal angle more obtuse. Border wide, especially on posterior side, deeply concave. Surface within border strongly and rather uniformly convex, the sulci appearing as trenches cut into it. Lash indistinguishable on the medio-ventral slope, barely indicated on the anterior lobe, broadly curved.

The general aspect of this species is exceedingly like that of *M. trilobata*, the agreement being particularly notable in the form of the lobes and sulci, in the size and local development of the border, and in the outline of the valves. Perhaps it should be viewed as a variety of that species. However that may be, the two forms are distinguishable. In the first place the flagellum is practically obsolete externally, hence much

less developed than even in *M. trilobata* and the trace that remains of it apparently merely a thinner part of the test in which the color is different from the remainder lies nearer the posterior edge of the anterior lobe and makes a wider curve. The anterior (wider) sulcus has straighter sides and is a little more oblique with respect to the hinge line and the posterior one also is straighter and slightly stronger. Finally, the posterior lobe is proportionately a trifle wider, the inequality in height of the anterior and posterior halves of the valves is a little greater and the dorsal extremity of the anterior lobe carries a small conical node that is lacking in *M. trilobata*. Though none of these differences would by itself be considered important it does not seem right to dismiss them so lightly when so many minor disagreements are presented in combination.

Most of the differences used in separating *M. trilobata* from *M. arctilimbata*, the main exception being that in the latter also the flagellum is obsolete, will serve also in discriminating *M. glabra*.

Occurrence.—CLINTON. Near base of *Mastigobolbina typus* zone, at Lakemont, Pennsylvania. The species seems to be rare.

Collection.—U. S. National Museum.

MASTIGOBOLBINA PUNCTATA n. sp.

Plate 14, Figs. 22, 23

Description.—This also appears to be a close ally of *M. trilobata* and *M. glabra* but possesses peculiarities by which it is easily distinguished. It seems to be a smaller species, the length and height of the type specimen being, respectively, 2.25 mm. and 1.46 mm. On comparison with its nearest relatives the peculiarity that will be at once observed, shown in casts of the interior as well as in testiferous specimens, is the extreme narrowness and shallowness of the posterior sulcus. Though having about the same curvature and direction with respect to the dorsal edge as has the corresponding sulcus in *M. trilobata*, the difference in width and depth is very striking. The anterior sulcus, also, except that it is slightly narrower, agrees very well with the corresponding depression in *M. trilobata*. The reduction in the width of the sulci is appropriated by the

posterior lobe, which consequently is wider than is the same part in its allies. The width of the border is less than in either of the mentioned species, the agreement in this feature being with *M. arctilimbata*. However, though the border is narrow all around, its widest part is on the posterior side and not, as is the case in *M. arctilimbata*, on the anterior side. Finally, magnification of the surface of the shell shows that it is closely but distinctly punctate—almost reticulate—a feature observed in only one other species of the genus, namely *M. retifera*. The flagellum is developed about as in *M. trilobata*, though more distinctly defined in its ventral part. However, it is barely elevated being notable because it lacks the punctations of the remainder of the surface.

The narrow, slit-like posterior sulcus recalls *M. clarkei* in which this sulcus is similarly reduced. That species, however, is at once distinguished by the smallness of its posterior lobe and the wide depressed space that lies between this lobe and the outer border.

As pointed out in the generic discussion, *M. punctata* is regarded as an important species in establishing the transition from the bilobed species of *Plethobolbina* to the trilobed forms.

The next in line in the suggested transition to that genus is *P. ornata* in which the posterior side of the post-median lobe is very obscurely outlined.

Occurrence.—CLINTON, Lakemont, Pa. Here it is associated with *M. typus, M. triplicata, M. glabra,* and other Ostracoda. Also in the soft shale above the oolitic ore at Clinton, New York.

Collection.—U. S. National Museum.

MASTIGOBOLBINA MICULA n. sp.

Plate LI, Fig. 24

Description.—As near as can be determined an average example of this species is 1.37 mm. in length and 0.94 mm. in height. The specimens occur in a sandy shale and have been flattened with the compacting of the beds so that their original thickness cannot be accurately ascertained. The species seems rare, only a few valves of males and none of females having been found.

The systematic relations of *M. micula* are somewhat doubtful. It suggests *Kladenia* but not enough to overcome our conviction that it belongs nearer such Mastigobolbinas as *M. clarkei* and *M. arctilimbata*. It is smaller than either of those species but agrees rather well with them in general aspect and particularly with the former in the relative shortness of its sulci. On the other hand it differs from *M. clarkei* in the narrower median sulcus, wider as well as less slit-like posterior sulcus, and broader posterior lobe. Except that the median sulcus is narrower and the posterior lobe not quite so wide the general appearance of the convex part of the valves is much the same as in *M. arctilimbata*. However, the exceptions mentioned together with the fact that the border in *M. micula* is relatively wider establishes beyond question that these are not merely young specimens of *M. arctilimbata*.

Occurrence.—CLINTON. One hundred and two feet beneath top of Keefer Sandstone, near Six Mile House, Maryland.

Collection.—Maryland Geological Survey.

III. Group of *Mastigobolbina bifida*

MASTIGOBOLBINA BIFIDA n. sp.

Plate LII, Figs. 17-20

Description.—This is a small transversely ovate species, with the males and females approximately equal in size but differing otherwise in the usual manner. The length and height of an average example is 2.1 mm. and 1.3 mm., respectively. Strangely, about nine-tenths of all specimens so far observed are females.

Except for its smaller size the male form of the species looks in general much like *M. triplicata*. More careful investigation, however, soon brings out a number of minor and two major differences that leave no doubt concerning their actual distinctness. Thus, while the outline, the course and general character of the border, the form of the median lobe and the form of the depressed areas of the surface are similar enough to require a second look it may be noted at once that the anterior lobe instead of being triangular in form and highest in its median part is

divided by a deep vertical furrow into two approximately equal narrow ridges, the outer one somewhat lower than the inner. Next it will be seen that the ventral confluence of the lobes is thicker, the median sulcus being correspondingly shorter. Further it will be noted that the posterior sulcus does not cut through the ventral ridge and that the posterior lobe is narrower and more definitely bounded on its posterior side.

The female form differs from the male in that its posterior third is occupied by a swelling—the brood pouch. Though holding the usual position, the pouch in this species is relatively smaller and less sharply defined from the rest of the valve than is the corresponding feature in *M. typus*, *M. triplicata* and other species of the typical section of the genus. In fact, its nature may not be immediately apparent, this perhaps mainly because of the uncommon fact that it does not cover the posterior part of the border but extends only to its inner base, thus appearing more like a thick posterior lobe as in *M. arctilimbata* and its allies than the type of brood pouches found on the females of most other species of the genus.

Only one other species has a similarly confined and delimited brood pouch, namely *M. ultima*. Though clearly allied to *M. bifida* and also found in the same zone though not certainly identified in Tennessee, it is easily distinguished by its smaller size and by certain structural characters that are pointed out in following notes.

Occurrence.—CLINTON. *Bonnemaia rudis* zone. Powell Mountain, about 5 miles northwest of Sneedville, Tennessee. At this place the zone lies at the top of the Clinton, the two succeeding zones of the upper Clinton being absent either because of non deposition or removal by erosion prior to the overlap of the formation by the Sneedville limestone which commonly succeeds the Clinton in southwestern Virginia.

Collection.—U. S. National Museum.

MASTIGOBOLBINA ULTIMA n. sp.

Plate LI, Figs. 21-28

Description.—A small left valve, male, is 1.44 mm. in length and 0.95 mm. high. In the largest specimen seen, an imperfect left valve,

male, the corresponding dimensions are about 1.92 mm., and 1.35 mm., respectively. A left female valve is 1.85 mm. by 1.24 mm. The species does not seem to be very rare but we were sure of it only at one place and even here we found it difficult to procure specimens suitable for photographing.

That *M. ultima* is a close ally of *M. bifida* may be readily appreciated by comparison of the figures of the two. The most important of the points of agreement is in the brood pouch of the female which does not, as in all other species of the genus, cover the posterior part of the elevated rim. Another is the fact that the anterior lobe is divided vertically by a furrow, only this furrow lies more on the anterior slope so that the outer division of the lobe lies at a lower level and appears much thinner in a side view of the valve than in *M. bifida*. Of less important differences we would call attention to the less angular dorsal extremities and more equally rounded ends. The form of the posterior lobe and its relations to the depressed spaces on either side of it also are not precisely the same in the two species. Finally, the average size of the present species is considerably inferior to that of *M. bifida*. In our experience specimens differing notably in size usually prove on closer investigation to differ also in other respects.

So long as the female of this species had not been recognized the males were mistakenly supposed to represent a derivative of *M. lata* or of its variety *nana*. The brood pouch of the female, however, proved to be quite different from that of *M. lata* and this led to more critical comparison of the male forms of the two. It was then that the furrow in the anterior lobe was observed. Also that the constricted part of the median lobe is narrower, the median sulcus wider in its lower half, and the inner boundary of the anterior lobe more curved and less oblique to the dorsal edge in *M. ultima* than in *M. lata*. The latter differences are not so apparent when the present species is compared with *M. lata nana* but the outline in that earlier form is distinctly shorter.

Occurrence.—CLINTON. One hundred and two feet beneath the top of the Keefer sandstone, near Six Mile House, Maryland. Here it is

associated with *Zygospira vallata nodifera* and other characteristic ostracoda of the *Bonnemaia rudis* zone.

Collection.—Maryland Geological Survey.

IV. Group of *Mastigobolbina lata*

MASTIGOBOLBINA LATA (Hall)

Plate LI, Figs. 1-11 and 16 and 19 (part); Plate LII, Figs. 5, 6

Agnostus latus (part) Vanuxem, 1842, Geol. New York, 3d Geol. Dist., p. 80 (name only).

Beyrichia lata (part) Hall, 1852, Pal. New York, ii, p. 301, pl. 46C, figs. 10c-e.

Beyrichia lata Jones, 1855, Ann. Mag. Nat. Hist., 2d ser., vol. xvi, p. 168, pl. vi, fig. 13.

Beyrichia lata Foerste, 1906, Bull. Geol. Sur. Kentucky, vii, p. 329.

(Not *Beyrichia lata* Ulrich and Bassler, Proc. U. S. Nat. Mus., vol. xxxv, pl. 292, fig. 25, 1908 (= *M. clarkei* of this work).

Description.—Presumably the collections made and studied by Vanuxem, who was the first to apply the specific name *lata* to Clinton Ostracoda, included specimens of the form to which it is proposed to restrict the name. However, as he neither described nor illustrated his species it is impossible to determine exactly which form or forms he had in mind. Under the circumstances the species must be credited to Hall, who in 1852 published the first description and figures of a number of specimens referred by him to the species. But Hall's work also failed to fix the species because—under the misapprehension that the two valves are different, one with two lobes, the other with three—the specimens described and figured by him represent at least two very different species. Jones was the first to disagree with Hall's conception of the species and when, in 1855, he described the three-lobed form as *Beyrichia lata* he practically redefined and restricted the species to it.

Long afterwards, Foerste, apparently unaware of Jones' work, similarly restricted the term *Beyrichia lata* to the trilobate form of the species as defined and illustrated by Hall. At the same time Foerste proposed the name *Bollia lata* for the bilobed form. Again he seems to have overlooked the fact that Jones had already used the latter combination when in 1890 he intended to distinguish the bilobed species from the trilobed *Beyrichia*

lata (Hall) Jones. However, Jones' effort failed on this occasion because the *Bollia lata* described and figured by him is based on a variety of the quadrilobate *Kladenella symmetrica*, an abundant fossil of the Rochester shale, which he wrongly identified with the very different lower Clinton bilobed ostracode of central New York which Hall had included in his conception of *Beyrichia lata*. The present status of *Bollia lata* Foerste, not Jones, is discussed on another page under the heading *Zygobolbina conradi* n. sp.

Two years after the publication of Foerste's recommendation Ulrich and Bassler published the first true illustration of a specimen occurring with many other beyrichian valves on a slab collected by Hall and labeled by him as *Beyrichia lata*. As the figure published by Jones 53 years before is obviously generalized the specimen selected for illustration by Ulrich and Bassler might automatically assume the rank of the type of the species should any further restriction of its limits be attempted.

During the present study of the species such an attempt became desirable when it was found that the three-lobed specimens in hand from the type locality of *B. lata* in central New York are divisible into four varieties or species. In one of these, herein named *Mastigobolbina clarkei*, the posterior lobe, though narrow, is sharply outlined by the flattening of its surface. The posterior sulcus in this form is very narrow and slit-like, the anterior lobe broad and but moderately convex. In the second form—by far the most common and for this reason the one thought to be the best qualified to become the type of restricted *Mastigobolbina lata*—the posterior lobe consists of a thin rounded or obtusely angulated ridge, the large anterior lobe is rather strongly but not uniformly convex, its inner and higher half presenting a flattened area bounded on the outer side by an obtuse angle beyond which the contour of the lobe drops with a gently biconcave but rather steep slope to the hollow of the border. The median lobe in this form is more inflated and the posterior sulcus (because of the rounding instead of flattening of the summit of the posterior lobe) seems wider than in the first variety. The third form (*M. lata* var. *nana*) is commonly smaller and relatively shorter than the associated varieties. Otherwise it is much like the second form, differing chiefly in that the

flattened area of the anterior lobe tilts strongly toward the larger (median) sulcus, the outer edge of the sloping area being not only more acutely angular and ridge-like but also relatively higher. The fourth form here described as new under the name *Mastigobolbina canuxemi* is like the second except that it commonly attains slightly greater size and proportionately greater length and that the anterior lobe is wider and only very obscurely crested.

The specimen selected and photographed by Ulrich and Bassler to illustrate the species *Beyrichia lata*, part., Hall, belongs to the first of these four forms. It was selected because it seemed to be the best of the specimens turned over to the U. S. National Museum from material labeled *Beyrichia lata* in the original Hall collection. However, as Ulrich and Bassler were not then aware that more than one trilobed species is represented in this supposedly typical material it is almost unnecessary to add that in selecting what they regarded as merely an uncommonly well-preserved specimen of the species there was no intention to restrict the species to some definite form. Moreover, investigation of the material used by Hall in illustrating *Beyrichia lata* and which is now preserved in the American Museum of Natural History, New York City, shows that the first of the three forms above described is not represented in it. Under the circumstances we have no choice but to select some specimen from the original types upon which to found the species as it is now proposed to restrict it; and at the same time it becomes necessary to propose a new name for the form erroneously referred to *B. lata* by us in 1908. So that it may be eliminated from further discussion in this connection it should be said at once that the specimen then figured by us as *B. lata* is now regarded as the type of a new species for which the name *Mastigobolbina clarkei* is herein proposed.

The restriction of the species is thus narrowed to choice between the second, third and fourth forms and quickly decided in favor of the second because it is by far the more abundant and widely distributed of the three. As thus restricted *Mastigobolbina lata*, giving the species its new generic setting is sufficiently illustrated on Plates LI and LII to make very detailed description unnecessary. We may therefore content ourselves

mainly with comparative discussions showing in what respects it differs from allied forms.

Before doing so it seems desirable to say that on account of varying appearances, due mainly to matters pertaining to conditions of preservation, it is not easy to distinguish the several forms. Too commonly the exterior molds are not clean, more or less of the ferruginous replacement of the shell being retained. Comparison of Figs. 1 to 11 on Plate LI and 1 to 6 on Plate LII illustrate some of these distressing imperfections. Only Fig. 11 comes near to showing the true characters of the exterior of *M. lata*. In all the other figures, and for one reason or another, the flatness of the tops of the two larger lobes and the sharpness of the keel on the anterior lobe are either not shown at all or but indefinitely. For like reasons the border looks unlike in different preparations and thus may suggest misconceptions concerning variations in outline.

Some of the distinguishing features of *Mastigobolbina lata* (Hall) as here restricted, were mentioned in the foregoing discussion. The male shells of the typical form are exceedingly abundant in certain layers of the Middle Clinton in central New York. As a rule these are of smaller size than those of the associated *M. vanuxemi* and *Zygobolbina conradi*. In one of average adult dimensions the length and height are respectively 2.75 mm. and 1.75 mm. The largest seen is 2.9 mm. in length. The point of greatest thickness lies near the middle of the anterior lobe. Here the thickness of each valve equals something between one-third and one-half of its height. In specimens that, like those from Tuscarora Mountain in southern Pennsylvania, are distorted by pressure, these proportions may be variously modified. The female form of the species is considerably larger than the male, the average length of these being about 3.0 mm. The brood pouch is in all respects as in typical species of the genus.

Compared with preceding congeners the principal distinguishing character of *M. lata* is the ridge-like form of the anterior lobe. The summit of this lobe is not rounded but flat and terminates on its outer side in a sharp edge from which the surface slopes very gently toward the edge of the subcentrally located deep anterior sulcus and with a much steeper concave descent toward the anterior border. The part within the crest

of the ridge curves backward below to meet the constricted neck of the median lobe, the joined lobes together forming an irregular U-shaped loop. The ventral part of the loop is thick, the turn on the posterior side rectangular. The lower third of the median lobe is narrow, the upper two-thirds distinctly fusiform though only moderately inflated. The posterior sulcus is deep and narrow, its width being about the same as that of the posterior lobe. The furrow outside of the lobes is rather sharply defined and, as usual in the genus, widest in the post-ventral quarter. The elevated border is thick and rather high, when fully preserved its outer edge faintly concave, and its dorsal termini on either side lie just within the cardinal angles. Of these angles the anterior one is the less obtuse, commonly about 105 degrees. Both are, however, sharply defined.

The flattened summit of the anterior lobe reminds considerably of corresponding parts in species of *Bonnemaia*, especially *B. celsa* and *B. fissa*. Though this resemblance probably is truly indicative of genetic alliance—in the way of convergence in a not distant common root—the general aspect of the concerned species is too different to render confusion between them at all likely. On the other hand, the character referred to serves excellently in distinguishing *M. lata* from all of the previously described species. As it is associated with *M. clarkei* and *M. vanuxemi* more detailed comparison with those species seems desirable. In the first place, the anterior lobe in *M. clarkei* is but moderately and apparently almost uniformly convex, the crest being low or barely distinguishable. In *M. lata* the lobe is more prominent and much more sharply and strongly crested, longitudinal profiles of shells of the two species therefore being very different. Further, in *M. lata* the median lobe is more inflated and its neck thinner, the posterior sulcus is wider and not sharp-edged, and the posterior lobe is proportionally narrower with the crest rounded and never distinctly flat-topped. Finally, the upper half of the anterior side of the outline is less nearly rectangular than in *M clarkei*.

The three species next described, *M. vanuxemi*, *M. declivis*, and *M. modesta*, doubtless are related to *M. lata* the first two perhaps more

closely than the last. It is distinguished from the first by its shorter and more ovate form the ventral part of the outline especially being more arcuate. The border also is somewhat thicker and the excavated part between it and the lobed inner area is not so broad as in *M. vanuxemi*. But the most conspicuous difference between the two, provided good exteriors are available, lies in the surface contours of their respective valves. Namely, in *M. lata* the anterior lobe is sharply carinate so that the inner half slopes strongly down to the edge of the median sulcus. In *M. vanuxemi* on the other hand, the whole anterior lobe is more rounded or at least less angulated in longitudinal profile.

Compared with *M. declivis*, a new species from southern Pennsylvania with similarly carinated anterior lobe the male of *M. lata* is distinguished at once by its more elongate elliptical outline and less inflated median lobe. The female pouch is relatively larger and thicker in *M. lata* than in *M. declivis*.

There seems little danger of confusion with *M. rotunda*. The outline in the two is quite different being nearly circular in that species whereas in *M. lata* the height is decidedly inferior to the length. Comparison of figures of the two on Plates L and LI soon reveals other more or less well-marked differences in the shapes of the lobes and furrows and in their borders. These comparisons establish beyond question that *M. rotunda* is more closely allied to *M. intermedia* and *M. argula* than to *M. lata*.

The relations to *M. modesta* probably are more intimate though not so close as one might believe on casual comparison. The carina on the anterior lobe, which represents the flagellum of *M. typus* and its immediate allies, is not recurved as in *M. modesta*, nor is the neck-like basal part of the median lobe as thin as in that species. Good specimens, even though but casts of the interior, are really more easily distinguishable than comparison of our imperfect illustrations indicates. The same is to be said of *M. ultima* which we regard as belonging to another group of species. *M. lata* has narrower sulci and differs in various details. The females of the two are quite different.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, New Hartford, New York, Cumberland, Maryland and many other localities in Maryland, Pennsylvania and Virginia.

Collection.—Maryland Geological Survey, U. S. National Museum.

MASTIGOBOLBINA LATA VAR. NANA n. var.

Plate LI, Figs. 12-17

Description.—The types of this variety are decidedly smaller and relatively shorter than the associated specimens of the typical variety of *M. lata*. In the specimens from New Hartford, New York, the length usually is slightly less than 1.9 mm. In Cove Gap, near Mercersburg, Pennsylvania, however, a few larger specimens (see Figs. 13-15) were found with others of more normal dimensions. These larger valves, like all the other fossils found in the same bed at Cove Gap, have been distorted by pressure so that one cannot be quite sure as to their proper classification. Depending solely on those that retain their original form the variety is distinguished not only by its smaller size and shorter valves but also by the fact that the crest of the anterior lobe is even more prominent, indeed so much so that the summit slopes distinctly inward from the crest. The neck of the middle lobe is somewhat thinner and the inflation of its upper part is relatively greater than in typical *M. lata*.

Variety *nana* somewhat resembles *M. ultima*, a younger species that is figured on the same plate. But the anterior lobe is not so prominent in that species and it has a furrow in its anterior slope that is not present in var. *nana*. But it is the females of the two rather than the males that show what we regard as the most important difference. Namely, in the female of the var. *nana* the brood pouch covers the posterior half of the border the same as it does in all but two of the seventeen species of *Mastigobolbina* of which the female form has been recognized. The exceptions are *M. ultima* and *M. bifida* in which the brood pouch is limited outwardly by the inner base of the elevated border.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, New Hartford, New York. It has not been observed in this zone in either Maryland or

Pennsylvania but has been found in the slightly lower *Zygobolbina emaciata* zone at the toll gate on the Mercersburg and McConnellsburg pike 4½ miles northwest of Mercersburg, Pa.

Collection.—U. S. National Museum.

MASTIGOBOLBINA VANUXEMI n. sp.

Plate LII, Figs. 1-4

Description.—As noted in the preceding discussion of *M. lata* this species is found associated with it at New Hartford, New York. The two occur together also in Maryland and Virginia. Though commonly a little larger and relatively longer than *M. lata*, and therefore likely to be noted in looking over the slabs of sandstone on which they occur, *M. vanuxemi* is distinguished mainly by structural differences. The most striking of these is the general rounding of the surface of the anterior lobe, there being no vertical ridge or crest nor a flattened or inwardly descending slope as in that species. Nor is the anterior slope so broadly and distinctly concave. Besides, the general outline is more elongated and the ventral side always straighter. In comparing exteriors of the two species, as may be done by means of gutta-percha squeezes, the border is found to be thinner and wider and more broadly, that is, not so steeply excavated on its inner side as in *M. lata*. These show also that the depressed area behind the posterior lobe is wider, especially in its upper half in *M. lata*.

Occurrence.—CLINTON. *Mastigobolbina lata* zone, New Hartford, New York, Cumberland, Maryland, and Cumberland Gap, Tennessee. At the last place it is found associated with *M. lata*, and *Zygobolbina conradi* about 100 feet above the iron ore bed. It will be noted that the association of species at Cumberland Gap is practically the same as at New Hartford in New York.

Collection.—U. S. National Museum.

MASTIGOBOLBINA VIRGINIA n. sp.

Plate XLV, Figs. 17 and 18, 15, 16 and 19 more or less doubtful

Description.—The original of Fig. 18, a large left valve of the typical form has a length of 2.46 mm. and height of 1.37 mm. The original of

Fig. 19 in which the dorsal and ventral edges are more nearly parallel than in the typical form, is 2.25 mm. in length and 1.13 mm. in height. Figs. 15 and 16 have been drawn from other specimens that differ in one or more respects from the typical variety of the species.

As comparison of the five figures given under this name clearly shows, we have combined provisionally in one species a number of elongated valves that differ more or less from each other in their respective outlines and lobing. Most of them were found together near Warm Springs, Virginia, and associations of similar forms were observed also at Cumberland, Maryland, and other places showing the same zone. Whether these many valves actually belong to a single variable species, which we doubt, or to several closely allied but distinct species cannot be satisfactorily determined without better material. That in hand is preserved in sandstones of too coarse a grain to permit detailed observations of characters usually employed in distinguishing species of this and allied genera. In the present instance nicety in discrimination is less essential than usual from the standpoint of stratigraphy, because all of the specimens of this type have been observed only in one zone.

Viewed as a single species its nearest ally appears to be *M. vanuxemi* which holds a lower position in the Clinton group. Except Fig. 15, which comes nearest to that species, *M. virginia* differs in its outlines. The anterior side is more produced in its lower half and the two ends usually are more nearly equal in height. The ventral side also commonly differs in being straighter and in many specimens it more nearly parallels the dorsal edge. Excepting Fig. 16, which is peculiarly inflated in its postventral part and may be an abnormal individual, the median sulcus flares more in dorsal direction than in *M. vanuxemi*. Commonly, too, the border looks different, being narrower especially on the anterior side of the specimens which are regarded as typical. Probably of greater importance than any of the differences so far mentioned is the fact that in all of the specimens provisionally assigned to *M. virginia* the posterior lobe, especially its lower half, is decidedly thicker than in *M. vanuxemi*.

Occurrence.—CLINTON. (*Bonnemaia rudis* or *Mastigobolbina typus* zone) Wills Creek in Cumberland, Maryland, in the gap 1½ miles north-

west of Warm Springs, Virginia, and other localities where the same horizon is exposed.

Collection.—U. S. National Museum.

MASTIGOBOLBINA CLARKEI n. sp.

Plate LI, Figs. 18-20

Beyrichia lata Ulrich and Bassler, 1908 (not Hall), Proc. U. S. Nat. Mus., vol. xxxv, p. 292, fig. 25.

Description.—Length of holotype, a right valve from New Hartford, New York, 2.50 mm., height of same 1.71 mm.; the same measurements in a smaller right valve from central Pennsylvania give 2.33 mm. and 1.54 mm., respectively. The latter seems to be relatively very slightly the longer but close investigation shows that most of the difference is due to incomplete preservation of the ventral part of its border.

As stated in the preceding discussion of *M. lata*, in which that species is redefined and restricted, the holotype of *M. clarkei* was discovered by the writers in material out of the original Hall collection that bore the label "*Beyrichia lata.*" Being in an unusually good state of preservation and also as we were as yet unaware of the fact that the Clinton trilobate ostracoda then generally referred to as *Beyrichia lata* are divisible into many distinct species and varieties, we figured the specimen referred to as a good representative of Hall's species. Now, since we have learned that Hall's original type does not include specimens precisely like the one figured by us in 1908 it has become necessary to remove it from Hall's species and to propose a new name for it. The type of the species being a New York fossil we have chosen to name it after Dr. J. M. Clarke who has been so long and so worthily connected with geological work in that state.

M. clarkei is distinguished from *M. lata* and its varieties by its more nearly rectangular antero-dorsal outline, the flatness of the posterior lobe, the sharp definition and narrowness of the posterior sulcus, the relative shortness and smallness of the median (or anterior) sulcus, and the relatively even and more moderate convexity of the anterior lobe. Cresting of this lobe is barely indicated. A few other differences may be

observed in critical comparisons of the illustrations on Plate LI. The median lobe especially may be mentioned as worthy of investigation. Likewise the furrow and depressed area between the elevated border and the lobed area.

M. vanuxemi, which also is found in the *M. lata* zone, is a longer form and differs more or less decidedly in the details of its lobing. These differences hardly need to be pointed out being readily appreciable by comparison of figures of the two in Plates LI and LII. Of remaining species only *M. micula* looks much like *M. clarkei* in outline and disposition of parts. Starting with this great disparity in size, that being much the smaller, the discrimination in this case should be comparatively easy.

Occurrence.—CLINTON. *Mastigobolbina lata* zone at New Hartford, New York, ¼ mile north of Reedsville, Pennsylvania, and at Cumberland, Maryland, where it occurs about 120 feet above the top of the Tuscarora sandstone.

Collection.—U. S. National Museum.

MASTIGOBOLBINA DECLIVIS n. sp.

Plate LII, Figs. 7-10

Description.—Three valves have the following dimensions: a right valve has a length of 2.70 mm. and height of 1.85 mm.; a left valve is 2.62 mm. long and 1.70 mm. high; and a right valve of a female is 2.50 mm. long and 1.62 mm. high. The point of greatest thickness lies on the crest of the anterior lobe near the middle of this half of the valve. It amounts to nearly half of the height. Some of the specimens show variations in their proportions and in their outlines that evidently are due to distortion by pressure in folding of the beds.

Fig. 7 represents what we regard as the normal form of a right valve of this species. Judging from this the more obvious relations of the species are with *M. lata* and, because of the rounded form and relatively greater height, the var. *nana* particularly is suggested. The same variety is further suggested by the extraordinary prominence and sharpness of the crest of the anterior lobe, the inward slope of its flattened top and the steepness of the anterior slope. But it requires only a glance to

satisfy one that *M. declivis* is distinct from both the typical form of *M. lata* and its var. *nana*. Compared with the latter its valves, referring now to males, are constantly larger, the posterior lobe narrower and shorter, the middle lobe thicker, especially in its constricted lower third, and its axis more oblique to the hinge line. Further, the dorsal extremity of the anterior lobe is more pointed, and the curvature of the crest of this lobe as seen in side views, is different, its course in *M. lata* and its varieties being such that it is convex anteriorly throughout its length whereas in *M. declivis* it changes its course sufficiently before reaching the dorsal edge to warrant one in describing it as imperfectly sigmoid. Finally, the most anterior point in the course of the crest lies farther up and the upward turn from its ventral part accordingly is less abrupt and broader than in the varieties with which we are comparing it. The female of the two species differ further in that the brood pouch is both smaller and less prominent in *M. declivis* than in *M. lata*. While the closeness and also the truly genetic character of the relations of *M. declivis* to *M. lata* are scarcely to be denied, it yet may seem probable that the genetic ties between the present species and *M. modesta*, and perhaps through this to the *M. typus* group of species, are even stronger. Of course, there is little or at least less excuse for confusion with *M. modesta* because the decidedly sigmoid curvature and the linear elevation of the flagellum and the smallness of the neck of the middle lobe in that species contrast too obviously with the characters of corresponding parts in *M. declivis*. Nevertheless, this species simulates the *M. typus* group of species in precisely those features that distinguish it from *M. lata* and its immediate allies. It occupies, therefore, an intermediate position between the two groups of species, but whether its apparently transitory combination of characters is to be viewed as a link in a line of evolution connecting the two groups or as a stage in a separate but similarly modifying line cannot be determined with the material in hand. That we lean for the present toward the latter view is indicated by our provisional assignment of the species to the group of *M. lata*.

Occurrence.—CLINTON. *Zygobolbina emaciata* zone, Cove Gap, Tuscarora Mountain, 4½ miles northwest of Mercersburg, Pennsylvania. The

extension of these beds in Maryland has not been searched for ostracoda by the writers. Doubtless this and other species occur there as in Pennsylvania.

Collection.—U. S. National Museum.

V. Group of *Mastigobolbina incipiens*

MASTIGOBOLBINA INCIPIENS n. sp.

Plate LIII, Figs. 8-12

Description.—Dimensions of a right male valve, that retains most of the wide concave border: length 2.32 mm., height 1.44 mm.; same of a left valve that has lost most of its border: length 2.12 mm., height 1.31 mm.

In the perfect state the free edges of the valves of this species are surrounded by a wide and rather deeply concave thin border or frill that projects beyond and overhangs the contact margin. It is easily broken away and in the highly ferruginous and spongy matrix in which the species is found at Frankstown, Pennsylvania the border is commonly lost in removing the specimen. The greater part of the median lobe is a moderately prominent convex subelliptical elevation contracting downward into a narrow neck. The latter then passes into a thin ridge (flagellum) that curves around the base and then up the anterior side of the moderately deep median sulcus to the dorsal edge where the ridge turns abruptly forward and downward to end near the middle of the outer edge of the anterior slope. This thin ridge shows on interior casts (see Plate LIII, Fig. 12) as well as the exterior surface. The posterior sulcus is merely a shallow depression between the elliptical median lobe and the broad convexity behind it that represents the posterior lobe. The anterior lobe is very broad, covering all the space between the median sulcus and the marginal furrow. Except the flagellum, which surrounds its dorsal half the surface of the anterior lobe is moderately and rather uniformly convex. In the ventral slope just beneath the median lobe and between the obscurely defined ventral extremities of the anterior and posterior lobes is a shallow depression. This is a family mark common to and usually more strongly developed in the Beyrichiinæ and the trilobed Zygobolbidæ.

The brood pouch of the female is a large and prominent inflation of the surface agreeing in position, size and form very closely with the corresponding feature in both the *M. typus* and *M. lata* groups of the genus.

None of the species described on preceding pages are sufficiently like this to require detailed comparison. The position and course of the flagellum is characteristic while the fulness of the anterior and posterior lobes is equalled only in the group of *M. trilobata*.

Occurrence.—So far this species has been found only in a thin bed of fossiliferous iron ore lying about 8 feet above the main ore seam near Frankstown, Pennsylvania. The same layer contains also *M. producta, M. retifera, Zygobolba buttsi* and other species of ostracoda that have not been found elsewhere. The Frankstown ore bed probably represents a fossil zone between those of *Zygobolbina emaciata* and *Zygobolba decora*. However, as neither of the mentioned zones were recognized in the Frankstown section the accurate determination of the position of this ore seam in the sequence of Clinton ostracod zones is a matter for future investigation. Provisionally it is assigned to the "top of the Lower Clinton."

Collection.—U. S. National Museum.

MASTIGOBOLBINA PRODUCTA n. sp.

Plate LIII, Figs. 13-17

Description.—A large mold of the exterior of a left valve, without the outer border, is 2.87 mm. in length and 1.50 mm. in height; an interior cast of the right valve of a smaller specimen also without the outer border, is 2.50 mm. in length and 1.32 mm. in height; in an interior cast of a left valve of the shorter variety of the species also lacking the outer border, the same measurements give 2.34 mm. and 1.31 mm., respectively; in a right valve of the short variety they give 2.34 mm. for the length, 1.32 mm. for the height without the border and 1.50 mm. with the border.

This species is closely allied to *M. incipiens* the only conspicuous difference between the two, as they usually occur, being in their longitudinal dimension. Comparison of their measurements shows that the valves of *M. producta* are always considerably longer than those of *M. incipiens*. In other respects interior casts of the two are essentially alike. As a

common but not constant exception we may point out that the dorsal half of the anterior edge usually forms more nearly a right angle with the dorsal edge than in *M. incipiens*. Comparison of specimens that retain any part of the outer border brings out another difference, namely, that this border is flatter in *M. producta* than in the other.

Two varieties are recognized, one relatively longer than the other. No other differences have been observed.

Occurrence.—Same as *M. incipiens*.

Collection.—U. S. National Museum.

MASTIGOBOLBINA RETIFERA n. sp.

Plate LIII, Figs. 1-7

Description.—Two valves of the typical rounded kind have the following dimensions; length 2.20 and 2.37 mm., height 1.58 and 1.75 mm., respectively. The largest seen is about 2.50 mm. in length, the smallest about 2.00 mm.

This species also is more closely allied to *M. incipiens* than to any other now known. It is shorter, more rounded in outline, with more obtuse cardinal angles, shorter hinge, shallower marginal furrow, and less upturned, flatter, outer border than in that species. The inflated upper part of the middle lobe also is more rounded, but the most striking difference pertains to the outer surface of the convex parts. In *M. incipiens* the shell is smooth, in this it is neatly reticulated. This ornament is plainly visible under an ordinary pocket lens. The convexity of the surface as a whole is somewhat less than in either of its associated allies, *M. incipiens* and *M. producta*. The middle lobe, however, is quite as prominent and more rounded than in the other two members of its group.

We know of no other Clinton species with which the present form might be confused. A possible exception is the *Plethobolbina ornata* an Upper Clinton fossil. In that species, however, the surface is minutely punctate instead of finely reticulate, with smaller rounded holes. It lacks also the flagellum, its median lobe is less prominent and undefined on the posterior

side, the median sulcus narrower and its dorsal angles more sharply produced.

Occurrence.—Same as *M. incipiens*.

Collection.—U. S. National Museum.

Genus PLETHOBOLBINA new genus

Carapace primitian in aspect, 2.0 mm. to 4.0 mm. in length, strongly convex, with rather narrow flat border, developed chiefly on the anterior side. Valves unisulcate, the sulcus median in position, extending obliquely backward from the dorsal edge about half across the valves. Median lobe merged with the posterior lobe, distinguishable only by a slight swelling just behind the sulcus. Posterior lobe indistinguishably merged in the general convexity of the surface. Anterior lobe essentially as in *Mastigobolbina* except that it is proportionally somewhat larger and less defined and commonly lacks the recurved lash-like extension of the median lobe. Brood pouch, if any, merely adds slightly to the height and convexity of the posterior half.

Genotype.—*Plethobolbina typicalis* n. sp.

One species found in the lower part and four in the upper part of the Clinton group in eastern North America.

It should be observed that a brood pouch has not been positively recognized in *Plethobolbina*. Of four of the five species this may be accounted for on the ground of insufficient material, only a few specimens of each being known. But this explanation seems inadequate in the case of the relatively abundant *P. typicalis*. However, study of many specimens of the latter suggests that the two sexes, though barely distinguishable, are much less different in appearance than is the case in the typical species of *Mastigobolbina*. Critical comparisons seem to establish that some specimens of *P. typicalis* are slightly fuller in the post-ventral part than the others. Probably these slightly more ventricose examples are female individuals of the species.

PLETHOBOLBINA TYPICALIS n. sp.

Plate LII, Fig. 21; Plate LIII, Figs. 28-33

Description.—Length 3.5 to 4.0 mm.; height 2 to 2.25 mm. Disregarding generic characters which it shares with the other species, *Plethobolbina typicalis* is distinguished by its distinct dorsal angles, rather short, oblique and posteriorly sharply defined median furrow, and great thickness of the anterior half, the surface rising slowly to a crested summit located near the middle of the anterior third and then descending abruptly to the border. The border is wide and well defined on the anterior end, but on the ventral and posterior sides until it approaches the hinder dorsal angle it is narrower and less distinct.

The small curved crest near the anterior margin doubtless represents the corresponding recurving part of the "whip-lash" of typical species of *Mastigobolbina*. Commonly it is injured or broken away in freeing the specimens from the stony matrix. A similar feature is developed in extreme manner in *Bonnemaia celsa*. Unless Fig. 32, which is one of several specimens that differ from others in being fuller in the post-ventral region, should prove to be the female form of this species then it is either unknown or the valves of the two sexes are indistinguishable.

Occurrence.—CLINTON. One of the most characteristic, abundant, and geographically widely distributed fossils of the *Mastigobolbina typus* zone. It occurs in the zone near Great Cacapon, W. Va., Six Mile House, Md., Hollidaysburg, Pa., and in sandstone of corresponding age at Big Stone Gap and other places in Virginia and at Clinton, N. Y.

Collection.—U. S. National Museum.

PLETHOBOLBINA ORNATA n. sp.

Plate LIII, Figs. 18-20

Description.—Length, 1.6 mm.; height, 1.05 mm. This species is associated with *Plethobolbina typicalis* but is considerably smaller, its valves are more evenly convex, and their convex surfaces are covered with small, closely arranged punctæ forming a neatly reticulated ornamenta-

tion. The posterior furrow is suggested in more definite fashion than in *P. typicalis*, the species showing in this and other respects a decided resemblance to *Mastigobolbina punctata*, in which the posterior furrow is yet very narrow but deeply impressed. Though easily distinguished by the mentioned difference and even though we have found it expedient to place them in distinct genera it is not to be denied that the relations in this case are truly genetic. Nearly the same kind of relation exists between the following *P. cornigera* and *Mastigobolbina trilobata*. However, systematic classification is necessarily more or less arbitrary and artificial, so that such interrelations among closely allied genera are to be expected.

Occurrence.—CLINTON. One of the rarer species in the *Mastigobolbina typus* zone, near Hollidaysburg, Pa.

Collection.—U. S. National Museum.

PLETHOBOLBINA CRIBRARIA n. sp.

Plate LIII, Figs. 23, 24

Description.—Length, 1.5 mm.; height, 0.9 mm. This has the same kind of surface reticulation as *Plethobolbina ornata* but differs in its outline, which is more elongate oval. Its ends also are more nearly equal in height. Further, the small swelling just behind the median sulcus is more prominent and narrower, but the posterior sulcus is no better developed. Other differences are obscurely indicated, but the specimens are too poorly preserved to permit more detailed comparisons.

Occurrence.—CLINTON. The types and only known specimens were found at Cumberland, Md., about 57 feet above the top of the underlying Tuscarora sandstone.

Collection.—Maryland Geological Survey.

PLETHOBOLBINA CORNIGERA n. sp.

Plate LIII, Figs. 21, 22

Description.—Length, 3.1 mm.; height, 2.0 mm. This is similar in general aspect to *Plethobolbina ornata* but is larger and had a smooth surface. The posterior side of the median sulcus also is sharper,

straighter, more nearly vertical in direction, and extends quite to the dorsal edge. A striking difference is the presence of a short spine or node on the dorsal edge half-way between the median sulcus and the anterior dorsal angle. This node is another feature that reminds of species of *Mastigobolbina* being found in *M. triplicata*, *M. argula*, and *M. intermedia*. The whip-lash too is clearly developed. However, on account of the practical absence of the posterior furrow the species must be referred to *Plethobolbina*.

Occurrence.—CLINTON. *Mastigobolbina typus* zone on Wills Creek at Cumberland, Md. Apparently the species is rare, very few specimens and all of them imperfect having been observed.

Collection.—Maryland Geological Survey.

PLETHOBOLBINA SULCATA n. sp.

Plate LIII, Figs. 25-27

Description.—Length, 2.0 mm.; height, 1.5 mm. The specimens on which this species is founded occur in a sandstone whose fossil content has suffered considerable distortion through lateral pressure. Moreover, the texture of the matrix is too coarse to preserve minor details of structure and surface marking. However, the bed belongs to a middle Clinton zone from which better material is not to be expected. This reason and because of the desire to register the Clinton ostracod fauna as fully as the material in hand permits may constitute a sufficient excuse for introducing new species on material that would ordinarily be regarded as unworthy of description.

So far as can be determined *Plethobolbina sulcata* is allied to *P. typicalis*, differing from it mainly in its longer and less steep-sided sulcus. As a result the bilobation of the valves and the convexness of the lobes are both decidedly greater than in *P. typicalis* or in any other species now referred to the genus.

Occurrence.—CLINTON. *Zygobolbina emaciata* zone. Toll-gate at Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.

Collection.—U. S. National Museum.

Genus KLŒDENIA Jones and Holl

KLŒDENIA NORMALIS n. sp.

Plate LXI, Figs. 15-19

Description.—Length, 2.0 mm.; height, 1.1 mm. This is a neatly outlined species with nearly equal ends, sharp dorsal angles, and normally developed lobation. The border is well developed on the ends but narrows on the ventral side. In the female the brood pouch has the usual size, form, and position for the genus. It is perhaps somewhat more prominent and more clearly outlined than usual. Though a perfectly typical species of the genus, we have found no exact match for it among the species hitherto published. *Klœdenia smocki* (Weller), an upper Manlius species in New Jersey, is as near as any. In Weller's species the median sulcus is larger and the outlines and profiles slightly different.

Occurrence.—WILLS CREEK FORMATION. Pinto (45 feet above base) and Flintstone, Md. (182 feet above base).

Collection.—Maryland Geological Survey.

KLŒDENIA NORMALIS var. APPRESSA n. var.

Plate LXI, Figs. 20-22

Description.—Length, 1.3 mm.; height, 0.90 mm. Compared with the typical form of the species, variety *appressa* is shorter and has less regularly rounded outlines. Another difference lies in the antero-dorsal quarter, which instead of being neatly convex as in *K. normalis* is slightly concave. There is a notable flattening of the surface also beneath the median lobe. The median sulcus is deep, long, and vertical; the anterior sulcus is likewise deep and curves around the median lobe, which is relatively prominent. The border is well developed on the posterior end but becomes rather indefinite in the antero-ventral region.

Occurrence.—WILLS CREEK FORMATION. Flintstone, Md., 162 and 182 feet above base.

Collection.—Maryland Geological Survey.

KLŒDENIA KENZIENSIS n. sp.

Plate LXI, Fig. 23

Description.—Length, 2.0 mm.; height, 1.1 mm. This species is near *Klœdenia sussexensis*—a basal Devonian species (Decker Ferry) but the sulci are not so deep and the border not so sharply defined. It differs from *K. normalis* in its less regularly rounded end and ventral sides and high but anteriorly less sharply defined median node. In fact, both of the sulci are shallower.

Occurrence.—McKENZIE FORMATION. Pinto, Md., 100 feet beneath top.

Collection.—Maryland Geological Survey.

KLŒDENIA CACAPONENSIS n. sp.

Plate LXI, Figs. 24, 25

Description.—Length, 1.6 mm.; height, 1.0 mm. Similar to *Klœdenia normalis* but is relatively a shorter and higher form, with larger and more produced dorsal angles, more nearly vertical rectangular ends, straighter furrows, ventrally obsolete border, and in general greater convexity of valves. The brood pouch is very large but hardly so prominent or so clearly outlined as in *K. normalis*.

Occurrence.—CLINTON. (*Drepanellina clarki* zone). One and one-half miles east of Great Cacapon, W. Va., and Lakemont, Pa.

Collection.—U. S. National Museum.

KLŒDENIA LONGULA n. sp.

Plate LXI, Figs. 30, 31

Description.—Length, 1.5 mm.; height, 0.75 mm. Characterized by its longish form, subequal ends, the anterior being but slightly lower than the posterior, and shallow posterior sulcus. The latter is very faintly continued across the ventral half, thus suggesting *Zygobeyrichia*, toward which type it is trending. It occurs, as shown in the figures, by thousands on certain bedding planes in the lower Wills Creek formation at Flint-

stone. Close study of these specimens shows how persistent these ostracoda are in minor details.

Occurrence.—WILLS CREEK FORMATION, lower part. Flintstone, Md.

Collection.—Maryland Geological Survey.

KLOEDENIA OBSCURA n. sp.

Plate LXI, Figs. 26-29

Description.—Length, 2.5 mm.; height, 1.75 mm. The outline itself is distinctive in this species, but there are other peculiarities even more so. Among these is the comparatively low convexity of the valves, the exceeding shallowness and indefiniteness of the furrows and consequently also the lowness and lack of definition of the lobes and the thick edges with overhanging border. So far as the type of lobation can be determined it reminds of species referred to *Mastigobolbina*. The middle lobe might be described as obscurely inverted, pear-shaped, its narrow end extending into the ventral half of the valve. Then there is a low posterior ridge essentially as in *M. virginia* and other species of its genus. In our opinion this ostracod is really a truer ally of *Mastigobolbina* than of *Kloedenia*, but on account of the general obscurity of its characters and because the only lobe about which one may be certain is quite obviously the homologue of the one between the two sulci in *Kloedenia* we have provisionally elected to refer it doubtfully to the latter genus.

Occurrence.—CLINTON. Top of Frankstown ore seam, one-half mile northwest of Frankstown, Pa.

Collection.—U. S. National Museum.

Genus WELLERIA new genus

Form and lobation of valves of males essentially as in *Kloedenia* from which it differs in the character of the ventral swelling in the female. This instead of forming a definitely outlined large subovate and prominent pouch covering the posterior two-thirds of the ventral slope, forms a low undefined swelling taking in nearly or quite the whole of the ventral two-thirds of the valves. At the base it is compressed and slightly overhangs the ventral edge.

Genotype.—*Welleria obliqua* new species.

This interesting generic type, named in honor of Professor Stuart Weller, is represented by an abundance of specimens in the Tonoloway limestone of Maryland and neighboring states.

WELLERIA OBLIQUA n. sp.

Plate LV, Figs. 6-10

Description.—Average length, 3.00 mm.; height, 2.00 mm. A large ostracod short and high with moderately convex valves, sharp dorsal angles, with curved ventral outline, vertical anterior side more obtusely angular posteriorly, the form as a whole therefore swings obliquely backward; border thick at and near the angles narrowing thence to the ventral side where it is always appreciable but usually not a conspicuous feature. Ventral edge thick, descending abruptly from the border to the contact edge. The ventral swelling in the female undefined above, low and very extensive, overhanging the ventral edge slightly. On well-preserved specimens the surface of this swelling shows a number of sparsely arranged small punctæ.

Occurrence.—TONOLOWAY LIMESTONE. Common throughout the formation especially in the lower part at Keyser, W. Va., Grasshopper Run, near Hancock, and other Maryland localities.

Collection.—Maryland Geological Survey.

WELLERIA OBLIQUA VAR. LONGULA n. var.

Plate LV, Figs. 11, 12

Description.—Length, 2.2 mm.; height, 1.2 mm. With the typical form of the species occurs fewer specimens of longer valves with less convexly curved outlines and more regularly developed border. These are provisionally distinguished as a variety under the name *longula*.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, West Virginia, Pinto and various other Maryland localities.

Collection.—Maryland Geological Survey.

WELLERIA OBLIQUA var. BREVIS n. var.

Plate LV, Fig. 13

Description.—Length, 2.00 mm.; height, 1.35 mm. This variety is distinguished by its dorsally converging terminal outlines and relatively short form.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, West Virginia, Pinto and various other Maryland localities.

Collection.—Maryland Geological Survey.

Genus KYAMMODES Jones

Male valves of *Kyammodes* differ from those of *Welleria* and *Kladenia* which are regarded as related genera, in having two short and small lobes on the dorsal slope besides the pair of larger ones on either side of the median sulcus. The latter as usual in *Kladenia* and *Welleria* is longer than the other sulci but in *Kyammodes* the lobation of the valves is on the whole more strictly confined to the dorsal slope than in the mentioned related genera. There seem also to be certain peculiarities about the overlapping of the valves on the ventral edge that are not yet fully understood. The female form of the type *K. whidborni* is unknown but in *Kladenia Kiesowi* Krause which seems to have all the characteristic features of *Kyammodes* the female has a very large strongly convex pouch, larger than usual in *Kladenia* and quite different from the undefined swelling of the valves in the female form of *Welleria*.

There are two species in the Silurian of Maryland that are quite certainly congeneric with at least *K. kiesowi*.

Genotype.—*K. whidborni* Jones from the Devonian of England.

KYAMMODES SWARTZI n. sp.

Plate LV, Figs. 14-16

Description.—Average valve, length, 1.66 mm.; height, 1.25 mm. Distinguished from *Kyammodes tricornis* and the European *K. kiesowi* by its shorter sulci and subpentagonal form. The right valve as usual in the genus, has the ventral slope near the edge broadly concave but projects conspicuously beyond the line of a regular curve. This gives the

obscurely five-sided outline that is characteristic of the species and a very uncommon feature in ostracoda. In the left valve the concavity in the ventral slope is practically wanting, the profile being merely somewhat straightened before bending down to the edge. Obviously, the right valve overlaps the free edges of the left.

Occurrence.—TONOLOWAY LIMESTONE. Lower part (128 feet above base), Grasshopper Run, near Hancock, Maryland.

Collection.—Maryland Geological Survey.

KYAMMODES TRICORNIS n. sp.

Plate LV, Figs. 1-5

Description.—Length, 2.00 mm.; height, 1.30 mm. *K. tricornis* is characterized by its semiovate outline, nearly equal ends, acuminate dorsal angle and subcarinate lobes. The two median lobes project beyond the dorsal edge and the posterior one is much smaller and as it nears the dorsal side curves distinctly forward. The small anterior lobe seen in the other species of genus is barely distinguishable as a low thin curved ridge in this. The anterior and median sulci, especially the latter, are deep and longer than usual in this genus extending nearly or quite halfway across the valves. In the male form the ventral border, though indefinitely outlined by a mere concavity is nevertheless a conspicuous feature. In the middle its edge stands well above the contact edge. In the female it is covered by a large strongly convex oval pouch two-thirds of which lies behind the middle of the valve.

This species is closely allied to *K. kiesowi* (Krause) but comparison with authentic males and females of that European species proves they are not strictly the same.

Occurrence.—MCKENZIE FORMATION. 77 and 82 feet below the top at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

Genus ZYGOBEYRICHIA Ulrich

Distinguished from related genera by the partial or complete obsolescence of the posterior lobe and the excessive development of the ventral junction of the median and anterior lobes.

Genotype.—*Zygobeyrichia apicalis* Ulrich.

ZYGOBEYRICHIA VENTRIPUNCTATA n. sp.

Plate LIV, Figs. 15-18

Description.—Average length, 3.20 mm.; height, 2.00 mm. *Zygobeyrichia ventripunctata* is characterized by the strong punctæ on the ventral two-thirds of its lobes. These are somewhat wide-spread in the male but on the female the brood pouch is thickly covered by them. Both are easily recognized by this and other characters clearly shown in the figures.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, West Virginia, Pinto and other localities in Maryland. Manlius limestone, Schoharie County, New York.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA REGINA n. sp.

Plate LIV, Figs. 1, 2

Description.—Average length, 3.0 mm.; height, 2.0 mm. Associated with *Zygobeyrichia ventripunctata* is an abundant closely related species of about the same size and general characteristics but differing in lacking the punctations of the ventral two-thirds. To this splendid form the specific name *regina* is applied.

Z. regina is also related to the associated *Z. tonolowayensis* but differs in its straighter ventral edge and stronger border.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, West Virginia.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA TONOLOWAYENSIS n. sp.

Plate LIV, Figs. 3-5

Description.—Length, 2.8 mm.; height, 1.8 mm. Related to and associated with *Zygobeyrichia regina* but differs in its more convex ventral outline.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, West Virginia, Pinto and other localities in Maryland.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA INCIPIENS n. sp.

Plate LIV, Figs. 13, 14

Description.—Length, 1.75 mm.; height, 1.2 mm. Differs from the other species of the genus and most of those of *Kladenia* in the ventral obsolescence of the border. The associated *Z. ventricornis* is distinguished at once by the large ventral node and greater height of anterior half. The posterior edge is uncommonly straight and nearly vertical in its upper three-fourths.

Occurrence.—WILLS CREEK FORMATION. Forty-five feet above base at Pinto, Maryland.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA VENTRICORNIS n. sp.

Plate LIV, Figs. 6-8, 11

Description.—Typical form, length, 2.25 mm.; height, 1.3 mm. This has passed out of the typical *Kladenia* type of structure into the province of *Zygobeyrichia* the posterior lobe being at least partially separated below from the base of the middle lobe. Under *Zygobeyrichia* it is distinguished by the node near the base of the middle of the ventral slope. This is somewhat broken down in the smaller of the left valves lying together on the specimen figured.

Occurrence.—WILLS CREEK FORMATION. Pinto (15 feet above base) and Flintstone, Maryland (182 feet above base). A later appearance of the species occurs in the upper Tonoloway at Keyser, West Virginia.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA VENTRICORNIS var. OBSOLETA n. var.

Plate LIV, Figs. 9, 10

Description.—The Tonoloway limestone also contains two supposed mutations of *Z. ventricornis*, both lacking the small ventral node. One of these is a little longer and the other a little shorter than the typical form.

Occurrence.—WILLS CREEK FORMATION. One hundred and eighty-seven feet above the base at a locality, 3 miles west of Hancock, Maryland.

Collection.—Maryland Geological Survey.

ZYGOBEYRICHIA MODESTA n. sp.

Plate LIV, Fig. 12

Description.—Length, 1.0 mm.; height, 0.60 mm. A small form whose structural relations seem nearer *Z. ventricornis obsoleta* than to any other. It differs however, in addition to its smaller size, in its narrower anterior end and relatively greater convexity of the ventral slope. There is a very faint continuation of the posterior sulcus across the ventral half of the valve suggesting *Zygobeyrichia*. It agrees in this respect with *Kladenia longula* but differs from it in its narrower anterior end and relatively shorter and more oblique outline.

Occurrence.—TONOLOWAY LIMESTONE. Lower part, 128 feet above base at Grasshopper Run, near Hancock, Md.

Collection.—Maryland Geological Survey.

Subfamily DREPANELLINAE

Genus DREPANELLINA new genus

Drepanellina evidently was evolved out of the Ordovician *Drepanella*. The valves of the male forms of the new genotype in fact are more like those of the oldest species of that genus, as for instance the middle Stones River *Drepanella ampla*, than the Richmond representatives of that genus. Except that the anterior lobe is well developed and confluent with the ventral part of the marginal ridge, there is no satisfactory difference between these Silurian species and their supposed Ordovician ancestors. But even the anterior ridge and in fact the marginal ridge as a whole is subject to considerable modification in *Drepanellina*. It is weakly developed and certainly but obscurely defined in *D. simplex* and *D. confluens*. In the former of these both the anterior and the posterior ridge is sunken, close to the dorsal edge, beneath the level of dorsal angles. In the males of the latter the posterior ridge is well and more normally developed but the anterior ridge is almost completely merged with the

antero-median lobe whereas the ventral ridge is so thick and low as scarcely to suggest the ventral ridge of *D. clarki* and *D. modesta*. Indeed, *D. confluens* presents a suspicious resemblance to *Kladenia*. Under the circumstances *Drepanellina* should be regarded as a type of varying aspect, the variability probably being caused by instability of generic characters in the decadence of an old genus. Compared with *Drepanella*, which itself is most variable in the lobation of its valves, the new Silurian genus *Drepanellina* is distinguished mainly by the development of a broad and indefinitely outlined brood pouch in the female. This swelling affects the posterior two-thirds of the ventral ridge in *D. clarki*, *D. modesta* and *D. simplex* and the post-ventral three-fifths of the ventral half in *D. confluens*.

D. simplex suggests *Kyammodes*, while *D. confluens* makes one think of *Kladenia*.

Genotype.—*Drepanellina clarki* n. sp.

DREPANELLINA CLARKI n. sp.

Plate LVI, Figs. 10-13

Description.—Length, 4.0 mm.; height, 2.3 mm. The sharply defined, high subcarinate marginal ridge and two vertically disposed high median lobes, the posterior of which is the broader and the extremities of which project beyond the dorsal edge and the subequal ends and sharp dorsal angles impart an unmistakable aspect to the male valves of this fine species. The female differs only in the much greater development of the ventral ridge. On its overhanging under side the pouch is finely striated.

The specific name of this splendid ostracode is in memory of Dr. William Bullock Clark, late state geologist of Maryland, to whose energetic efforts science owes the initiation of the series of paleontologic reports of which this is one.

Occurrence.—CLINTON. The principal guide fossil of the *Drepanellina clarki* or upper zone at Cumberland and other localities in Maryland, and Lakemont, Hollidaysburg, McKees farm, 7 miles west of Lewiston, etc., Pennsylvania.

Collection.—Maryland Geological Survey.

DREPANELLINA MODESTA n. sp.

Plate LVI, Figs. 1, 2

Description.—Length, 2.8 mm.; height, 1.8 mm. Differs from *D. clarki* mainly in the fact that the median lobes are somewhat lower and do not quite reach the dorsal edge. So far as known it does not attain the size of that species. The relations in this respect are indicated by the illustrations.

Occurrence.—CLINTON. *Drepanellina clarki* zone at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

DREPANELLINA? SIMPLEX n. sp.

Plate LVI, Fig. 3

Description.—Length, 0.95 mm.; height, 0.60 mm. This is a much smaller species than either *D. clarki* or *D. modesta* and more nearly semiovate in outline. It differs especially in the greater convexity of the valves and the resulting immersion of the marginal ridge. The dorsal continuations of the immersed ridge, that is, the parts that correspond to the anterior and posterior ridges in *D. clarki*, are exceedingly weak and sunken beneath the level of the dorsal angles. The pair of median lobes, on the contrary, stand out very prominently.

This is perhaps more than a suggestion of *Kyammodes* in this species, but until whole specimens shall have been found we prefer to classify it as above provisionally.

Occurrence.—CLINTON. (*Drepanellina clarki* zone), Lakemont, Pennsylvania.

Collection.—U. S. National Museum.

DREPANELLINA CONFLUENS n. sp.

Plate LVI, Figs. 7-9

Description.—Length, 3.0 mm.; height, 1.75 mm. Despite the general resemblance to species of *Kloedenia* this species is believed to be a closer genetic ally of *Drepanellina clarki*. It is thought to be merely a case of almost complete confluence of the two anterior lobes and consequent

elimination of the anterior sulcus. The ventral ridge also is practically effaced in the broader convexity of the ventral half. However, the edge is thick and descends vertically from the edge of the ventral and lateral slopes, as in typical *Drepanellina*. In the female, too, the brood pouch is undefined low and otherwise much the same as in *D. clarki*. The only difference in this feature is that the anterior limits of the pouch lie somewhat nearer the midlength. As a species, of course, these distinctions are sufficiently conspicuous to render its identification and separation comparatively easy.

Occurrence.—Mt. Wissick, Temiscouta Lake, Quebec, Canada.

Collection.—U. S. National Museum.

DREPANELLINA VENTRALIS n. sp.

Plate LVI, Figs. 5, 6

Description.—Length, 1.70 mm.; height, 1.00 mm. Though having the essential characters of *Klædenia* this species makes one think of other genera before finally deciding that it does not fit as well in any other. The peculiar transverse elevation near the middle of the ventral side and the suggestion of its continuance in the posterior lobe brings *Drepanella* with its sickle-shaped marginal ridge to mind. Besides, the sulci extend rather farther across the valves than usual in *Klædenia*. However, they are somewhat shorter in the variety. For the present then the classification adopted seems the least objectionable. The variety occurring with the typical form of the species differs in having inturned dorsal angles, a shorter hinge and the transverse ventral ridge farther removed from the edge.

Occurrence.—CLINTON. *Drepanellina clarki* zone, 34 feet above Keefer sandstone at Rose Hill, Maryland.

Collection.—Maryland Geological Survey.

DREPANELLINA CLAYPOLEI n. sp.

Plate LVI, Fig. 4

Description.—Length, 1.85 mm.; height, 1.00 mm. Distinguished from all of the species now referred to *Drepanellina* by its oblique shape,

prominent sharpness of the anterior dorsal angle and smallness of the antero-median node. The ventral ridge and node is more prominent than in *D. ventralis* and the posterior broken continuation of the marginal ridge is better developed. *D. claypolei* may be regarded as intermediate between *D. ventralis* and *D. clarki* and through the former which it precedes in age possible connection with *Kyammodes* and such species of *Zygobeyrichia* as *Z. ventricornis* is strongly suggested.

Occurrence.—CLINTON. Juniata County, Pennsylvania. Specimen collected by Professor E. W. Claypole and received from him many years ago.

Collection.—U. S. National Museum.

Family BEYRICHIIDAE

Genus BEYRICHIA McCoy

BEYRICHIA EMACIATA n. sp.

Plate LXIII, Fig. 28

Description.—Length, 1.5 mm.; height, 1.0 mm. The valves in this species suggest emaciation, the thickness being uncommonly low and the anterior and posterior ridges narrower, the furrows being correspondingly wide. The median lobe extends to the dorsal edge, long elliptical in form and drawn out ventrally to form a thin loop connecting it with the base of the anterior lobe. The junction of the anterior and dorsal sides is rectangular, the posterior part of outline decidedly rounded. The valves on the whole are unusually high in comparison with the length.

This combination of characters is not exactly matched by any of about 100 species of this genus recognized by us. With possibly a single exception that we know from the Richmond of Ohio, this is the oldest species of the genus. This fact excuses the establishment of a new species on material that is not in a satisfactory state of preservation.

Occurrence.—CLINTON. Fifty-seven feet above the Tuscarora sandstone along Wills Creek, Cumberland, Maryland.

Collection.—Maryland Geological Survey.

BEYRICHIA KIRKI n. sp.

Plate LXIII, Figs. 29, 30

Description.—Length, 2.0 mm.; height, 1.40 mm. Characterized by its relatively narrow anterior end, long hinge, angular dorsal extremities, the anterior especially being drawn out, and irregularly nodose surface. The posterior ridge or lobe is low in its ventral half but rises into a prominent node at the dorsal margin. A similar node occurs at the dorsal extremity of the inner side of the anterior lobe. The latter is of irregular form, wide and high below, low in its middle and antero-dorsal parts. The middle lobe is spindle shaped being drawn out dorsally, and ventrally, the latter part narrowing like the neck of a gourd and curving forward to join the base of the anterior lobe. The border as usual has a thickened rim, the concave space within it being wider at the dorsal angles and in the post-ventral part but narrows decidedly in the lower part of the anterior side. The radial striations are practically wanting.

The specific name is in honor of Dr. Edwin Kirk of the U. S. Geological Survey, who collected most of the specimens used in the above description.

Occurrence.—CLINTON. Lower part at Lakemont, Pennsylvania.

Collection.—U. S. National Museum.

BEYRICHIA LAKEMONTENSIS n. sp.

Plate LXIII, Fig. 25

Description.—Length, 1.9 mm.; height, 1.25 mm. *B. lakemontensis* is allied to and commonly associated with *B. kirki* with which it was first confused. On more careful study we find many small differences: the hinge-line is shorter, the rim thinner, the anterior dorsal angle is obtuse instead of sharply angular and produced, the nodes and irregularities in surface contour while similar in position are less prominent; and in other features that are best appreciated by comparison of the illustration. Of these other differences one may be pointed out, namely, the frill is radially marked by waves rather than striations.

Although these characters tend toward the normal among species of *Beyrichia* there is none with which we are acquainted that is a closer ally

than *B. kirki*. This is true particularly so far as American species are concerned.

Occurrence.—CLINTON. *Mastigobolbina typus* zone at Lakemont and other localities near Hollidaysburg, Pennsylvania, and in the corresponding beds at Great Cacapon, Maryland.

Collection.—U. S. National Museum.

BEYRICHIA MESLERI n. sp.

Plate LXIII, Figs. 17-20

Description.—Length, 1.50 mm.; height, 1.10 mm. This species occurs with and is likely to be confused with *B. moodeyi*. However, it seems constantly a smaller form and with well-preserved material is distinguished at once by its lack of surface punctæ or reticulation. Another constant difference lies in the presence of the low nodes at the dorsal extremities of the anterior and posterior lobes, a feature that is wanting in *B. moodeyi*. Further the anterior sulcus is not so oblique and usually at least is also narrower than in the associated species. Finally, there is a shallow groove in the outer slope of the anterior lobe that is wanting in *B. moodeyi*. Several of these differentiating features, notably the absence of surface ornament, the nodes on the dorsal extremities of the anterior and posterior lobes and the furrow on the antero-dorsal slope of the anterior lobe, remind sufficiently of *B. lakemontensis* and somewhat less of *B. kirki* to impress us with the conviction that the genetic relations of *B. mesleri* are with those species rather than with *B. veronica* and *B. moodeyi*. It is too clearly distinct from the former pair of species to require detailed comparison.

The specific name is in honor of Mr. H. D. Mesler of the U. S. Geological Survey.

Occurrence.—MCKENZIE FORMATION. Upper part, 77 and 82 feet below top at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

BEYRICHIA TONOLOWAYENSIS n. sp.

Plate LXIII, Fig. 26

Description.—Length, 1.30 mm.; height, 1.00 mm. This is another derivative of *B. kirki* and one that followed *B. mesleri*. Its outline is much more oblique than that of the latter and also more so than in the former; and its length is relatively less than in either though particularly in *B. kirki*. It differs again from both in its narrower anterior lobe. The two thin carinæ on either side of the ventral half of the anterior lobe are characteristic. The wide, radially striated ventral border suggests its nearness to *B. mesleri*.

Occurrence.—TONOLOWAY LIMESTONE. Lower part, 128 feet above base at Grasshopper Run near Hancock, Maryland.

Collection.—Maryland Geological Survey.

BEYRICHIA VERONICA n. sp.

Plate LXIII, Figs. 21-24.

Description.—Length, 0.90 mm.; height, 0.65 mm. A well-characterized species resembling in general the McKenzie species *B. moodeyi*. It differs in having a coarser surface reticulation, in the greater curvature and decidedly lesser obliquity of the anterior sulcus, its narrower posterior sulcus which is not cut off at the base of the median lobe as in that species but continues on into the post-ventral depression which affects more of the area wherein the ventral extremities of the lobes commonly join than usual in species of this section of the genus. The posterior lobe, therefore, is more definitely separated below from the other lobes than in *B. moodeyi*.

B. veronica is an altogether normal species of the typical *B. kladini* group of the genus. Three or four European species might be cited as close allies but detailed comparisons of specimens and illustrations have satisfied us of the specific distinctness of this Appalachian species. Among the American species its nearest relative in addition to *B. moodeyi* mentioned above is *B. granulifera* Hall which is one of the rare members of the fauna of the Waldron shale of Indiana. Regarding the relations to

the latter, one would hardly suspect their actual closeness judging it solely from the description and figures published by Hall and the name *granulifera* applied to it. However, investigation of the original type now preserved in the American Museum of Natural History has brought out the fact that the surface is not granulose as stated and figured by its author but finely reticulated as in *B. veronica* and *B. moodeyi*. In view of this fact, the question arises whether *B. waldronensis* Ulrich and Bassler is not founded on a specimen of the misnamed *B. granulifera*.

B. veronica differs from *B. moodeyi* and the Waldron species in the lesser development of the ventral part of the posterior lobe and its narrower, less distinctly striated but thicker rimmed border. Other differences may be observed on critical comparison of the illustrations. For instance, the base of the median lobe and its junction with the base of the anterior lobe is more depressed. The reticulate surface ornament is also of a coarser pattern in *B. veronica*.

Occurrence.—CLINTON. *Drepanellina clarki* zone at Cumberland, Maryland, and Hollidaysburg and McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—Maryland Geological Survey.

BEYRICHIA MOODEYI Ulrich and Bassler

Plate LXIII, Fig. 27.

Beyrichia moodeyi Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 285, pl. xxxvii, fig. 8.

Description.—Length, 1.50 mm.; height, 1.00 mm. This species is probably the American form referred to *Beyrichia maccoyiana* by Jones. It is distinguished from that European species by the greater isolation of the median lobe and the very finely punctate surface of the lobes. Apparently derived out of Upper Clinton *B. veronica* from which it differs in the obliquity of the anterior sulcus, the minor constriction at the base of the middle lobe and lesser separation of the ventral extremity of the posterior lobe from adjacent parts of the middle and posterior lobes. The surface reticulation also is of a finer pattern and the average size of the carapace somewhat greater.

Occurrence.—McKenzie formation. One and one-half miles east of Great Cacapon, West Virginia, Cumberland, Maryland, and 237 feet below top at Pinto, Maryland.

Collection.—Maryland Geological Survey.

BEYRICHIA HARTNAGELI n. sp.

Fig. 27, 3-5

Description.—Intermediate in size and also in its outline between *B. veronica* and *B. normalis*, from both of which it differs in its narrower and obtusely carinated posterior lobe and uncommonly thick, semiglobular median lobe. The frill or border is rather wide, radially striated, and distinctly concave. The surface marking is by small, closely arranged punctæ as in the mentioned species, but the pits are so shallow and obscure that the surface in some specimens appears quite smooth. A more important and also more striking difference is observed in comparing females. In those of *B. veronica* and *B. normalis* the brood pouch is almost round, whereas in *B. hartnageli* it is decidedly ovate and also much larger.

This species is introduced here mainly to help in showing that the ostracod fauna of the Irondequoit limestone of western New York is not strictly comparable with that of any Appalachian Clinton zones. The senior author collected at least six species of Ostracoda, among them this *Beyrichia*, out of a block of Irondequoit limestone found about 8 miles east of Lockport. The other species comprise one of *Kladenella*, one of *Dizygopleura* (allied to *D. proutyi* and *D. pricei* of the *Drepanellina clarki* zone but a clearly distinct new species), a *Thlipsura* and two species of *Bythocypris*. Except the last, which are too simple in structure to be of value in stratigraphic correlation, none of these Ostracoda is precisely like any of the Silurian species found in Maryland. The *Beyrichia hartnageli* is perhaps as near, if not more closely related, to *B. lakemontensis*, a species of the *Mastigobolbina typus* zone, than to either of the two species of the genus found in the overlying *Drepanella clarki* zone. As for the new *Dizygopleura*, it might well represent an antecedent stage

in the development of a species like *D. pricei*. In view of these considerations we feel warranted in suggesting the possibility that the Irondequoit limestone of New York falls into the Maryland section at the horizon of the Keefer sandstone.

Occurrence.— IRONDEQUOIT LIMESTONE. Near Lockport, N. Y.

Collection.—U. S. National Museum.

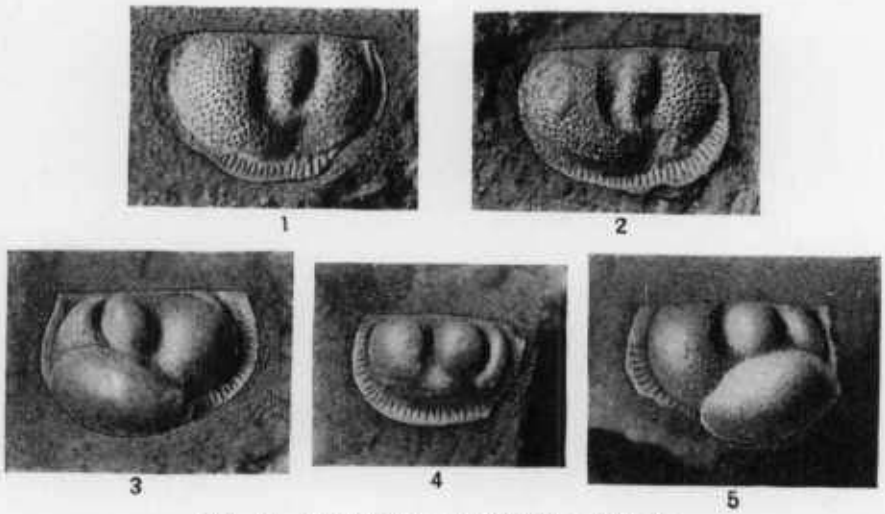


FIG. 27.—ILLUSTRATING THE GENUS BEYRICHIA.

1, 2. *Beyrichia normalis* new species. Two left valves, ×20. Clinton (*Dreparella clarki* zone) McKees farm, 7 miles west of Lewiston, Pennsylvania.
3-5. *Beyrichia kurtnagrii* new species. 3. Right valve, female, ×20. 4. Left valve, male, ×20. 5. Left valve, female, ×20. Irondequoit limestone, 8 miles east of Lockport, New York.

BEYRICHIA NORMALIS n. sp.

Fig. 27. 1, 2

Description.—Associated with *B. veronica* at McKees, Pa., there is another reticulated species. It attains a larger size than *B. veronica* and differs further in its relatively shorter form and much more rounded and very slightly projecting antero-dorsal angle. These characters bring it into even closer alliance with *B. waldronensis*, with which, indeed, we were

at first inclined to unite these specimens. However, on closer comparison they were found to differ from the Waldron species in being relatively shorter, more equal-ended, with the posterior lobe longer, the median lobe narrower and more deeply separated from the posterior lobe. Moreover, the frill is much narrower and differently oriented with respect to the plane of the valves.

Occurrence.—CLINTON, *Dropanellina clarki* zone, McKees farm, 7 miles west of Lewiston, Pa.

Collection.—U. S. National Museum.

Genus DIBOLBINA new genus

Widely frilled Beyrichiidæ in which the median lobe is almost completely merged with the posterior lobe by great shallowing and practical elimination of the posterior sulcus. However, the median lobe is still indicated by a small prominence located nearly in the middle of the valves excluding the frill. Just in front of it is a fairly deep curved sulcus or depression that fails to reach the dorsal edge and on the opposite side passes into a much shallower post-ventral depression. In the females the latter is covered by the inner half of a semiglobose brood pouch, the outer half lying on the frill.

This new genus is at present represented by only two species, both found in the Tonoloway limestone—the youngest formation of the Silurian system in Maryland. Their genetic relations to other ostracoda are somewhat obscure, because they remind in one or another respect of several widely differing generic types. The general aspect, with particular reference to the wide frill, elongate form and simple lobation, suggests *Eurychilina*. The body of the valves reminds in its curved furrow of the unisulcate species of *Ctenobolbina* and also of species now referred to *Eutomis*. But these seem to be mere resemblances and not, we are convinced, indicative of truly close relationships.

Decadence of the stock of typical *Beyrichia* had set in when these late Silurian Dibolbinas existed; and no unquestionable representative of that genus survived into the Devonian. Descendants there were and in con-

siderable number and variety too, but all of them had sustained striking modifications in important structural features.

It is interesting to observe how these newer Devonian modifications of the typical Silurian Beyrichian stock harked back to pre-Silurian facies and stages in the evolution and development of the family. One *Drepanellina* reminds of the Ordovician *Drepanella*, others strongly suggest *Ctenobolbina*, typically also an Ordovician genus, still others recall *Eurychilina*.

Now, something of similarly regressive or atavistic nature happened in the evolution of *Dibolbina*. That this type really was derived out of typical *Beyrichia* and not out of either *Entomis*, *Ctenobolbina* or *Eurychilina* is strongly indicated by its retention of certain features that are strictly characteristic of the first but wanting in all of the last, namely, (1) the shape of the anterior lobe; (2) the delicate ridge on the antero-ventral slope of the anterior lobe the like of which is not uncommon in *Beyrichia* (*e. g., B. tonolowayensis*) but hardly known among the other possible relatives; (3) the depression in the ventral slope behind the midlength than which there is nothing more characteristic of *Beyrichia;* and (4) the semiglobular form of the brood pouch. Presumably in the ontogeny of *Dibolbina* only these characters attained typical Beyrichian stages, other features halting at various larval stages.

Genotype.—Dibolbina cristata.

DIBOLBINA CRISTATA n. sp.

Plate LXIII, Figs. 13-15

Description.—Length with frill, 1.80 mm.; height, 1.00 mm. The specific peculiarities of this species are the delicate crest-like ridge on the antero-ventral slope of the anterior lobe, the rounded posterior side, and the obtusely angular posterior termination of the hinge.

Except the following species no other ostracode is known in the Silurian rocks of America or elsewhere that could possibly be confused with this species.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, West Virginia, Pinto and other localities in Maryland.

Collection.—Maryland Geological Survey.

DIBOLBINA PRODUCTA n. sp.

Plate LXIII, Fig. 16

Description.—Length with frill, 1.40 mm.; height, 0.80 mm. This species is distinguished from *D. cristata* by its longer hinge, the dorsal half of the posterior end being rectangular instead of incurved and the anterior extremity of the hinge even more produced; second, by the presence of a low crescentically curved ridge behind the acuminate anterior extremity; third the slightly greater convexity of the ventral half of the anterior lobe; and fourth by the absence of the antero-ventral crest of that species.

Occurrence.—TONOLOWAY LIMESTONE. Lower part (128 feet above base) at Grasshopper Run near Hancock, Maryland.

Collection.—Maryland Geological Survey.

Family KLOEDENELLIDAE new family

The genus *Kloedenella* was established by the writers in 1908.[1] At the same time the subfamily Kloedenellinæ, comprising besides *Kloedenella* the Carboniferous genera *Beyrichiopsis*, *Beyrichiella*, *Jonesina*, and *Kirkbyina*, was proposed. Measured against the present state of information our conception of at least the Silurian and early Devonian representatives of the subfamily or rather family, as we now prefer to view it, was far from adequate. We knew nothing of the astounding wealth of slightly differentiated species and varieties or mutations whose small shells now occur by millions, packing many of the thin limestone layers in the McKenzie, Wills Creek, and Tonoloway formations in Maryland and adjoining states. The great majority of these ostracodal remains, especially those in the McKenzie formation, belong to this family. Although many different forms have been determined and are here illustrated, in nearly all cases for the first time, the fulsome material in hand is still far from exhausted. Doubtless many other distinguishable forms will reward further investigation. However, enough of them have been studied and discriminated to

[1] Proc. U. S. Nat. Mus., vol. xxxv, p. 817, 1908.

make them of great value in definitely recognizing and correlating the major zones of the Silurian deposits in the middle Appalachian region.

Very few of the species range beyond the limits of the formation in which they occur. Indeed, most of them are confined to either the lower or the upper part of the formation. The exceptions, even, are commonly sufficiently different in their successive stratigraphic occurrences to enable one to decide which are earlier and which later manifestations of the particular species. Such closely discriminated forms when found in areas outside of Maryland should make very trustworthy correlation criteria.

In the original description of *Klædenella* (*loc. cit.*) it was recognized that the genus is divisible into two groups. In the first, comprising the genotype *K. pennsylvanica*, the posterior and median furrows are short and the anterior one either wanting or more or less well developed. In the second group, of which *Beyrichia halli* Jones was cited as a good example, the posterior and anterior furrows are subequal and so long that they extend nearly or quite across the valve. In the light of the much larger specific representation of Klædenellidæ now available there is ample warrant for the statement that these two groups are for the greater part perfectly natural and really of higher systematic value than we believed in 1908.

With the present great increase in the number of species that would fall under *Klædenella* as conceived by us in 1908 it follows quite naturally that restriction of that name to some natural and well-characterized group of forms should now be advocated. But, as usual, the separation of the species into natural generic groups is no easy matter. The mutation of the species and their subsequent development is never along regular and sharply defined lines. Except the groups are made very small it is impossible to avoid all artificiality in their classification. There is certain to be some real or at least apparent overlapping and interfingering of relationships. Besides, genera of many species are not developed out of a single root but all are more or less polyphyletic in origin.

In *K. pennsylvanica*, the genotype, we have a fairly definite combination of characters. Seven of the following Silurian species conform with reasonable fidelity to its essential features. In all of them the anterior

sulcus is either wanting entirely or barely suggested by a slight depression in the ventral slope. So far the composition of the restricted genus is clearly indicated. The uncertainties and troubles begin when we take up species like those to which the specific names *intermedia, micula,* and *asymmetrica* have been given. In the first the anterior sulcus is still entirely wanting but the outer side of the part that would correspond to the anterior lobe if the anterior sulcus were developed is clearly defined by a curved or nearly straight depression in the anterior slope. In this species the anterior pair of lobes as developed in the "quadrijugate" types of Kloedenellidæ is merged in a single correspondingly broad lobe. In the second and third species the anterior furrow is incompletely and shallowly developed, partially setting off a narrow anterior lobe. Finally, there is the species *loculata* in which the anterior sulcus is represented by a large and deep rounded depression. From the conditions obtaining in species *micula* and *asymmetrica* we pass then gradually through species *subdivisa* and *concentrica* to the *subquadrata* in which quadrilobation is clearly developed.

The difference between those species like *K. pennsylvanica* in which only the posterior half of the carapace is sulcated and those others like the species *clarkei* in which the anterior half as well as the posterior is divided into two lobes is so striking that we were inclined already in 1908 to regard them as warranting their classification under distinct generic names. The intention was then abandoned solely because the extremes seemed to be linked together by transitional forms. Now, however, since the species of the family have greatly increased in number we carry out not only the original desire for two genera but we feel constrained to institute a third also closely allied generic group for a type of structure that was not represented in our collections when *Kloedenella* was proposed in 1908. In accord with these conclusions the new generic term *Dizygopleura* is proposed for the group of quadrilobate species and *Eukloedenella*, for the third new group in which the lobation of the valves is either entirely obsolete, as in *E. indivisa* and *E. umbonata*, or restricted to a simple small median pit or short sulcus, as in *E. umbilicata* and the remaining others of the total of 15 species.

There is no difficulty in drawing the line between *Kuklædenella* and *Klædenella*, the separation being accomplished on the clearly cut basis of the presence of a well-defined posterior sulcus in the latter and the absence of this sulcus in the former. However, in the case of *Klædenella* and *Dizygopleura* the separation is not so easily carried out. In defining the limits of these two genera, as intimated above, we are confronted not only with some real and many apparent transitions but also with questions concerning the genetic alliances of certain species that viewed from the empirical standpoint of actual resemblance in character would be referred to *Klædenella*, whereas the recognition of genetic derivation as a dominant factor in the problem would require their reference to *Dizygopleura*.

A solution of most of these problems has been carefully tested and found to be as a rule readily applied and also to produce the least of confusion and unnaturalness of association. Namely, if the area that normally is affected in the quadrilobation of the valves is clearly outlined on the anterior side and the posterior pair of furrows is well developed then the species falls under *Dizygopleura*. Likewise if the anterior furrow is distinctly developed across at least the ventral half of the valves even when the outer side of the quadrilobate area is not sharply defined. Under the first condition the species *intermedia* and *planata* are admitted to *Dizygopleura* and referred to an extreme position in the group of *D. subdivisa*. Under the second condition the species *proutyi* and its immediate allies and the species *acuminata* together with its closest allies also are referred to *Dizygopleura* and not *Klædenella*. Just over the line is the species *Klædenella transitans*, in which the development of the anterior sulcus from the ventral side has progressed only to an insignificant degree and the outer of the two anterior lobes is quite inappreciable. *K. nitida* also has a faint indentation in the ventral slope but makes a truer *Klædenella* because of the shortness of the posterior sulcus. In *K. cacaponensis*, on the contrary, the posterior sulcus is so long that with the added fact that the anterior side of the lobed area is defined, though rather weakly, it is really doubtful whether this species is more properly placed with *Klædenella* or in the *D. subdivisa* group of *Dizygopleura*. However,

aside from these few mentioned instances wherein valid doubts obtain the classification of the 56 species of American Silurian Klœdenellidæ is reasonably convincing.

Genus *Poloniella* Gurich. In a short paper received while the present work was going through the press Miss J. E. Van Veen[1] asserts the generic identity of *Klœdenella* Ulrich and Bassler and the older term *Poloniella* proposed by Gurich[2] for a rather peculiar ostracod from the middle Devonian ostracod marl of Dombrowa near Kielce, Poland. Gurich based his genus on several whole shells and separated valves of a single species to which he applied the name *Poloniella devonica*. Miss Van Veen reproduces the apparently very good figures originally published by Gurich.

Judging from these illustrations we are regretfully obliged to disagree with the conclusion that our *Klœdenella* viewed either in the broad sense in which it was originally proposed or in the restricted one now given it is identical with Poloniella. On the contrary we doubt that the two belong even to the same family. Unfortunately, we lack the space and time to discuss the relations of these two genera as they should be. Under the circumstances we must content ourselves with the simple statement that in our opinion *Poloniella*, instead of being the same as any of the genera of the Klœdenellidæ is really very near and perhaps generically the same as species now referred to Jones and Holl's genus, *Octonaria*. When the critical revision of the latter genus now in progress shall have been completed it seems not unlikely that *Poloniella* may prove worthy of separate recognition either as a subgenus or independent genus in the family Thlipsuridæ.

Mentioning only the essential differentiating features, the three Silurian genera now recognized as forming the Klœdenellidæ may be briefly characterized as follows:

Euklœdenella, n. gen.: Surface of valves evenly convex or with only a median pit or sulcus and more rarely with a shallow depression in the ventral slope. Genotype, *E. umbilicata* new species.

[1] The identity of the genera *Poloniella* and *Klœdenella*, Koninklijke Akademie van Wettenschappen te Amsterdam, vol. xxiii, 1921.

[2] Gurich, G., Verhandl. der Russisch-Kaiserl. Mineral. Gesellsch. zu St. Petersburg, 2d series, vol. xxxii, 1896.

Klædenella Ulrich and Bassler (restr.): Surface of valves with a median and a posterior sulcus both usually confined to the post-dorsal quarter, otherwise like *Euklædenella*. Genotype *K. pennsylvanica* (Jones).

Dizygopleura, n. gen.: Surface of valves usually quadrilobate, rarely trilobate, the lobes separated by three, rarely two, long sulci, of which the anterior may be in part or entirely obsolete. In the former case the anterior sulcus begins on the ventral slope and dies out before reaching two-thirds across the valve; or it may be represented by a crescentic or more rounded depression midway between the dorsal and ventral edges. In the latter case the elevated and anteriorly defined area lying in front of the median sulcus is much wider than the posterior ridges, since it comprises the confluent anterior pair of lobes. Genotype, *D. swartzi* n. sp.

As now known and understood *Kladenella* is represented by 10 species, *Euklædenella* by 15 species and 4 named varieties, and *Dizygopleura* by 35 species and 10 partly named varieties. The species of *Euklædenella* are divisible into five sections or groups. The same number of sections are recognized in classifying the species of *Dizygopleura*. Passing in regular order from the most simple to the most complex type of structure the species of the several genera are named and classified as follows:

Genus EUKLOEDENELLA new genus

	Middle Clinton	Upper Clinton	McKenzie form 30	McKenzie form 100	McKenzie form 30	McKenzie form 50	Wills Creek	Tonoloway Lower	Tonoloway Upper
I. Group of *E. indivisa*. Species without median or other sulci.									
Euklœdenella indivisa n. sp.			X						
E. umbonata n. sp.			X						
II. Group of *E. umbilicata*. Species with only a median pit or sulcus.									
Euklœdenella umbilicata n. sp.			X						
E. umbilicata curta n. var.							X		
E. primitioides n. sp.			X						
E. primitioides minor n. var.			X						
E. brevis n. sp.			X						
E. simplex n. sp.			X						
III. Group of *E. sinuata*. Species with short median sulcus and projecting antero-ventral flange.									
Euklœdenella sinuata n. sp.					X				
E. sinuata angulata n. var.					X				
E. sinuata proclivis n. var.					X				
E. punctillosa n. sp.						X	X		
E. dorsata n. sp.					X				
IV. Group of *E. sulcifrons*. Species as in II except that the anterior slope is broadly concave.									
Euklœdenella sulcifrons n. sp.			X						
E. similis n. sp.			X						
E. abrupta n. sp.		X							
V. Group of *E. bulbosa*. Species as in II except anterior third is slightly swollen and segregated by a shallow depression in the ventral slope.									
Euklœdenella bulbosa n. sp.			X						
E. foveolata n. sp.			X						
E. longula n. sp.			X						

Genus KLOEDENELLA Ulrich and Bassler

	Upper Clinton	McKenzie form 30	McKenzie form 100	McKenzie form 50	McKenzie form 60	Wills Creek	Tonoloway Lower	Tonoloway Upper
I. Group of *K. pennsylvanica*. Species with evenly convex surface except the two posterior sulci.								
Klœdenella pennsylvanica (Jones) (Lower Devonian)								
K. obliqua n. sp.							X	
K. rectangularis n. sp. (Manlius of New York)								
K. cacsponensis n. sp.		X						
K. scapha n. sp.		X						
K. scapha brevicula n. var.		X	X					
K. subovata n. sp.				X				
II. Group of *K. nitida*. Species with a shallow depression in ventral slope.								
Klœdenella nitida n. sp.			X					
K. immersa n. sp.			X					
K. gibberosa n. sp.				X				
K. transitans n. sp.		X						

	Middle Clinton	Upper Clinton	McKenzie form				Willa Creek	Tonoloway	
			50	100	50	50		Lower	Upper
I. Group of *D. proutyi*. Anterior sulcus confined to ventral half; anterior lobe more or less bulbous.									
Dizygopleura proutyi n. sp		x							
D. pricei n. sp		x							
D. lacunosa n. sp		x							
D. minima n. sp	x								
D. gibba n. sp					x				
D. carinata n. sp						x			
D. acuminata n. sp						x			
D. acuminata prolapsa n. var						x			
D. affinis n. sp							x		
D. bulbifrons n. sp					x				
II. Group of *D. intermedia*. Anterior side of lobed area defined but anterior sulcus wanting, the pair of anterior lobes confluent.									
Dizygopleura intermedia n. sp			x						
D. intermedia antecedens n. var		x							
D. intermedia cornuta n. var		x							
D. planata n. sp. (Manlius of New York)									
III. Group of *D. subdivisa*. Like II but anterior sulcus developed in anterior median part of raised lobed area.									
Dizygopleura subdivisa n. sp			x						
D. micula n. sp		x							
D. asymmetrica n. sp		x							
D. cranei n. sp		x							
D. loculata n. sp	x								
D. concentrica n. sp					x				
D. subquadrata n. sp			x						
IV. Group of *D. swartzi*. Distinctly quadrilobate, lobes thick, anterior and posterior sulci long, narrow, deeply impressed, the middle sulcus shorter.									
Dizygopleura swartzi n. sp						x			
D. pinguis n. sp			x						
D. falcifera n. sp			x						
D. symmetrica (Hall)		x							
D. stosei n. sp					x				
D. stosei var			x						
D. macra n. sp	x								
Subgroup *D. halli*. Sulci shorter than in typical *D. swartzi*.									
Dizygopleura halli Jones								x	x
D. halli obscura n. var								x	
D. subovalis n. sp									x
D. simulans n. sp								x	
D. simulans limbata n. var								x	
D. clarkei Jones (Manlius of New York)									
V. Group of *D. hieroglyphica*. Valves depressed convex, lobes narrower than the furrows.									
Dizygopleura hieroglyphica (Krause) (Baltic drift)									
D. virginica n. sp. (base of Sneedville ls.)									
D. unipunctata n. sp					x				
D. costata n. sp									x
D. perrugosa n. sp				x					

Genus EUKLOEDENELLA new genus

As mentioned in the foregoing discussion the surface of the valve is evenly convex or with a median pit or sulcus and more rarely with a shallow depression in the ventral slope.

Genotype.—*Eukladenella umbilicata* new species.

For convenience of description and recognition the known species of *Eukladenella* may be divided into five groups based upon the surface markings of the valves.

1. Group of *Eukladenella indivisa*

Species without median or other sulci.

EUKLOEDENELLA INDIVISA n. sp.

Plate LVII, Figs. 1-4

Description.—Length, 1.6 mm.; height, 0.94 mm. Carapace very slightly oblique, the ends being rounded with the greatest convexity in the diagonally opposed corners. Front end somewhat wider, slightly higher and thicker although the slope in profile toward the anterior edge is not very abrupt. Surface smooth, without definite sulci or pit of any sort.

Occurrence.—McKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA UMBONATA n. sp.

Plate LVII, Figs. 5-7

Description.—Length, 1.75 mm.; height, 1.0 mm. Differs from *E. indivisa* in its very prominent antero-dorsal quarter giving the carapace a somewhat umbonate appearance found in many pelecypods. Besides the vertical edge is straight and there is a slight depression in the middle of the outer slope.

Occurrence.—McKENZIE FORMATION, 30 feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

II. Group of *Eukladenella umbilicata*

Species with a median pit or sulcus.

EUKLADENELLA UMBILICATA n. sp.

Plate LVII, Figs. 8-12

Description.—Length, usually about 1.5 mm., rarely as much as 1.7 mm. or as little as 1.3 mm.; height, 0.8 mm. The species is characterized by a simple umbilical pit, its oblique round-oblong outline in which there are no sharp curves, and its acuminately elliptical or rather lens-shaped profile in dorsal and ventral views. In such profile views the point of greatest thickness lies nearly always in front of the middle but not far enough to produce any great difference in the slopes to the two ends. In perfect specimens the surface is puncto-reticulate.

Occurrence.—McKENZIE FORMATION, 30 feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

EUKLADENELLA UMBILICATA var. CURTA n. var.

Plate LVII, Fig. 13

Description.—Length, 1.1 mm.; height, 0.75 mm. In most features like *E. umbilicata* but immediately distinguished by its shorter form. As the shortening is confined to the anterior three-fifths the umbilical pit lies much nearer the midlength than in typical *E. umbilicata*. The anterior also descends much more rapidly.

A general resemblance to *E. simplex* may be noted but the relation to that species is not very close. This is shown (1) in the very different outline of the anterior edge, (2) in the absence of the gentle concavity of the anterior slope pertaining to that species, (3) the absence of a rim on the posterior border and (4) the more uniform convexity of the middle part of the dorso-ventral profile.

Occurrence.—WILLS CREEK FORMATION. Forty-five feet above base, Pinto, Maryland.

Collection.—Maryland Geological Survey.

KLOEDENELLA PRIMITIOIDES n. sp.

Plate LVII, Figs. 14-17

Description.—Length, usually about 0.95 mm., the observed extremes being 0.88 mm., and 1.02 mm. Height, about 0.6 mm.

Allied to *K. kloedenella umbilicata* with which it is associated, but differing in its smaller size and in the overlap of the valves, the right failing to overlap the left anteriorly, the reverse condition obtaining in the genotype. In addition, the carapace is relatively more convex than in *K. umbilicata*, the anterior slope is steeper and the antero-dorsal quarter much thicker. Finally, there is rather more than a suggestion of the sulcus of typical *Kloedenella*.

Occurrence.—McKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

KLOEDENELLA PRIMITIOIDES var. MINOR n. var.

Plate LVII, Figs. 18-20

Description.—Associated with the typical form of the species are numerous specimens that differ only in being invariably much smaller. So far as observed the length in them ranges between 0.60 mm. and 0.65 mm. In the typical form the length seldom falls under 0.95 mm. The constancy of this small form seems worthy of a varietal name.

Occurrence.—McKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

KLOEDENELLA BREVIS n. sp.

Plate LVII, Fig. 21

Description.—Length, 1.1 mm.; height, 0.70 mm. Characterized by its relatively short form, nearly regularly oval outline, the dorsal angles being obtuse and the ends subequal. The umbilical pit lies near, just a little anterior to the middle of the dorsal half. Around it are a half-

dozen rows of concentrically arranged elongate puncte. The posterior edge only has a well-developed flat border.

Resembles *E. umbilicata curta* but the middle region of the valves is less convex, the outer more ovate and the pit lies slightly in front instead of behind the middle. The umbilical pit also embraces a larger area.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, West Virginia.

Collection.—Maryland Geological Survey.

EUKLŒDENELLA SIMPLEX n. sp.

Plate LVII, Figs. 22, 23

Description.—Length, 1.8 mm.; height, 1.00 mm. Like *E. sulcifrons* with which it is associated, this species has a broad sloping convexity in the anterior slope but the convexity is not so deep, is less sharply defined on its inner side and the anterior slope on the whole is less steep. Moreover, the anterior part of the outline is more uniformly rounded with the dorsal half less produced. Finally, the valves are relatively shorter and the umbilical pit is smaller.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

III. Group of *Euklœdenella sinuata*

Species with short median sulcus and projecting antero-ventral flange.

EUKLŒDENELLA SINUATA n. sp.

Plate LVII, Figs. 24-27

Description.—Length, 1.6 mm.; height, 0.75 mm. Three varieties of this species are recognized. All are marked by a distinctly developed sinus in the ventral edge. The ends are approximately equal in height and in the typical form of the species the outlines of the two ends are similarly incurved at the dorsal angles. In the right valve of the typical variety the dorsal angles are simply rounded or obtusely angular but in the left

the posterior extremity of the hinge forms a projecting spinelike process which locks into a corresponding depression in the right valve. The sulcus is rather large and deep but does not extend more than one-third across the valve. Often a barely perceptible depression marks the spot where the posterior sulcus commonly occurs in *Klodenella*.

The variety *angulata* differs mainly in the more angular antero-cardinal angle and smaller umbilical pit.

The variety *proclivis* also has a smaller umbilical pit but differs from both the typical form and the var. *angulata* in the more sharply angular and more produced antero-dorsal region.

Occurrence.—McKENZIE FORMATION. Seventy-seven and eighty-two feet beneath top, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

EUKLODENELLA SINUATA var. ANGULATA n. var.

Plate LVII, Figs. 28-31; Plate LVIII, Fig. 1

Description.—Associated with the typical form of the species are numerous examples in which the antero-cardinal angle is more angular and the umbilical pit is smaller.

Occurrence.—McKENZIE FORMATION. Seventy-seven and eighty-two feet below top, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

EUKLODENELLA SINUATA var. PROCLIVIS n. var.

Plate LVIII, Figs. 2-5

Description.—Differs from the typical form of the species in its smaller umbilical pit and in the more sharply angular and more produced antero-dorsal region.

Occurrence.—McKENZIE FORMATION. Twenty feet above base at locality 1½ miles east of Great Cacapon, Maryland, Cumberland, Maryland, and upper part of the formation at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA PUNCTILLOSA n. sp.

Plate LVIII, Figs. 7-9

Description.—Length, 1.0 mm.; height, 0.65 mm. *E. punctillosa* is related to *E. sinuata* but the anterior half is relatively much higher and the carapace of inferior size. The umbilical pit also is smaller, the convexity of the valves less and their surface covered with minute crowded punctæ so far not obscured in *E. sinuata* and its varieties.

Occurrence.—McKENZIE FORMATION. Upper 50 feet at Cumberland, Maryland. A very similar form occurs in the basal 50 feet of the Wills Creek formation at Pinto, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA DORSATA n. sp.

Plate LVIII, Fig. 6

Description.—Length, 1.75 mm.; height, 1.06 mm. Similar to *E. sinuata* and its variety *angulata* in general outline and aspect but differs in various minor details and more importantly in the more shallow and undefined character of the umbilical depression.

Occurrence.—McKENZIE FORMATION. Eighty-two feet beneath top at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

IV. Group of *Euklodenella sulcifrons*

Species as in Group II except that the anterior slope is broadly concave.

EUKLOEDENELLA SULCIFRONS n. sp.

Plate LVIII, Figs. 10-12

Description.—Length, 1.6 mm.; height, 0.75 mm. Characterized by its rounded oblong outline, simple small umbilical pit, rather strongly convex valves, and particularly by the wide concavity in the anterior slope.

The greater convexity of the valves, straighter ventral edge and larger size distinguish it from the associated *E. similis*.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA SIMILIS n. sp.

Plate LVIII, Figs. 15, 16

Description.—Length, 0.9 mm.; height, 0.5 mm. Differs from *E. sulcifrons* in the lesser convexity of its valves and the gently convex instead of straight ventral edge. It is also a smaller form and its surface is less prominent in the antero-dorsal quarter.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA ABRUPTA n. sp.

Plate LVIII, Fig. 13

Description.—Length, 0.85 mm.; height, 0.5 mm. This species differs from its allies in the *E. sulcifrons* group in the much greater abruptness of descent and consequent features of the crescentic border. Of other peculiarities we may mention the slight curvature of the inner side of the border and its abrupt termination ventrally. The umbilical pit also is uncommonly shallow and small and seems to be supplemented below by another more rounded pit.

Occurrence.—CLINTON. *Drepanellina clarki* zone at McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—U. S. National Museum.

V. Group of *Euklodonella bulbosa*

Species as in Group II except anterior third is slightly smaller and segregated by a shallow depression in the ventral slope.

EUKLOEDENELLA BULBOSA n. sp.

Plate LVIII, Fig. 18

Description.—Length, 1.6 mm.; height, 0.9 mm. Related to *E. dorsata* and *E. sinuata* but the antero-ventral projection of the edge—hence also the sinus in middle of ventral edge—is less than in those species. It differs again from both in the development of a low bulbous swelling in the lower middle part of the anterior half. This gives probably a false suggestion of alliance to *Dizygopleura proutyi*. The umbilical pit is a broad undefined and dorsally flaring depression agreeing in this respect with *E. dorsata*.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA FOVEOLATA n. sp.

Plate LVIII, Fig. 17

Description.—Length, 0.80 mm.; height, 0.50 mm. Related to *E. longula* from which it differs in its much smaller size and relatively higher posterior half. Both have the kind of constriction in front of middle of ventral slope that is so often observed in *Dizygopleura* and *Kladenella*. This constriction when more fully developed makes the anterior furrow in the deeply sulcated types of the family.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

EUKLOEDENELLA LONGULA n. sp.

Plate LVIII, Fig. 14

Description.—Length, 1.6 mm.; height, 0.75 mm. Related to *E. bulbosa* with which it is associated but is easily distinguished by differences in outline of the ends, in the form of the umbilical pit which is more definitely defined and lower, and in the relatively greater length of the carapace.

Occurrence.—McKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

Genus KLOEDENELLA Ulrich and Bassler

Like *Euklædenella* but surface of valves with a median and a posterior sulcus both usually confined to the post-dorsal quarter.

Genotype.—*Klædenella pennsylvanica* (Jones).

The 10 species referred at present to this genus may be divided into two groups according to the surface characters of the valves.

I. Group of *Klædenella pennsylvanica* (Jones)

Species with evenly convex surface except the two posterior sulci.

KLŒDENELLA OBLIQUA n. sp.

Plate LIX, Fig. 1

Description.—Length, 1.3 mm.; height, 0.85 mm. Similar to *K. pennsylvanica* (Jones) but differs in its shorter and more oblique form, more sharply angular anterior cardinal extremity and particularly in the fact that the two posterior furrows are shorter and much nearer the posterior angle. Resemble in general *K. rectangularis* but is a higher form with shorter sulci.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA RECTANGULARIS n. sp.

Plate LIX, Fig. 2

Description.—Length, 1.4 mm.; height, 0.80 mm. *K. rectangularis* has a long sinuous dorsal outline, with sharp rectangular anterior end, deep and long posterior and median sulci extending quite to or beyond the mid-height of valve. There is a well-developed flange on the antero-ventral half. This is practically wanting in the somewhat shorter but similarly

oblique right valves of *K. obliqua*. This New York species differs further from that species in the greater length of its two furrows. The posterior furrow is also farther removed from the outer edge and the dorsal edge more sinuous. It seems hardly necessary to compare it with *K. pennsylvanica* though in some respects it is nearer than *K. obliqua*.

Occurrence.—MANLIUS LIMESTONE, Herkimer County, N. Y., in association with *Dizygopleura halli* (Jones), *D. clarkei* (Jones), and *Zygobeyrichia regina* new species.

Collection.—U. S. National Museum.

KLOEDENELLA CACAPONENSIS n. sp.

Plate LIX, Fig. 3

Description.—Length, 1.10 mm.; height, 0.65 mm. The moderately elongate form, obtusely but distinctly angular anterior cardinal angle, long deep posterior furrow, subcarinate posterior pair of lobes, wide and ventrally sharply defined median sulcus, well-developed anterior and postventral border and the very slight definition of the lobed area in the antero-dorsal quarter make a combination of characters that is different from any other species of the family. Some of these features suggest species referred to *Dizygopleura*, as for instance *D. micula* and *D. intermedia*, but the reasons that have caused us to place those species into that genus are too weakly indicated in *K. cacaponensis* to warrant similar action in this instance. The present species agrees too well with *Kloedenella scapha*, *K. obliqua* and *K. rectangularis* to leave any doubt as to the propriety of placing it in the same genus with them.

Occurrence.—MCKENZIE FORMATION. Twenty feet above base, 1½ miles east of Great Cacapon, Maryland, and other localities exposing this horizon.

Collection.—Maryland Geological Survey.

KLOEDENELLA SCAPHA n. sp.

Plate LIX, Figs. 4-9

Description.—Average length, 1.0 mm.; height, 0.60 mm. Related to *K. transiluna* on the one hand and *K. rectangularis* on the other. From

the former it differs in its more elongate form, more produced antero-dorsal angle which moreover has a small thickness on the right valve that is characteristic of this and wanting in the other. Further the antero-dorsal quarter of the surface is more convex—fuller—and the point of greatest convexity farther forward than in *K. transilians* in which it is sub-centrally located. Compared with *K. rectangularis* numerous minor and several more important differences will be observed in comparing the illustrations. Among the latter the more curved sulci and the fact that the posterior one lies much nearer this edge of the valve are of particular significance.

A very similar but distinct form with blunter ends as seen in edge views occurs in the Irondequoit limestone of the Upper Clinton near Lockport, New York.

Occurrence.—McKENZIE FORMATION. Thirty feet above base at Flintstone, Maryland and 20 feet above base, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA SCAPHA VAR. BREVICULA n. sp.

Plate LIX, Fig. 10

Description.—Length, 1.1 mm.; height, 0.70 mm. This variety is shorter than the typical form of *K. scapha* and differs also in other respects. It also reminds somewhat of *K. obliqua* and *K. rectangularis* on the one hand and in other respects of *K. transilans*. But it is not precisely like any of these and as the general aspect and probably also its affinities seem closest to *K. scapha* it is provisionally referred to this species as var. *brevicula*.

The specimen apparently came from a higher position in the McKenzie formation than that in which the typical form of *K. scapha* is commonly found.

Occurrence.—McKENZIE FORMATION. Ranging from 50 to 150 feet above the base at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA SUBOVATA n. sp.

Plate LIX, Figs. 11-13

Description.—Average length, 1.00 mm.; height, 0.60 mm. We have recognized only right valves of this species and these have an outline that is exceedingly like that of the same valve in *K. gibberosa*. We fear indeed that they belong to that species but judging from the only complete specimen we have seen of *K. gibberosa* this cannot be true because the right side in this species has a peculiar flange in the middle part of the ventral edge that is certainly wanting in these right valves. Instead of a flange the edge in these is undercut. Besides the profiles in the two is different, the point of greatest thickness in that species being near the middle whereas in these the corresponding position is somewhat flat in edge view and the greatest thickness farther forward. For the present then we must regard them as distinct.

Occurrence.—McKENZIE FORMATION, 82 feet beneath top at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

II. Group of *Kloedenella nitida* new species.

Species with a shallow depression in the ventral slope.

KLŒDENELLA NITIDA n. sp.

Plate LIX, Fig. 14

Description.—Length, 1.25 mm.; height, 0.8 mm. About the same size and general aspect as in *K. transitans* but with more convex anterior slope and less defined broader depression in middle of ventral slope. More important differences occur in the furrows which are shorter and less defined; and in the post-median ridge which is more rounded, shorter, less prominent and appears as lying in a sunken area in which the very short posterior sulcus often is difficult to see except in the proper light.

Occurrence.—McKENZIE FORMATION. Middle part at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA IMMERSA n. sp.

Plate LIX, Figs. 15, 16

Description.—Length, 1.25 mm.; height, 0.70 mm. In most of its characters like *K. nitida* with which it was found but it is a longer form, narrow behind with the sunken area around the rounded and low post-median node more extended in anterior direction and deeper. The middle part of the valves is highly convex, the convexity being accentuated by the depression above and also beneath when the slope is distinctly impressed and the edge sinuate. None of the other species is near enough to require comparison.

Occurrence.—McKENZIE FORMATION. Middle part at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA GIBBEROSA n. sp.

Plate LIX, Figs. 17, 18

Description.—Length, 1.50 mm.; height, 1.00 mm. The main peculiarity of this species is the peculiar crestlike ridge on the middle third of the dorsal margin of the left valve. The right valve is without a similar structure as shown in Fig. 18.

The right valve differs from the left also at the ventral edge, having a kind of flange probably for overlap purposes where the other exhibits only a steep descent.

The two sulci are well developed and deep but do not extend more than two-fifths across either valve.

The anterior sulcus and ridge of *Dizygopleura* are faintly suggested, especially in the larger specimen figured.

Aside from the extraordinary dorsal crest this form is considerably like *K. transitans* and also somewhat less like *K. nitida*. The former even has a crest but of much more modest proportions. Right valves of the two species require most careful discrimination; at that, identifications are not altogether safe except when specimens retain both valves.

Occurrence.—McKENZIE FORMATION. Eighty-two feet below top at Flintstone, and 100 feet below top at Pinto, Maryland.

Collection.—Maryland Geological Survey.

KLŒDENELLA TRANSITANS n. sp.

Plate LIX, Figs. 19, 20

Description.—Length, 1.3 mm.; height, 0.75 mm. The general outline is rounded oblong, the antero-dorsal part only being angular and quite obtusely so. The median and posterior furrows extend about half across the valves, are deep, the former rather wide the latter narrow, and in the left valve both curve strongly forward as they approach the dorsal edge. Just in front of the middle of the ventral edge, which is gently sinuate, there is a faint broad depression that curves forward and upward. The greatest thickness of the carapace lies near the middle of the valves. The right valve overlaps the left posteriorly and ventrally.

This species suggest relations to *Dizygopleura acuminata* at least as great as to *D. turgida* Ulrich and Bassler. It is the anterior sulcus that is more or less imperfectly indicated in these three species and not the outer anterior one. In the species *D. acuminata* and *D. turgida* its development has progressed far enough to leave no doubt as to its meaning. These, therefore, are regarded as belonging to *Dizygopleura* rather than typical *Kladenella*. The present species on the contrary is still too near in structure to typical *Kladenella* to warrant placing it in that genus. None of the species of *Kladenella* (as restricted) is sufficiently close to require detailed comparisons. The main difference used in separating it from *Dizygopleura acuminata* and *D. turgida* has been mentioned already. Others will be observed on comparing the illustrations on the plates.

Occurrence.—McKENZIE FORMATION, 30 feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

Genus DIZYGOPLEURA new genus

Surface of valves usually quadrilobate, rarely trilobate, the lobes separated by three, rarely two, long sulci, of which the anterior may be in part or entirely obsolete.

Genotype.—Dizygopleura swartzi n. sp.

The many species of this prolific genus may be divided into five groups for purposes of comparison.

I. Group of *Dizygopleura proutyi* new species

Anterior sulcus confined to ventral half, anterior lobe more or less bulbous.

DIZYGOPLEURA PROUTYI n. sp.

Plate LIX, Figs. 21-23

Description.—Length, 1.3 mm.; height, 0.9 mm. Related to *D. pricei* and to *D. luminosa*, in fact these three species form a natural series passing respectively from a short irregularly ovate form to a longer and then a still longer one, and in the progressive development of the depression in the antero-ventral part of the lobed area. In *D. proutyi* this depression extends only about half across the lobed area thus serving to partly separate a small and bulbous rather than ridge-like representation of the anterior lobe from the larger antero-median lobe with which it remains confluent in the antero-dorsal quarter. These convex parts trend diagonally across the valve and are separated from the antero-ventral edge by a wide flange. The posterior sulcus is narrow, nearly closed dorsally, but deep in its lower half. The median sulcus is V-shaped and shorter extending only about two-fifths across the valve. The specific name is in honor of Dr. W. F. Prouty.

Occurrence.—CLINTON. Near top of *Drepanellina clarki* zone at Cumberland and other localities in Maryland and Pennsylvania exposing this horizon.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA PRICEI n. sp.

Plate LIX, Fig. 24

Description.—Length, 1.3 mm.; height, 0.75 mm. Differs from *D. proutyi* with which it is sometimes associated in its greater proportional length more nearly longitudinal trend of the convexities, wider ventral

slope but narrower antero-ventral flange. Perhaps more important is the fact that the passage from the anterior to the dorsal part of the outline is without angulation whatever, whereas in *D. prouty*i the antero-dorsal angle is rather prominent.

The specific name is in recognition of the stratigraphic work upon the Silurian of Maryland done by Dr. W. A. Price, Jr.

Occurrence.—CLINTON. *Drepanellina clarki* zone, 21 feet above the Keefer sandstone, Pinto, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA LACUNOSA n. sp.

Plate LIX, Figs. 27-29

Description.—Length, 1.3 mm.; height, 0.7 mm. *D. lacunosa* is more closely allied to *D. price*i and through it to *D. prouty*i than to any other species known. It is at once distinguished from both of those species by its more elongate carapace. Coming to details the anterior sulcus is longer extending almost to the dorsal edge, near which it attains its greater depth, the median sulcus is deep and more broadly triangular and the posterior sulcus wider and more flat-bottomed than in either of its closest allies.

Occurrence.—CLINTON. *Drepanellina clarki* zone, 17 inches above the Keefer sandstone, 1½ miles east of Great Cacapon, Maryland. Also in the same zone at McKees farm, 7 miles west of Lewiston and at Hollidaysburg, Pennsylvania.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA MINIMA n. sp.

Plate LIX, Fig. 26

Description.—Length, 0.5 mm.; height, 0.3 mm. The exceedingly minute size of this species may of itself suffice in distinguishing it from its structurally nearest allies. None of the specimens so far seen exceed 0.5 mm. in length. *D. gibba*, which is much larger and occurs at a higher horizon, is perhaps as near as any known. The lobation of the valves in the two is similar, especially in the fact that the anterior sulcus is

confined to the ventral two-thirds so that the lobes on either side of it merge in the dorsal third. The median and posterior sulci, however, are wider and extend to points nearer the ventral edge than in *D. gibba*. Other species of its group are *D. carinata*, *D. lacunosa* and *D. proutyi*, all of which are figured in this work.

Occurrence.—CLINTON. *Mastigobolbina typus* zone at Hollidaysburg, Pennsylvania.

Collection.—U. S. National Museum.

DIZYGOPLEURA GIBBA n. sp.

Plate LIX, Fig. 25

Description.—Length, 1.15 mm.; height, 0.7 mm. Allied to *D. halli* but readily distinguished by the much greater fullness of the anterior pair of tubes the hump in middle part of dorsum and the dorsal incompleteness of the anterior sulcus. The ventral part of the anterior sulcus on the contrary is better developed. In most of these respects *D. gibba* is nearer *D. swartzi* particularly to one of its varieties. However, it is clearly distinct also from that species. The dorsal hump in that abundant and variable species is never so strongly developed and the anterior sulcus always extends farther toward the dorsal ridge. Closer allies, most probably are *D. proutyi* and the very much smaller *D. minima*. Both of these occur in the Upper Clinton Lakemont formation. With the aid of our photographic illustrations there seems little excuse for confusion between these three species.

Occurrence.—MCKENZIE FORMATION, 82 feet below the top, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA CARINATA n. sp.

Plate LX, Figs. 1-3

Description.—Length, 1.3 mm.; height, 0.8 mm. *D. carinata* seems intermediate in most of its characters between *D. acuminata* and the variety *prolapsa* on the one hand and *D. symmetrica* on the other. It agrees better with the former in the fulness of the ventral part of the

anterior lobe but in its outline and lobation it corresponds the more nearly with the second. However, it has several peculiarities of its own so that it is easily distinguished from them all. Compared with the various mutations of *D. symmetrica* it differs strikingly in the carination of the posterior and antero-median lobes, the carina of the latter continuing posteriorly and downward toward the base of the posterior lobe. On further comparison with that species, it is found that the anterior sulcus is straighter and dies out a considerable distance further from the dorsal edge and that the part of the valve in front of it is much wider and being without a ventral flange is also lower.

Occurrence.—McKENZIE FORMATION, upper part at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA ACUMINATA n. sp.

Plate LX, Figs. 4-9

Description.—Length, 1.6 mm.; height, 0.9 mm. Characterized by its produced angular antero-dorsal extremity, outwardly undefined, and rather tumid anterior lobe, ventrally obsolete and narrow posterior sulcus, and dorsally undeveloped anterior sulcus. In the left valve the posterior sulcus is longer than in the right. In a small variety found at Cumberland in the same bed with more typical examples of the species the anterior lobe is less inflated than usual and the anterior sulcus longer and more regularly curved. Except that the anterior sulcus is clearly indicated in the ventral half of the surface the species would have to be referred to *Kladenella*. None of the other species is very close.

Occurrence.—McKENZIE FORMATION. Very abundant at a zone about 24 feet below the top at Flintstone and Cumberland, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA ACUMINATA var. PROLAPSA n. var.

Plate LX, Figs. 10-12

Description.—Length, 2.1 mm.; height, 1.2 mm. This variety differs from the typical form of the species in being larger, in having more of

a medio-dorsal hump especially in the left valve, a less produced antero-dorsal angle and a stronger inflation and downward slumping of the ventral part of the anterior lobe. In some respects it reminds of *D. gibba* but is readily distinguished by its greater size relatively larger anterior lobe and shallower as well as narrower sulci.

Strangely, the specimens of this variety are replaced by marcasite whereas the associated ostracoda have the usual black color.

Occurrence.—McKENZIE FORMATION. About 21 feet below the top, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA AFFINIS n. sp.

Plate LX, Fig. 13

Description.—Length, 2.1 mm.; height, 1.2 mm. A large species, in fact probably the largest known, the specimens averaging 2.1 mm. in length. Its greatest thickness lies near the middle of the anterior half, hence, in front of the slightly sigmoid anterior sulcus. In general the species reminds of *D. acuminata*, a common and smaller fossil in the upper part of the McKenzie formation. From the typical forms of that species it differs decidedly in the relative obtuseness of the antero-dorsal angle, in the greater width of the anterior and posterior lobes, in the greater fulness of the anterior lobe and in the fact that the anterior sulcus is wider and deeper in the middle part of the valve and does not cross the ventral slope. In fact, this sulcus terminates in this species at a point that would fall about the middle and deepest part of the sulcus in *D. acuminata*.

Closer allies are found among the observed varieties of *D. acuminata*. It agrees with *D. affinis* in the outline of the anterior end but differs in the lesser fulness of the anterior lobe, the much narrower posterior lobe and the greater length of the anterior sulcus. The variety *prolapsa* comes nearer than all in that it too is large and has nearly the same outline with wide anterior and posterior lobes. The only differences of consequence lie in their respective antero-ventral quarters. In *D. acuminata prolapsa* the anterior sulcus is narrow and almost entirely confined to the ventral

half, and the greatest fulness of the anterior lobe lies so much lower that the slope to the ventral edge is continuously convex and does not, as in *D. affinis*, pass through a concave space.

Another close ally is *D. bulbifrons*, from the upper part of the McKenzie formation. In that species the sulci, especially the anterior and posterior are deeper and wider and more sharply impressed, the surface of the ridges consequently is somewhat flat and drops abruptly into the sulci, the middle sulcus appears narrower the anterior one extends farther in ventral direction and the ventral edge is almost straight, hence, with much less of a sinus than in *D. affinis*.

Occurrence.—WILLS CREEK FORMATION. Ninety feet below top, Grasshopper Run, near Hancock, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA BULBIFRONS n. sp.

Plate LX, Fig. 14

Description.—Length, 1.9 mm.; height, 1.1 mm. Like *D. stosei* except that the anterior lobe is larger and swollen. It seems also that the sulci are slightly shorter, the anterior failing in dorsal direction and the posterior one in ventral direction. It is probably more closely related to *D. affinis*, a Wills Creek species, but the shallowness or complete absence of a sinus in the ventral part of the outline and its deeper sulci should serve very well in distinguishing them.

Occurrence.—MCKENZIE FORMATION. Seventy-seven feet below top, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

11. Group of *Dizygopleura intermedia* n. sp.

Anterior side of lobed area defined but anterior sulcus wanting, the pair of anterior lobes confluent.

DIZYGOPLEURA INTERMEDIA n. sp.

Plate LX, Figs. 15, 16

Description.—Length, 1.10 mm.; height, 0.65 mm. The main characteristic of this species is the definite elevation of the anterior side of the area usually lobed in *Dizygopleura* coupled with the fact that the anterior sulcus is entirely wanting. Otherwise it is structurally very close to the more diminutive *D. subdivisa* in which the anterior sulcus is imperfectly indicated.

Occurrence.—McKENZIE FORMATION. Lower part, Cumberland, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA INTERMEDIA VAR. ANTECEDENS n. var.

Plate LX, Figs. 18-20

Description.—Length, 1.6 mm.; height, 1.0 mm. This early variety is larger, relatively higher and has a smaller umbilical pit than the typical McKenzie form of the species. Also there is a slight depression within the raised anterior side of the lobed area (incipient anterior furrow) that is not seen in the typical form.

Occurrence.—CLINTON, 17 inches above the Keefer sandstone, 1½ miles east of Great Cacapon, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA INTERMEDIA VAR. CORNUTA n. var.

Plate LX, Fig. 17

Description.—Length, 1.1 mm.; height, 0.75 mm. Differs from corresponding valves of the typical form in surface contour of antero-ventral quarter where the depressed sloping bordering area is much wider; and particularly in having a blunt spine in front of the middle of the cardinal edge.

Occurrence.—CLINTON. Seventeen inches above Keefer sandstone, 1½ miles east of Great Cacapon, Maryland. IRONDEQUOIT LIMESTONE, 8 miles east of Lockport, New York.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA PLANATA n. sp.

Plate LX, Fig. 21

Description.—Length, 1.50 mm.; height, 0.75 mm. Related to *D. intermedia* and with it forms a small extreme section of the group of *D. subdivisa* and at the same time of *Dizygopleura* differing from the more typical species of the genus in the entire absence of the anterior furrow. From its immediate allies it differs in the transverse flatness of the lobate area, in the sigmoid anterior outline and sharpness of the latter, in the greater width of the posterior lobe, longer more sharply defined and more nearly vertical posterior and median furrows, and in the anteriorly curving prolongation of the dorsal extremity of the posterior lobe.

Occurrence.—MANLIUS LIMESTONE, Herkimer County, N. Y. This species may be expected in the Tonoloway limestone of Maryland.

Collection.—U. S. National Museum.

III. Group of *Dizygopleura subdivisa* n. sp.

Like II but anterior sulcus developed in anterior median part of raised lobed area.

DIZYGOPLEURA SUBDIVISA n. sp.

Plate LXI, Figs. 1, 2

Description.—Length, 0.55 mm.; height, 0.35 mm. This small species is an outgrowth of *Dizygopleura asymmetrica* from which it differs in being smaller, less convex, with shallower sulci and more angularly produced antero-dorsal region. Both this and the following species trend toward typical *Kladenella* but the development of the anterior pair of sulci has gone too far or is still too well expressed to keep them out of *Dizygopleura*. At the same time their evident relationships to *Dizygopleura intermedia* and *D. planata* lend confidence to their position under *Dizygopleura*.

Occurrence.—MCKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland, and at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA MICULA n. sp.

Plate LXI, Fig. 3

Description.—Length, 0.65 mm.; height, 0.35 mm. A small species quite similar to *D. subdivisa* but differing in its greater length and less distinct development of the sulci.

Occurrence.—MCKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA ASYMMETRICA n. sp.

Plate LXI, Figs. 9, 10

Description.—Right valve: Length, 1.30 mm.; height, 0.80 mm. This species has a wide inclined flange on anterior (left) side with unthickened edge. On the right valve the anterior flange appears wider and has a thickened border that overlaps the left valve. The right valve therefore is more elongate than the left. The species is related to *D. symmetrica* and more particularly to *D. subdivisa*. From the former it will be distinguished at once by its shorter posterior sulcus and the altogether different lobing of the anterior half; from the latter by its more rounded and less oblique anterior outline and the dorsal incurving of the anterior lobe. Close comparisons bring out differences in many other respects.

Occurrence.—CLINTON. *Drepanellina clarki* zone, Cumberland Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA CRANEI n. sp.

Plate LXI, Figs. 4-8

Description.—Length, 1.0 mm.; height, 0.60 mm. Four right valves showing some variation in the height of the anterior end and in the development of the low and thin ridge that often defines the ventral side of the lobed part of the valves are figured. In 5 and 6 this marginal ridge is practically wanting and the swelling of the antero-ventral half also is greater than in 7 and 8 in which the ridge occurs. This difference in

convexity is perhaps more apparent than a real increase in thickness. The anterior sulcus is represented by a small elongate crescentic depression on which account the species is referred to the group of *D. subdivisa*. In its group it stands distinctly apart from the others with *D. intermedia* and *D. subdivisa* probably its nearest relatives. In *D. intermedia*, however, the anterior sulcus is entirely obsolete and the anterior end higher and made by a wide sloping area that is much wider than in *D. cranei*. In *D. subdivisa* the valves are relatively shorter, the whole surface less convex and the anterior sulcus narrower and longer but much shallower. In both of the McKenzie species the posterior sulcus is narrower and the lobes on either side of it are thicker.

Occurrence.—CLINTON, *Drepanellina clarki* zone. McKees farm, 7 miles west of Lewiston, Pennsylvania.

Collection.—U. S. National Museum.

DIZYGOPLEURA LOCULATA n. sp.

Plate LXI, Figs. 13, 14

Description.—Length, 1.20 mm.; height, 0.65 mm. Allied to *D. symmetrica* and *D. asymmetrica* but readily distinguished from both, and in fact all other species of the genus by the dorso-ventral restriction of the antero-median sulcus so as to form a simple rounded pit. Whereas the posterior half of the valves is much the same as in the mentioned species the anterior half looks quite different.

Occurrence.—CLINTON, *Mastigobolbina typus* zone. Lakemont, Hollidaysburg, Pennsylvania. Near Great Cacapon, West Virginia, and various Maryland localities exposing this zone.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA CONCENTRICA n. sp.

Plate LXI, Fig. 11

Description.—Length, 0.90 mm.; height, 0.60 mm. Related to *D. subdivisa* having a very similar outline and also mostly shallow sulci.

However, this is a slightly larger form and more convex in the median part of the valves. More important differences are: (1) the fact that the two median lobes form a horseshoe shaped loop that is divided below from the ventral continuation of the anterior ridge by a shallow furrow; (2) the ventral continuation of the anterior ridge which does not occur in that species but in this overhangs the contact margin and terminates at the base of the posterior part of the outline; (3) the post-median lobe more of a ridge than a rounded boss; and, finally, (4) the two posterior sulci are deeper.

Occurrence.—McKENZIE FORMATION. One hundred feet below top, Pinto, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA CONCENTRICA VAR. SUBQUADRATA n. var.

Plate LXI, Fig. 12

Description.—Length 0.60 mm.; height, 0.40 mm. In this minute early variety of *D. concentrica* the two median lobes are united below to form a squarish loop defined on the ventral side by an uncommonly deep furrow or transversely elongated pit. The posterior and antero-median sulci which bound the loop laterally are deep in their dorsal two-thirds but shallow ventrally. The anterior ridge curves backward around the ventral edge which it overhangs in the middle and thence passes into the posterior ridge. In typical *D. concentrica* confluence of the ventral and posterior ridges can hardly be said to occur. The depression in the middle of the ventral slope also is not so deep whereas the passage between it and the antero-median sulcus is much more gradual in the typical form than in this variety. Should these differences prove constant the two would deserve to be held as distinct species. Provisionally it will suffice to distinguish them as varieties. The smaller form does not suggest immaturity.

Occurrence.—McKENZIE FORMATION. Thirty feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

IV. Group of *Dizygopleura swartzi* n. sp.

Distinctly quadrilobate, lobes thick, anterior and posterior sulci long, narrow, deeply impressed, the middle sulcus shorter.

DIZYGOPLEURA SWARTZI n. sp.

Plate LXII, Figs. 1-8

Description.—Typical form. Length, 1.00 mm.; height, 0.65 mm. Greatest thickness just in front of the mid-length. Otherwise the species is considerably like the younger (Manlius) *D. clarkei* and *D. halli*. However, in both of them the posterior as well as the anterior lobe is thicker and the anterior sulcus does not extend so far downward as in *D. swartzi*. In the latter again the anterior sulcus commonly is not so deep nor so wide in its middle part as in the two Manlius species. But the difference mainly relied is the fact that the two median lobes are more prominent than either of the lateral ones, whereas in *D. halli* and *D. clarkei* the four lobes attain practically the same plane.

Besides the typical form, which is represented by Plate LXII, Figs. 1, 2, four varieties or mutations have been observed. One is characterized by an uncommonly wide and differently outlined frontal slope.

The second (both probably from upper 50 feet of McKenzie) is more elongate than the others except var. 1 and has a deeper and wider inwardly sloping anterior sulcus.

The third is distinguished by relatively high posterior end, the anterior part being distinctly the narrower. It is peculiar also in lacking the sinus in the median part of ventral outline.

The fourth, which is abundant at Flintstone, 24 feet beneath top of McKenzie, differs from the other mutations in its relative shortness and the clear definition and greater depth of the lateral sulci.

Occurrence.—McKENZIE FORMATION. Upper third at Cumberland, Flintstone, Pinto, etc., Maryland, where it almost completely fills certain thin layers of limestone.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA PINGUIS n. sp.

Plate LXII, Figs. 9, 10

Description.—Length, 1.00 mm.; height, 0.62 mm. Size and general outline not much different from that of *D. symmetrica* and *D. concentrica* but differing in various respects from both. Obesity of the carapace and its narrow sulci distinguishes it particularly from the former. The variety *subquadrata* of *D. concentrica* is more like *D. pinguis* than is the typical form of that species. However, *D. pinguis* is without the deep impression in the ventral slope that characterizes the variety *subquadrata*.

Occurrence.—McKENZIE FORMATION, 30 feet above base, Flintstone, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA FALCIFERA n. sp.

Plate LXII, Figs. 11, 12

Description.—Length, 1.1 mm.; height, 0.55 mm. Related most closely to *D. stosei*, especially to its small older variety, and to *D. concentrica subquadrata* but quite obviously represents a distinct species distinguished mainly by its produced antero-dorsal angle and certain peculiarities in the ventral parts of the ribs. Namely, the anterior ridge is decidedly recurved in its dorsal part and the furrow behind it is deep and rather wide, in both of which features it differs from *D. subquadrata*. Nor does *D. falcifera* show anything like the ventral depression of that species, but it does show a very slender raised line in that position. Anteriorly this line passes into the outer edge of the anterior lobe. From *D. stosei*, which probably is its nearest relative, this present species differs in its smaller size and conspicuously different form.

Occurrence.—McKENZIE FORMATION, 20 feet above base, 1½ miles east of Great Cacapon, West Virginia.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA SYMMETRICA (Hall)

Plate LXII, Figs. 13-17

Beyrichia symmetrica Hall, 1852, Pal. New York, vol. ii, p. 317, pl. lxvii, fig. 16.

Bollia symmetrica Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 319, fig. 61.

Description.—Length, 1.10 mm.; height, 0.70 mm. In 1908 we left this species under *Bollia*, to which it had previously been referred by the senior author. Study of the original types together with an abundance of specimens recently collected at Lockport, N. Y., has shown conclusively that the species is not a *Bollia* but a true member of the Kloedenellidæ and one of the strongly lobate and quite typical species of *Dizygopleura*. Its characters are sufficiently brought out in the illustration to make a description unnecessary.

Occurrence.—ROCHESTER SHALE, Lockport, etc., New York. CLINTON, *Drepanellina clarki* and *Mastigobolbina typus* zones at localities in Maryland and Pennsylvania, particularly at Cumberland, Md.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA STOSEI n. sp.

Plate LXII, Figs. 18-20

Description.—Length, 1.4 mm.; height, 1.0 mm. *D. stosei* is of the type of *D. symmetrica* but differs: (1) in having the tops of the ridges flattened and sharp-edged instead of rounded; (2) in the greater length of the median sulcus; and (3) in having a short, dorsally directed spine at the anterior cardinal angle; and (4) in being considerably larger. The general aspect of the two species is sufficiently different because of the greater rigidity of the lobes in *D. stosei*, so that with the other peculiarities mentioned there seems little danger of confusion. The specific name is in honor of Mr. George W. Stose, of the U. S. Geological Survey.

Occurrence.—MCKENZIE FORMATION, 62 feet below top, Flintstone, Md., and 20 feet above Keefer sandstone, 1½ miles east of Great Cacapon, Md.

Collection.—U. S. National Museum.

DIZYGOPLEURA MACRA n. sp.

Plate LXII, Figs. 21-23

Description.—Length, 0.80 mm.; height, 0.45 mm. This species seems to be related on the one hand to *D. symmetrica* and its allies and *D. virginica* and *D. perrugosa* on the other. From the former it is distinguished by its thin ridges—on especially the ventral part of the loop, which is very thick in that species—and its broad furrows, which together with the delicacy of the ridges impart an emaciated appearance that is scarcely suggested in that species. The valves are also much longer relatively. Compared with *D. virginica* the outline is found to differ and the triangular thickening at the base of the loop which characterizes the species of the *D. hieroglyphica* group is wanting. *D. perrugosa* is a much larger and more rugged species.

Occurrence.—CLINTON, *Mastigobolbina typus* zone, near Six Mile House, Md.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA HALLI (Jones)

Plate LXII, Figs. 24, 25

Beyrichia halli Jones, 1890, Quart. Jour. Geol. Soc. London, vol. xlvi, p. 15, pl. iv, fig. 21.

Klodenella halli Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 319, fig. 62, pl. xlii, fig. 4.

Description.—Right valve, length, 1.10 mm.; height, 0.70 mm. Characterized by its moderately elongate form, angular dorsal extremities, sinuate ventral edge, deep furrows which extend nearly to the dorsal edge but become obsolete before reaching the middle of the ventral half. It is commonly associated with *D. clarkei*, which it resembles sufficiently to require some care in discriminating them. However, *D. clarkei* is a larger and relatively shorter form, with broadly rounded instead of angular postero-dorsal region and different furrows. The anterior one is shorter in that species, especially in its dorsal extent, whereas the posterior one is longer in ventral direction. Further, the anterior sulcus is farther removed from the anterior edge, so that the outer of the pair of

anterior lobes is wider and the inner one is relatively narrower than in *D. halli*. Finally, the right valve has a wide, deeply concave border around the anterior and more than half of the ventral side, the like of which does not occur in the present species.

Occurrence.—Lower (typical) MANLIUS of New York. TONOLOWAY LIMESTONE, Grasshopper Run, near Hancock, Pinto and other Maryland localities.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA HALLI VAR. OBSCURA n. var.

Plate LXII, Fig. 26

Description.—Length, 1.3 mm.; height, 0.75 mm. A relative or distinct variety of *Dizygopleura halli* in which the sulci tend toward obsolescence, being shorter, narrower, and shallower. The anterior pair especially is much weaker than the typical form of the species. This divergence from type brings typical *Kladenella* to mind, but we are fully convinced that the true affinities of the variety are with *D. halli* on the one hand and *D. swartzi* and *D. symmetrica* on the other, hence, that it is genetically a species of *Dizygopleura*. As shown in the figure, specimens of the variety are exceedingly abundant on certain bedding planes.

Occurrence.—TONOLOWAY LIMESTONE. Lower part, Keyser, W. Va., Pinto and other Maryland localities.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA SUBOVALIS n. sp.

Plate LXII, Fig. 27

Description.—Right valve. Length, 1.10 mm.; height, 0.70 mm. In its lobation *Dizygopleura subovalis* is intermediate between *D. halli* and *D. clarkei* but differs from both in its rather definitely oval outline. The difference in this respect is particularly notable on the ventral side, which is distinctly convex instead of more or less concave in the middle.

Occurrence.—TONOLOWAY LIMESTONE. Numerous zones at Keyser, W. Va., Pinto and other Maryland localities.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA SIMULANS n. sp.

Plate LXII, Fig. 28

Description.—Right valve. Length, 1.00 mm.; height, 0.70 mm. Like *Dizygopleura subovalis* but is shorter and too narrow in anterior half. Resembles also *D. clarkei* but lacks the wide hollow anterior border of that species. The anterior lobe also is smaller and the anterior sulcus extends farther up toward dorsum. The ventral outline also is gently convex instead of slightly sinuate in the middle.

Occurrence.—TONOLOWAY LIMESTONE. Lower part, Keyser, W. Va., Pinto and other localities in Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA SIMULANS var. LIMBATA n. var.

Plate LXII, Figs. 29, 30

Description.—Length, 0.85 mm.; height, 0.55 mm. Distinguished by its shorter form and anterior sulcus, but particularly by its wide and continuous border. The continuity of the border around the ventral edge is a very unusual feature in species of this genus.

Occurrence.—TONOLOWAY LIMESTONE. Lower part, Keyser, W. Va., Pinto, etc., Md.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA CLARKEI (Jones)

Plate LXII, Figs. 31, 32

Beyrichia clarkei Jones, 1890, Jour. Geol. Soc. London, vol. xlvi, p. 17, fig. 2.

Description.—Length, 1.30 mm.; height, 0.90 mm. In this right valve, which is the original type of the species, the anterior sulcus seems to extend as a definite depression farther in dorsal direction than in the better example of same valve in the U. S. National Museum that also is figured on this plate. Otherwise, however, the two are practically identical in character. The surface pitting and apparent tuberculation probably is due to unequal corrosion of the test. The same cause may be at least partly

responsible for the lengthening of the anterior sulcus. *Dizygopleura clarkei* has much in common with *D. swartzi* out of which it may have been derived.

Occurrence.—Lower (typical) MANLIUS of Schoharie County, New York. Associated with *Dizygopleura halli* (Jones), *Zygobeyrichia regina* new species, etc. Will probably be found in the Tonoloway limestone of Maryland.

Collection.—U. S. National Museum.

V. Group of *Dizygopleura hieroglyphica* (Krause)

Valves depressed convex, lobes narrower than the furrows.

DIZYGOPLEURA VIRGINICA n. sp.

Plate LX, Figs. 27-29

Description.—Length, 1.00 mm.; height, 0.58 mm. Evidently related to *D. hieroglyphica* (Krause) (see Plate LX, Fig. 22) common species in the Silurian drift in the Baltic region of Germany. The Virginia specimens differ in having thinner ridges and correspondingly wider furrows and in lacking the two pits in the triangular ventral thickening of the loop.

These species are strikingly like certain Ordovician and Richmond species now referred to *Tetradella* (*s. g., T. quadrilirata*). Possibly the suggested relationship is closer than has been believed hitherto.

Occurrence.—SNEEDVILLE LIMESTONE, Big Stone Gap, Virginia, in shale just over the basal conglomerate associated with *D. bulbifrons* and Upper McKenzie species.

Collection.—U. S. National Museum.

DIZYGOPLEURA UNIPUNCTATA n. sp.

Plate LX, Fig. 25

Description.—Length, 1.30 mm.; height, 0.75 mm. This species, though probably more closely related to *D. hieroglyphica* (Krause) than to any other now described, is clearly differentiated by its large size, relatively longer valves, sinuate ventral edge, the single instead of two

depressions in the thick ventral part of the loop and more carinate ridges. Other minor differences are to be noted in detailed comparison of the ridges and furrows. For instance, the posterior ridge is narrow and the post median one much more so.

Occurrence.—McKENZIE FORMATION. Seventy-seven feet below top at Flintstone, Maryland.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA COSTATA n. sp.

Plate LX, Figs. 23, 24

Description.—Length, 0.95 mm.; height, 0.60 mm. This species also is not far removed from *D. hieroglyphica* (Krause) and at least belongs to the same section of the genus. Specifically, however, it is readily distinguished not only from the Baltic species but also the various members of the same group found in the Appalachian region by its more quadrate outline, and also by the fact that the depressions at the base of the loop open below instead of forming pits. Finally, the species is marked by the peculiar fact that the ridge summits are grooved.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, W. Va., Pinto, etc., Md.

Collection.—Maryland Geological Survey.

DIZYGOPLEURA VERRUCOSA n. sp.

Plate LX, Fig. 26

Description.—Length, 1.6 mm.; height, 0.80 mm. This species differs from all others in shape and general aspect. It is marked in particular by extraordinary high ridges, carinate at their summits and correspondingly deep and wide sulci which extend completely across the valves. The two ridges that form the inner loop are especially prominent and peculiarly joined at their dorsal and ventral extremities. On the dorsal side of the left valve this loop projects well over the edge and when the valves are in position it overlaps the edge of the right valve and locks on its anterior side with a smaller projecting process of the right valve.

Occurrence.—McKENZIE FORMATION. Middle part at Cumberland, Maryland.

Collection.—Maryland Geological Survey.

Superfamily CYPRIDACEA

Family THLIPSURIDAE

Genus OCTONARIA Jones

OCTONARIA CRANEI n. sp.

Plate LXIII, Fig. 12

Description.—Length, 0.70 mm.; height, 0.40 mm. This interesting early Silurian species is not, as might be expected, related to the Silurian genotype *O. octoformis* Jones but to the Devonian *O. stigmata* Ulrich, which has oblong instead of rounded valves. Indeed, *O. cranei* is the earliest known of the *O. stigmata* group.

The species is so different from all other Silurian Ostracoda that no difficulty will be encountered in its identification. The specific name is in honor of Mr. W. E. Crane, who collected the type specimen.

Occurrence.—CLINTON. *Drepanellina clarki* zone at McKees farm, 7 miles west of Lewiston, Pa.

Collection.—U. S. National Museum.

OCTONARIA MURICATA n. sp.

Plate LXIII, Figs. 10, 11

Description.—Length, 1.25 mm.; height, 0.90 mm. Somewhat similar in surface characters to *Octonaria angulata* Ulrich and Bassler from the lowest Devonian (Keyser) rocks of Maryland but differing conspicuously in its more equal ended instead of sharply angular valves. The pit is a well-marked feature in all of the specimens so far worked. The lobing of the valves is so different from any other Maryland Silurian Ostracoda that comparisons are unnecessary.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

Family CYPRIDAE

Genus BYTHOCYPRIS Brady

BYTHOCYPRIS PHASEOLUS Jones

Plate LXIII, Figs. 5, 6

Bythocypris phaseolus Jones, 1887, Ann. and Mag. Nat. Hist. (5), vol. xix, p. 189, pl. vii, figs. 11, 12.

Description.—Length, 0.80 mm.; height, 0.50 mm. Specimens of a *Bythocypris* occurring abundantly on the surface of thin bedded limestones in the Upper Tonoloway limestone are so similar to *B. phaseolus* Jones described from the Wenlock of England that we have little hesitancy in identifying them as above.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

BYTHOCYPRIS PHILLIPSIANA Jones and Holl

Plate LXIII, Fig. 9

Hairdia phillipsiana Jones and Holl, 1869, Ann. and Mag. Nat. Hist. (4), vol. iii, p. 213, pl. xiv, figs. 7a-c.

Description.—Length, 0.90 mm.; height, 0.55 mm. The Maryland specimens referred to this European Silurian species vary slightly from the published illustrations but hardly enough to make the determination doubtful under present methods of discrimination.

Occurrence.—MCKENZIE FORMATION. Eighty-two feet below top at Flintstone, Md.

Collection.—Maryland Geological Survey.

BYTHOCYPRIS OBESA Jones

Plate LXIII, Fig. 8

Bythocypris symmetrica obesa Jones, 1889, Ann. and Mag. Nat. Hist. (6), vol. iv, p. 270, pl. xv, fig. 7.

Description.—Length, 1.00 mm.; height, 0.50 mm. Originally described from the Silurian of the Island of Gotland, this species marked

by its unequal, rounded ends and tumid carapace appears to be represented in the McKenzie formation of Maryland.

Occurrence.—McKENZIE FORMATION. Cumberland, Md.

Collection.—Maryland Geological Survey.

BYTHOCYPRIS PHASEOLINA n. sp.

Plate LXIII, Fig. 7

Description.—Length, 1.00 mm.; height, 0.45 mm. Although somewhat similar in outline to *Bythocypris phaseolus* Jones this species may readily be distinguished by its more elongate carapace with more equal ends. Ostracoda very similar in outline have been figured by Jones and by Krause under the name of *Bythocypris symmetrica* Jones, but these are undoubtedly not typical *B. symmetrica* as figured by Jones.

Occurrence.—TONOLOWAY LIMESTONE. Lower part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

BYTHOCYPRIS ? KEYSERENSIS n. sp.

Plate LXIII, Figs. 1, 2

Description.—Length, 0.80 mm.; height, 0.35 mm. Distinguished from other Silurian species of *Bythocypris* by its somewhat quadrate elliptical outline and by the rather straight dorsal and ventral edges. Better preserved material is necessary before the true alliances of this species can be determined.

Occurrence.—TONOLOWAY LIMESTONE. Upper part at Keyser, W. Va.

Collection.—Maryland Geological Survey.

BYTHOCYPRIS PERGRACILIS n. sp.

Plate LXIII, Figs. 3, 4

Description.—Length, 1.30 mm.; height, 0.55 mm. The elongate slender carapace of this ostracod is so different from other Silurian species that the shape alone will suffice to distinguish it. Added to this the fact that the left valve is larger and overlaps the right and that the surface is smooth makes a combination of characters quite distinctive for the species.

Occurrence.—McKENZIE FORMATION, 20 feet above base, 1½ miles east of Great Cacapon, W. Va. Equally elongate specimens from the WILLS CREEK FORMATION, 45 feet above the base at Pinto, Md., are referred to the species.

Collection.—Maryland Geological Survey.

Subclass TRILOBITA
Order OPISTHOPARIA
Family PROETIDAE
Genus PROETUS Steininger

PROETUS (?) sp.

Plate XXXIII, Fig. 8

Description.—Pleura of pygidium grooved, causing them to appear double towards axis, single anteriorly. Margin flat, narrow. Surface finely granulose. The fragment here described does not appear to be clearly referable to any described species. It is too imperfect to permit specific identification.

Occurrence.—TONOLOWAY FORMATION. National Road on Martin Mountain.

Collection.—Maryland Geological Survey.

Family LICHADIDAE
Genus CORYDOCEPHALUS Rawle and Corda

CORYDOCEPHALUS PTYONURUS (Hall and Clarke)

Plate XXXIII, Fig. 7

Lichas (Hemiegmus) ptyonurus Hall and Clarke, 1888, Pal. N. Y., vol. vii, p. 86, pl. xixa, figs. 19-21.

Corydocephalus ptyonurus Bassler, 1915, U. S. Nat. Mus., Bull. 92, vol. 1, p. 281.

Description.—"Pygidium relatively large, flabellate, depressed convex. Axis less than one-third as wide as the shield upon the anterior margin, strongly arched upon the first two annulations, becoming depressed posteriorly, tapering to an obtuse termination just below the center of the

PLATE XXXVI

PAGE

FIGS. 1, 2. LEPERDITIA ELONGATA Weller 500
The type specimen, a right valve, natural size and × 2.
Helderbergian ("Rondout"). Two miles south of Tristates, N. Y.

FIGS. 3-6. LEPERDITIA ELONGATA WILLSENSIS n. var 500
3. Right valve, × 2.
4. Left valve, × 2.
Wills Creek formation (172 feet above base), Cedar Bluff, Md.
5. Left valve, × 2.
Wills Creek formation (235 feet above base), Cumberland, Md.
6. Surface of slab, × 2, showing abundance of this variety.
Wills Creek formation (48 feet above base), Pinto, Md.

FIGS. 7, 8. LEPERDITIA MATHEWSI n. sp 500
The type specimens, right and left valves, × 6, showing the well-defined border on each valve.
Tonoloway formation (Basal part), Grasshopper Run near Hancock, Md.

FIGS. 9, 10. LEPERDITIA ALTOIDES Weller 501
One of the original types, nat. size and × 2.
Helderbergian ("Rondout"). Flatbrookville, N. J.

FIG. 11. LEPERDITIA ALTOIDES MARYLANDICA n. var 501
The type specimen, a right valve, × 2.
Wills Creek formation (182 feet above base), Flintstone, Md.

FIGS. 13, 13. LEPERDITIA SCALARIS PRAECEDENS n. var 501
Two left valves, × 6.
Tonoloway formation (lower part), Keyser, W. Va., and Pinto, Md.

FIGS. 14-17. LEPERDITIA ALTA (Conrad) 503
14, 15. Two right valves, × 2.
16. A left valve, × 3, preserving the eye-spot.
Manlius limestone, Schoharie, N. Y.
17. Left valve, × 3, showing eye-spot.
Wills Creek formation (163 feet above base). Flintstone, Md.

FIG. 18. LEPERDITIA ALTA CACAPONENSIS n. var 502
18. Right valve, type, × 3, upon which the variety is founded.
Upper Clinton (*Drepanellina clarki* zone) (4 feet above Keefer sandstone). 1½ miles east Great Cacapon, Md.

FIG. 19. LEPERDITIA ALTA BREVICULA n. var 502
Slab with two left valves, × 3.
Wills Creek formation, Pinto, Md.

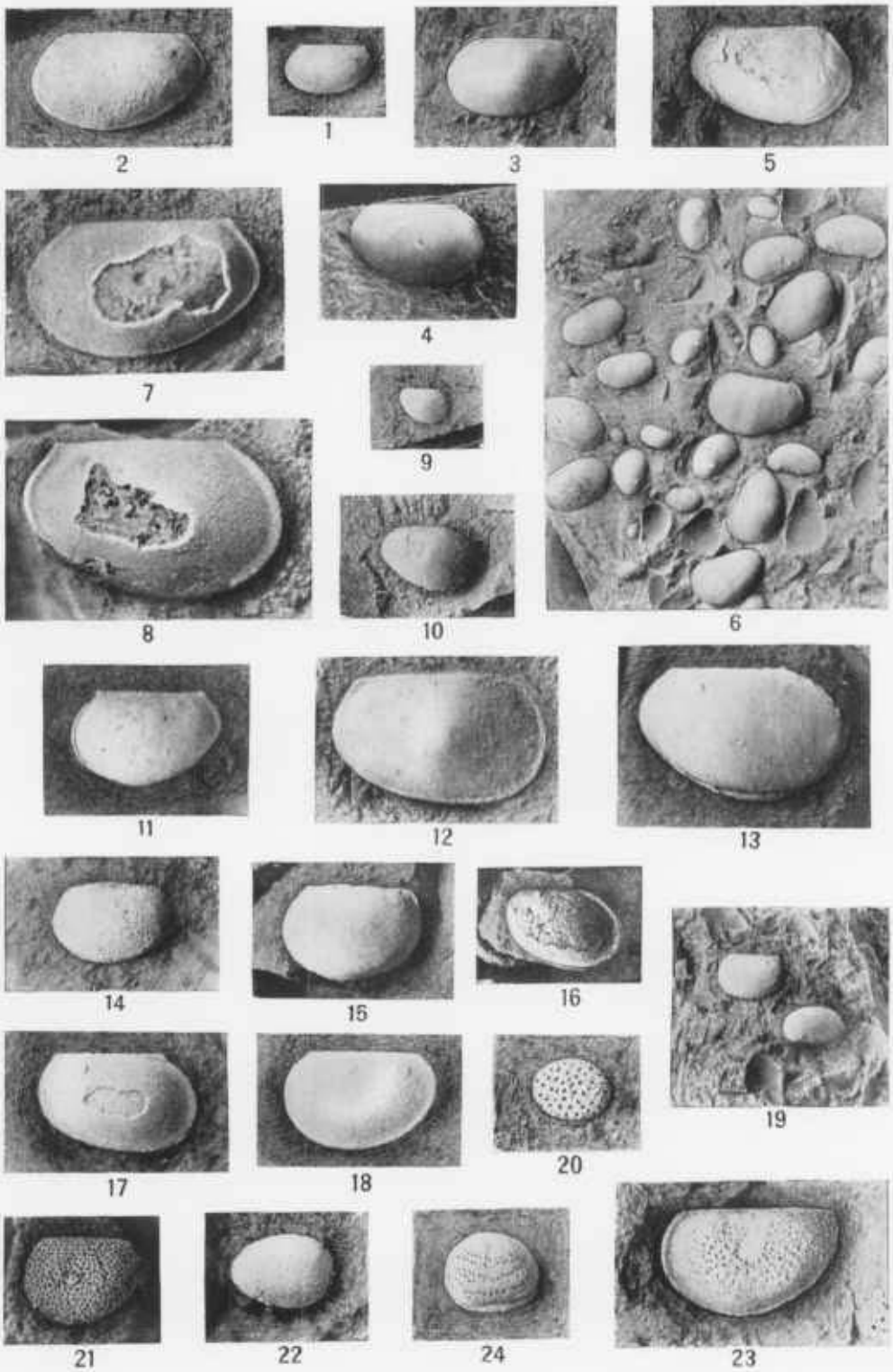
FIG. 20. APARCHITES VARIOLATUS n. sp 504
A valve of this curiously marked species, × 20.
Lower Clinton (57 feet above Tuscarora sandstone), Wills Creek, Cumberland, Md.

FIG. 21. APARCHITES (?) PUNCTILLOSA n. sp 503
The type specimen, a right valve, × 20.
Tonoloway formation (lower part), Keyser, W. Va.

FIG. 22. APARCHITES ALLEGHENIENSIS n. sp 504
A left valve, × 20.
Upper Clinton (*Drepanellina clarki* zone, 5 feet below top). Cumberland, Md.

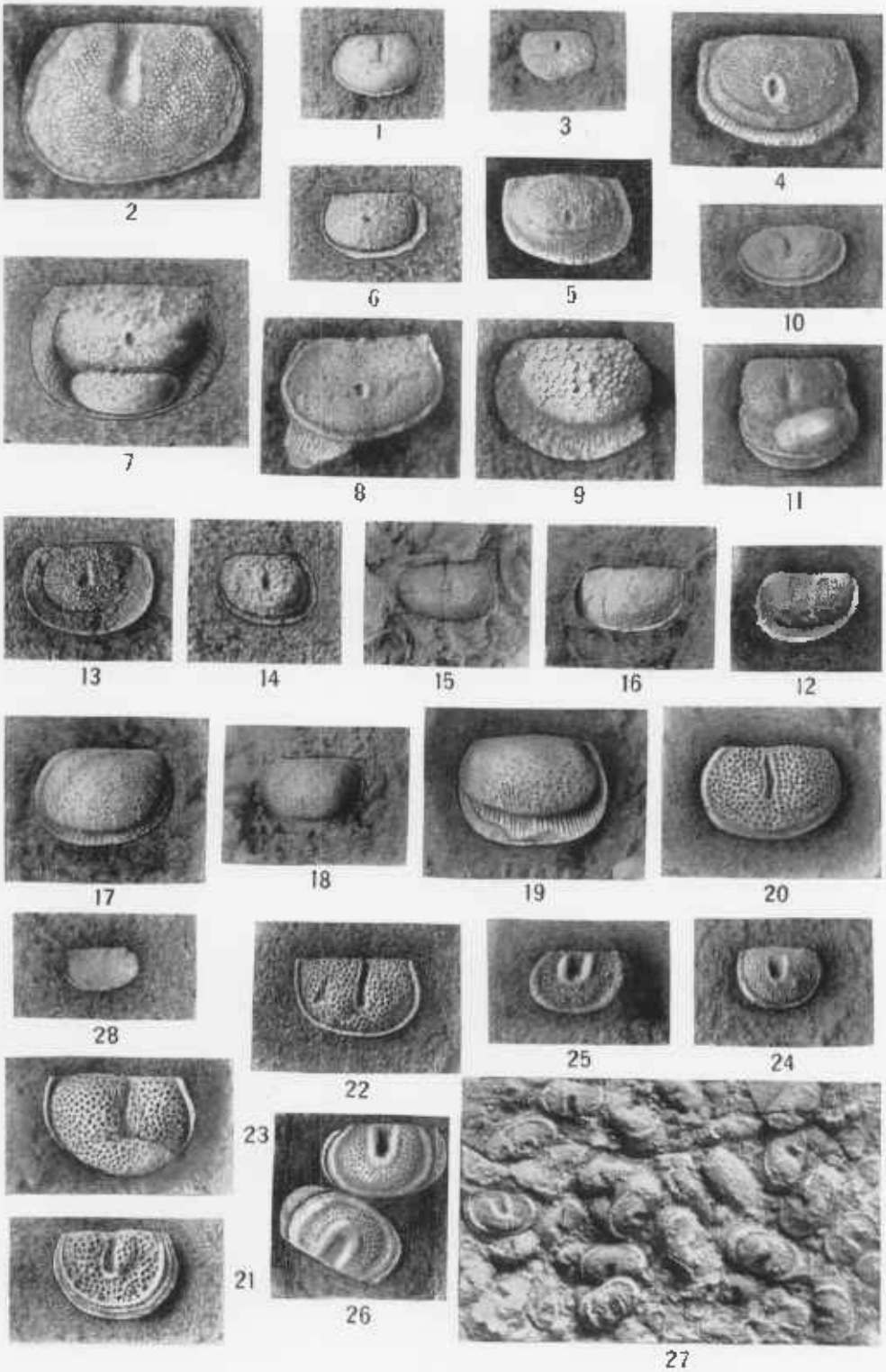
FIG. 23. APARCHITES OBLIQUATUS n. sp 503
The type specimen, × 12. A right valve showing the central spot and the surface marking.
Tonoloway formation (near top). Keyser, W. Va.

FIG 24. ERIDOCONCHA ROTUNDA n. sp 504
View, × 20, of the specimen upon which this peculiar species is founded.
Upper Clinton (*Mastigobolbina typus zone*). Lakemont, Pa.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XXXVII



ARTHROPODA-CRUSTACEA-OSTRACODA.

PAGE

FIGS. 1-3. PARAECHMINA SPINOSA Hall..... 506
1, 2. Two right valves, × 20, showing the spine and pit and the characteristic form of the marginal ridge.
Upper Clinton (Rochester shale). Lockport, N. Y.
3. A large right valve, × 20.
Upper Clinton (*Drepanellina clarki* zone). McKees farm, 7 miles west of Lewiston, Pa.

FIG. 4. PARAECHMINA CUMBERLANDIA n. sp..... 511
A left valve, × 20, with spine restored in outline.
Upper Clinton (*Drepanellina clarki* zone). Cumberland, Md.

FIG. 5. PARAECHMINA (?) DUMA n. sp..... 512
The type specimen, a right valve, × 20.
Tonoloway formation (upper part). Keyser, W. Va.

FIGS. 6-10. PARAECHMINA POSTICA n. sp..... 507
6. Right valve, × 20.
7. Right valve, × 20, tilted to show ventral edge and length of spine.
8. Exterior of large right valve, × 12, illustrating pit and base of spine.
9. Left valve, × 20.
Upper Clinton (*Drepanellina clarki* zone). Cumberland, Md.
10. Cast of interior of right valve, × 20.
Upper Clinton (*Drepanellina clarki* zone). McKees farm, 7 miles west of Lewiston, Pa.

FIG. 11. PARAECHMINA ABNORMIS Ulrich..... 507
A left valve, × 20, introduced for comparison. Figure poor because of uneven natural etching of the specimen.
Upper Clinton (Rochester shale). Lockport, N. Y.

FIGS. 12, 13. PARAECHMINA INTERMEDIA n. sp..... 508
12. Right valve, × 20, with apex of spine broken away.
13. Cast of interior, left valve, × 20, doubtfully referred to this species.
Upper Clinton (*Drepanellina clarki* zone). McKees farm, 7 miles west of Lewiston, Pa.

FIG. 14. PARAECHMINA CRASSA n. sp..... 506
Right valve, × 20, with spine and pit well preserved.
Upper Clinton (*Mastigobolbina typus* zone). Hollidaysburg, Pa.

FIG. 15. PARAECHMINA SIMURALIS n. sp..... 510
The type specimen, × 20, showing the marginal ridge, the ridge around the spine, which is broken, and the finely reticulated surface.
McKenzie formation (20 feet above base), one and one-half miles east of Great Cacapon, Md.

FIGS. 16-18. PARAECHMINA INÆQUALIS n. sp..... 510
Three right valves, × 20, showing spine in various degrees of preservation, the pit posterior to it and the marginal ridge along the posterior half.
McKenzie formation (73 and 82 feet below top). Flintstone, Md.

FIG. 19. PARAECHMINA POSTMURALIS n. sp..... 509
The type specimen, × 12, a right valve distorted laterally by pressure, the normal outline indicated by dotted line.
Middle Clinton (*Zygobolbina ornatella* zone). Cove Gap, Tuscarora Mt., 4½ miles n. w. Mercersburg, Pa.

FIG. 20. ARCHIMINA SIMPLEX n. sp..... 512
Right valve, × 20.
Upper Clinton (*Drepanellina clarki* zone). McKees farm, 7 miles west of Lewiston, Pa.

FIG. 21. PARAECHMINA PUNCTATA n. sp..... 511
The type specimen, × 30, a right valve.
Upper Clinton (*Mastigobolbina typus* zone). Two miles west of Hollidaysburg, Pa.

FIG. 22. PARAECHMINA DEPRESSA n. sp..... 509
The type specimen, × 20, a left valve showing the high marginal wall and decidedly unequal ends.
McKenzie formation (middle). Cumberland, Md.

FIGS. 23-26. PARAECHMINA ALTIMURALIS n. sp..... 509
23. Dorsal edge view of right valve, × 20, showing remains of the high crested ridge in the background.
24. Casts of interior of several valves, × 20.
25. Casts of interior of two left valves, × 20.
26. A large left valve, × 20, in which the marginal ridge is thicker than in the typical form. Probably more closely allied to *P. intermedia* (see fig. 13).
Upper Clinton (*Drepanellina clarki* zone). McKees farm, 7 miles west of Lewiston, Pa.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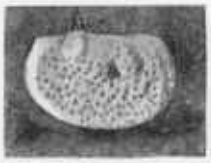
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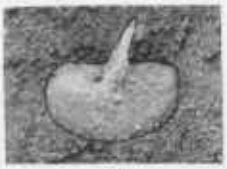
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XXXIX

PAGE

FIGS. 1-4. ZYGOBOLBA ERECTA n. sp. 539

1. Gutta percha squeeze, right valve male, × 8.
2. Natural mold, exterior of left valve male, × 8.
3. Gutta percha squeeze of left valve female, × 12.
4. Right valve male, × 8.

Lower Clinton (*Zygobolba erecta* zone). East slope Tussey Mountain, 1½ miles southwest of Cherrytown, Pa.

FIGS. 5, 6. ZYGOBOLBA CARINIFERA n. sp. 540

5. Gutta percha squeeze, × 8, of right valve male.
6. Natural cast of interior of a left valve. × 8. The overhanging post ventral part of the border is incompletely indicated.

Lower Clinton (*Zygobolba erecta* zone). East slope Tussey Mountain, 1½ miles southwest Cherrytown, Pa.

FIGS. 7-9. ZYGOBOLBA REVERSA n. sp. 541

7. Gutta percha squeeze right valve male, × 8.
8. Natural mold exterior left valve, × 8.
9. Natural cast exterior left valve male, × 8.

Lower Clinton (*Zygobolba erecta* zone). East slope Tussey Mountain, 1½ miles southwest of Cherrytown, Pa.

FIGS. 10-14. ZYGOBOLBA ARCTA n. sp. 539

10. Gutta percha squeeze right valve male, × 8, selected as the holotype.
11. Right valve male, × 8.

Middle Clinton, Gap, Gate City, Va.

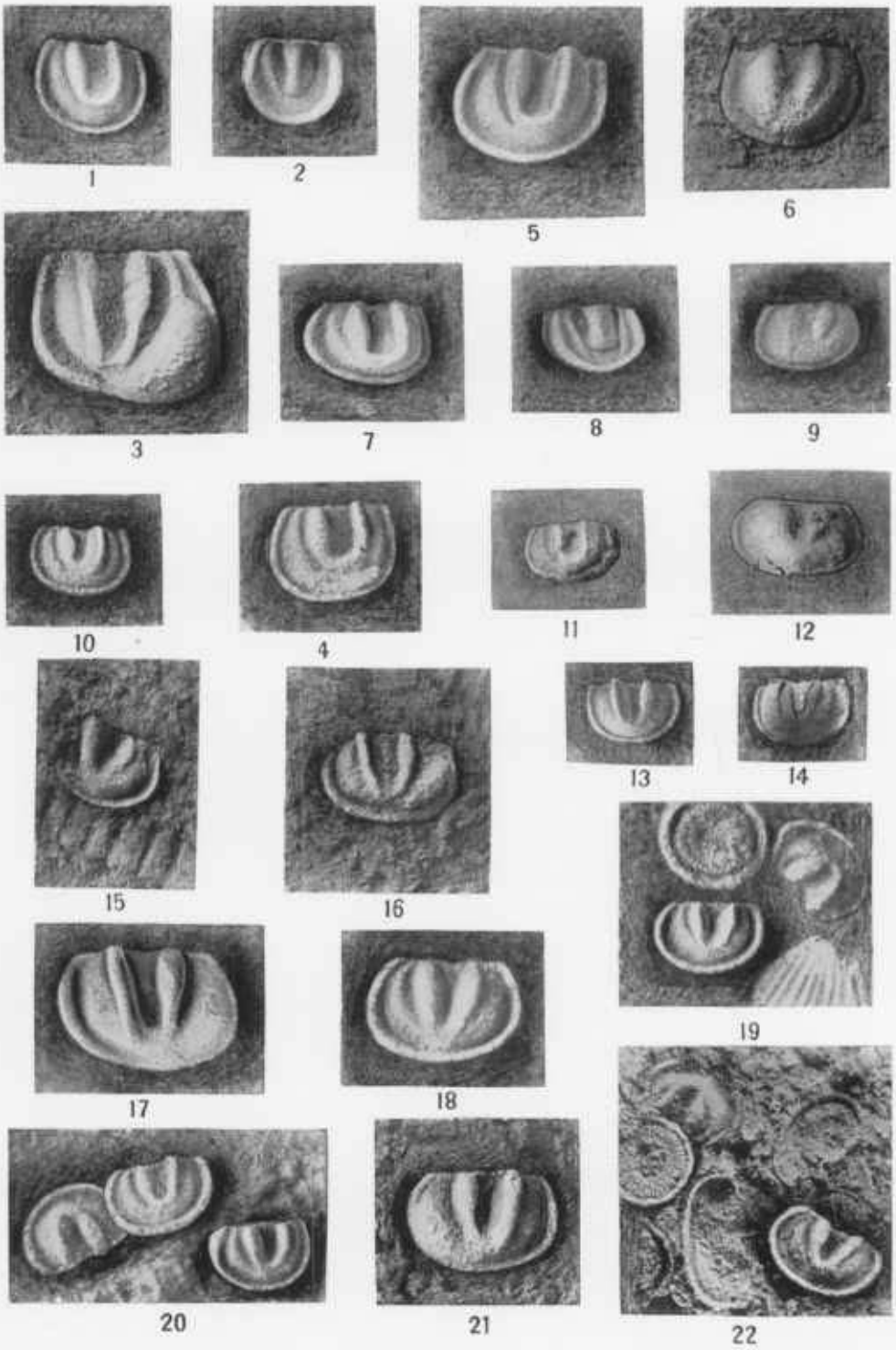
12. Natural cast interior left valve male, × 8.
13, 14. Two valves, male, × 8.

Middle Clinton, 50 feet beneath ore bed. 8 miles south of Big Stone Gap, Va.

FIGS. 15-22. ZYGOBOLBA DECORA (Billings) (see also Plate LXIV, figs. 21-25) 537

15. Gutta percha squeeze of imperfect left valve, male, × 8.
16 and 17. Gutta percha squeezes of two left valves, female, of a short variety with antero-dorsal angle more obtuse than usual, × 12.
18. Gutta percha squeeze of right valve, male, of same variety as figs. 16 and 17, × 12.
19. Right and left valves, males, of more nearly typical forms, × 8.
20. Gutta percha squeezes of three male valves, the middle and left specimens of typical form, the one on right side badly drawn and of doubtful relations, × 8.
21. Gutta percha squeeze of right valve, female, of same variety as figs. 16, 17 and 18.
22. Two right valves and incomplete impressions of others, all males, × 8, of fairly typical examples.

Middle Clinton, Gap, Gate City, Virginia.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XL

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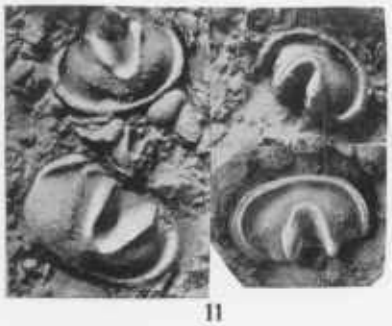

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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLI

PAGE

FIGS. 1-9. ZYGOBOLBA WILLIAMSI n. sp. 550

1. Left valve, male, × 8. This and fig. 6 give the normal male form of the species. All the other figures differ more or less from these because they lie in variously tilted positions in the matrix.
2, 3. Two right valves, female, × 8.
4. Small left valve, female, × 8.
5. Right valve, female, × 8. Except that the antero-dorsal angle is defective, this specimen illustrates the normal outline of the female of this species.
6. Right valve, male, × 8.
7. Right valve, female, × 8.
8, 9. Slab with numerous specimens, a portion × 8 and natural size.

Clinton (probably middle), green shales at base of Dyer dolomite. Clay Cliffs, 2 miles west of Cabot Head, Lake Huron, Ontario.

FIGS. 10, 11. ZYGOBOLBA MINIMA n. sp. 553

The type specimen, a male left valve, × 8 and × 20.

Lower Clinton (57 feet above base). Cumberland, Md.

FIGS. 12, 13. ZYGOBOLBA LIMBATA n. sp. 544

Gutta percha squeeze of a left male valve, × 8 and natural size.

Lower Clinton (*Zygobolba erecta* zone). East slope Tussey Mountain, 1½ miles southwest Cherrytown, Pa.

FIGS. 14, 15. ZYGOBOLBA OBSOLETA n. sp. 549

The type specimens, two male left valves, × 8.

Top of Lower Clinton, 8 feet above ore bed. One-half mile northwest Frankstown, Pa.

FIGS. 16-24. ZYGOBOLBA BUTTSI n. sp. 545

16. Valves, natural size.
17-19. Three male left valves, × 8.
20, 21. Right and left valves respectively, male, × 8.
22. Right valve male, × 8 (figs. 16-22, natural casts of the interior).
23. Ferruginous pseudomorph of shell, left valve male, × 8, showing width of flange, which is never fully indicated in the preceding casts of the interior.
24. Interior cast, left valve female, × 8.

Top of Lower Clinton, 8 feet above ore bed. One-half mile northwest Frankstown, Pa.

FIGS. 25, 26. ZYGOBOLBA PULCHELLA n. sp. 548

25. Natural cast of interior, left valve, male, × 8.
26. Similar cast of left valve, female, × 8, retaining part of shell.

Top of Lower Clinton, 8 feet above ore bed. One-half mile northwest Frankstown, Pa.

FIG. 27. ZYGOBOLBA PARVINITA n. sp. 543

The holotype, a male right valve, × 8.

Lower Clinton (*Zygobolba erecta* zone). East slope of Tussey Mountain, 1½ miles southwest of Cherrytown, Pa.

FIGS. 28, 29. ZYGOBOLBA RUSTICA n. sp. 547

28, 29. Casts of interior, left valve, male, × 8, the former somewhat disturbed by pressure.

Top of Lower Clinton, 8 feet above ore seam. One-half mile northwest of Frankstown, Pa.


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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLII

PAGE

FIG. 1. ZYGOBOLBINA CONRADI LATIMARGINATA n. var. (see also Plate XLIII, Figs. 12-19) 565

Gutta percha squeeze of 3 female valves, two right and one left, × 8.

Middle Clinton (*Mastigobolbina lata* zone), 300-325 feet above Tuscarora sandstone, ¾ mile south of Reedsville, Pa.

FIGS. 2-10. ZYGOBOLBINA EMACIATA n. sp. 567

2. Gutta percha squeeze of exterior, left valve, female, × 8.

Lower part of Middle Clinton, Gate City, Va.

3. Left valve, male, distorted (reduced in height), × 8.

4-6. Three right valves, female, × 6, showing varying aspects due to distortion.

7. Male left valve, × 8, shortened by pressure. The normal form may be imagined as a composite of this and fig. 3.

8. Female left valve, × 6, distorted, doubtfully referred to this species.

9, 10. Surface of slab, natural size and × 3, illustrating abundance of examples.

Lower part of Middle Clinton (*Zygobolbina emaciata* zone). Near toll-gate, Cove Gap, Tuscarora Mountain, 4½ miles n. w. Mercersburg, Pa.

FIGS. 11-20. ZYGOBOLBINA CARINATA n. sp. 566

11-12. Two casts of the interior of left valves, male, × 8.

13. Similar cast of young male left valve, × 8, showing impression of flange.

14. Left valve, male, × 8.

15, 16. Two right valves, exterior, male, × 8.

17. Surface of slab with examples, × 1.

18. Cast interior, female, right valve, × 8.

19. Partial cast of the interior, male, right valve, × 8, but retaining shell of flange.

20. Left valve, male, × 8, cast of interior.

Top of Lower Clinton. Eight feet above main seam of Frankstown ore bed, 1 mile northwest of Frankstown, Pa.


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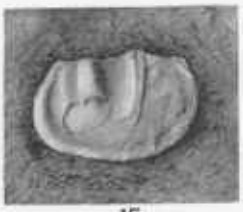
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLIII

PAGE

FIGS. 1-11. ZYGOBOLBINA CONRADI n. sp. 564

1. Gutta percha squeeze, left valve, male, × 8.
2. Squeeze of right valve, male, × 8.

   Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.
3. Sandstone fragment with molds, natural size.
4. Half ventral view of left valve, female, × 8.
5. Right valve, female, × 8.
6. Right valve, male, × 8.
7. Gutta percha squeeze of right valve, male, × 8.

   Middle Clinton (*Mastigobolbina lata* zone, 120 feet above base) along Wills Creek, Cumberland, Md.
8. Squeeze of fairly typical right valve, male, × 8.
9. Right valve, male, not typical, × 8.
10. Exterior of right valve, male, × 8, doubtfully referred to this species. The outline is more rounded, the border thinner and wider and more deeply excavated than in the typical form.

    Middle Clinton (*Mastigobolbina lata* zone), eastern end Lavender Mt., Armuchee, Ga.
11. Left valve, female, × 8. Anterodorsal part of outline obscured by matrix.

    Middle Clinton, Gate City, Va.

FIGS. 12-19. ZYGOBOLBINA CONRADI LATIMARGINATA n. var. (see also Pl. XLII, Fig. 1) 565

12. Right valve, female, × 8.

    Middle Clinton, Eastern end of Lavender Mountain, Armuchee, Ga.
13. Gutta percha squeeze of right valve, male, × 8.
14. Sandstone slab with specimens, natural size.

    Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.
15. Gutta percha squeeze of right valve, male, × 8.

    Middle Clinton, 306-325 feet above Tuscarora sandstone, ¾ mile south of Reedsville, Pennsylvania.
16. Left valve, male, gutta percha squeeze, × 8.

    Middle Clinton, 173 feet above Tuscarora sandstone, Cumberland, Md.
17. Right valve, male, × 8.

    Middle Clinton (120 feet above base) along Wills Creek, Cumberland, Md.
18. Right valve, female, × 8.

    Middle Clinton, Lavender Mountain, Armuchee, Ga.
19. Defective cast of interior, left valve, male, × 8, doubtfully referred to the variety.

    Top of lower Clinton, 8 feet above main seam, Frankstown ore bed. One-half mile northwest Frankstown, Pa.

FIGS. 20-22. ZYGOBOLBINA PANDA n. sp. 566

20. Left valve, male, × 8.
21. Right valve, male, × 8.
22. Left valve, female, × 8.

    Top of lower Clinton, 8 feet above main seam of Frankstown ore bed. One-half mile northwest of Frankstown, Pa.


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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLIV

PAGE

FIGS. 1-10. ZYGOSELLA POSTICA n. sp. 572

1. Sandstone slab with valves, natural size.
2. Gutta percha squeeze of exterior, right valve, male, × 8.
3. Natural cast of interior, left valve, female, × 8.

Middle Clinton, New River, one mile west of Narrows, Va.

4. Casts of the interior of male and female valves, × 6.
5. Left valve, male, × 8.
6. Two natural molds of the exterior, male, × 5.
7. 8. Natural casts, left valves, female, × 8; the apparent difference from the normal shape being due to tilting of the specimens in the rock.

Middle Clinton, Wills Creek gorge at Cumberland, Md.

9. Gutta percha squeeze, right valve, male, × 8.
10. Cast of interior of male, right valve, × 8.

Middle Clinton (*Zygobolbina emaciata* zone), Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.

FIGS. 11-14. ZYGOSELLA GRACILIS n. sp. 573

11. Cast of interior, left valve, male, × 8.
12. Cast of interior, right valve, female, × 8.

Middle Clinton, New River, 1 mile west of Narrows, Va.

13. Male, left valve, × 8, cast of interior.
14. Examples, × 1.

Middle Clinton (*Zygobolbina emaciata* zone), toll-gate, Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.

FIGS. 15-17. ZYGOSELLA LIMULA n. sp. 575

15. Valves, natural size.
16. Gutta percha squeeze of right and left male valves, × 8.
17. Interior casts of same specimens, × 8.

Middle Clinton (*Zygobolbina emaciata* zone), Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.

FIGS. 18-20. ZYGOSELLA MIMICA n. sp. 571

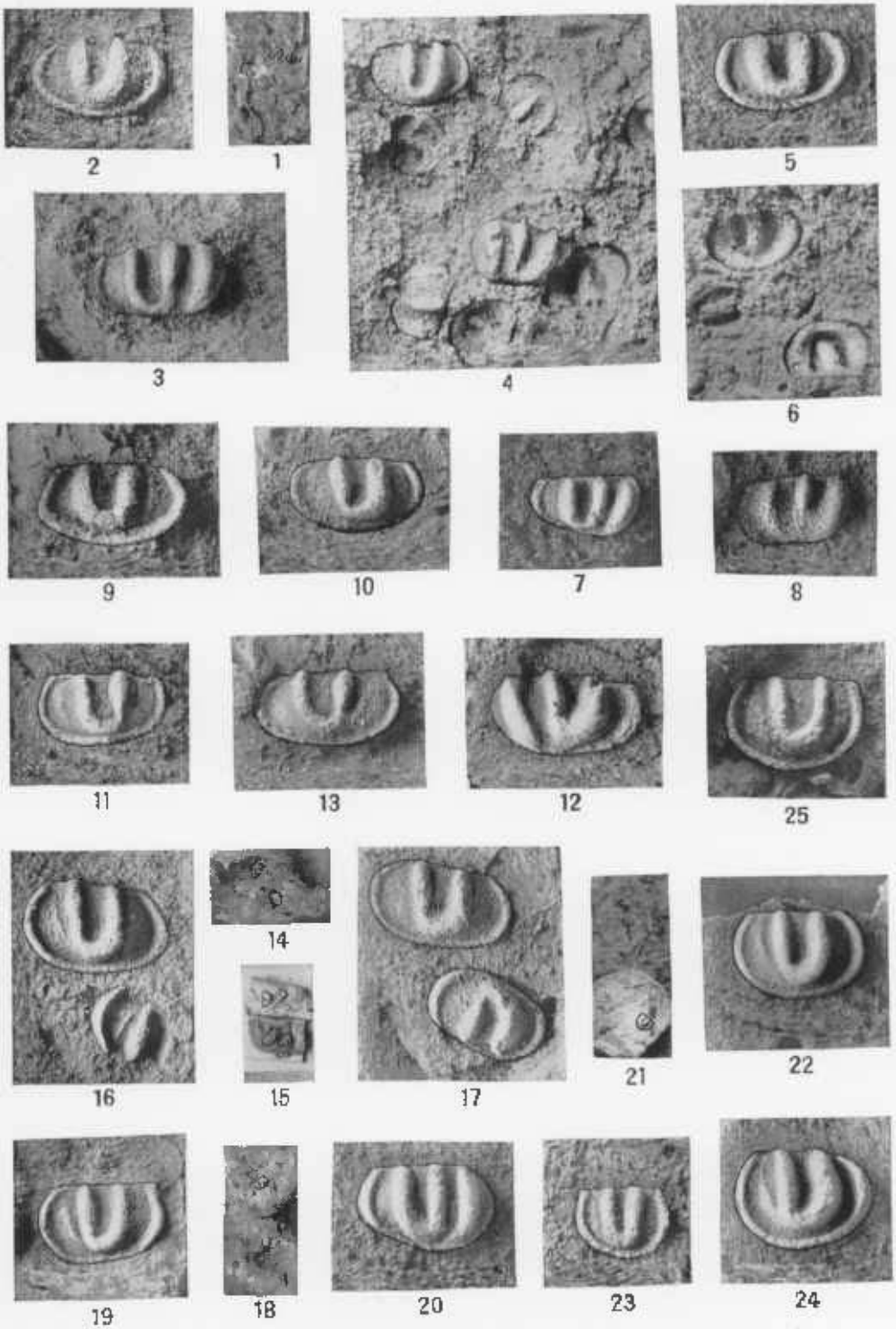
18. Natural size, view of valves.
19. Gutta percha squeeze of right valve, male, × 8.
20. Similar squeeze of a left valve, female, × 8.

Middle Clinton (*Mastigobolbina lata* zone), Gap, 1½ miles northwest of Warm Springs, Va.

FIGS. 21-25. ZYGOSELLA BREVIS n. sp. 573

21. Valves, natural size.
22. A male right valve, × 8, slightly distorted by pressure.
23, 24. Left and right valves, male, × 8, more distorted but still showing specific characters.
25. Right valve of male, × 8, showing normal form.

Middle Clinton (*Zygobolbina emaciata* zone), Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLV

PAGE

FIGS. 1-3. ZYGOSELLA VALLATA n. sp. 569

1. Gutta percha squeeze of slab, × 8, containing a right and a left male valve of this species (1) associated with *Zygosella macra*.
   Upper Clinton (*Mastigobolbina typus* zone). North of Williamsville, Va.
2. Left valve, male, × 8.
   Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone. One and one-half miles east of Great Cacapon, W. Va.
3. Right and left valves, male, × 6.
   Upper Clinton (*Mastigobolbina typus* zone), 29 feet beneath Keefer sandstone). Near Six-Mile House, Md.

FIGS. 1, 4-6. ZYGOSELLA MACRA n. sp. 571

1. Gutta percha squeeze, × 8, containing several male (2) and female valves (3) associated with *Zygosella vallata* (1).
   Upper Clinton (*Mastigobolbina typus* zone). North of Williamsville, Va.
4. Natural cast of interior, right valve, female, × 8.
   Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath top of Keefer sandstone. Near Six-Mile House, Md.
5. A right valve, female, × 8, associated with left valve, male, of *Z. vallata* (1).
6. Female right valve, × 8.
   Upper Clinton (*Mastigobolbina typus* zone). North of Williamsville, Va.

FIGS. 7-10. ZYGOSELLA VALLATA NORMERA n. var. 569

7. Valves, natural size.
8. 9. Gutta percha squeezes, male, left valves, × 8.
10. Right valve, female, × 8.
    Upper Clinton (*Bonnemaia rudis* zone). Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.

FIG. 11. ZYGOSELLA ALTA n. sp. 570

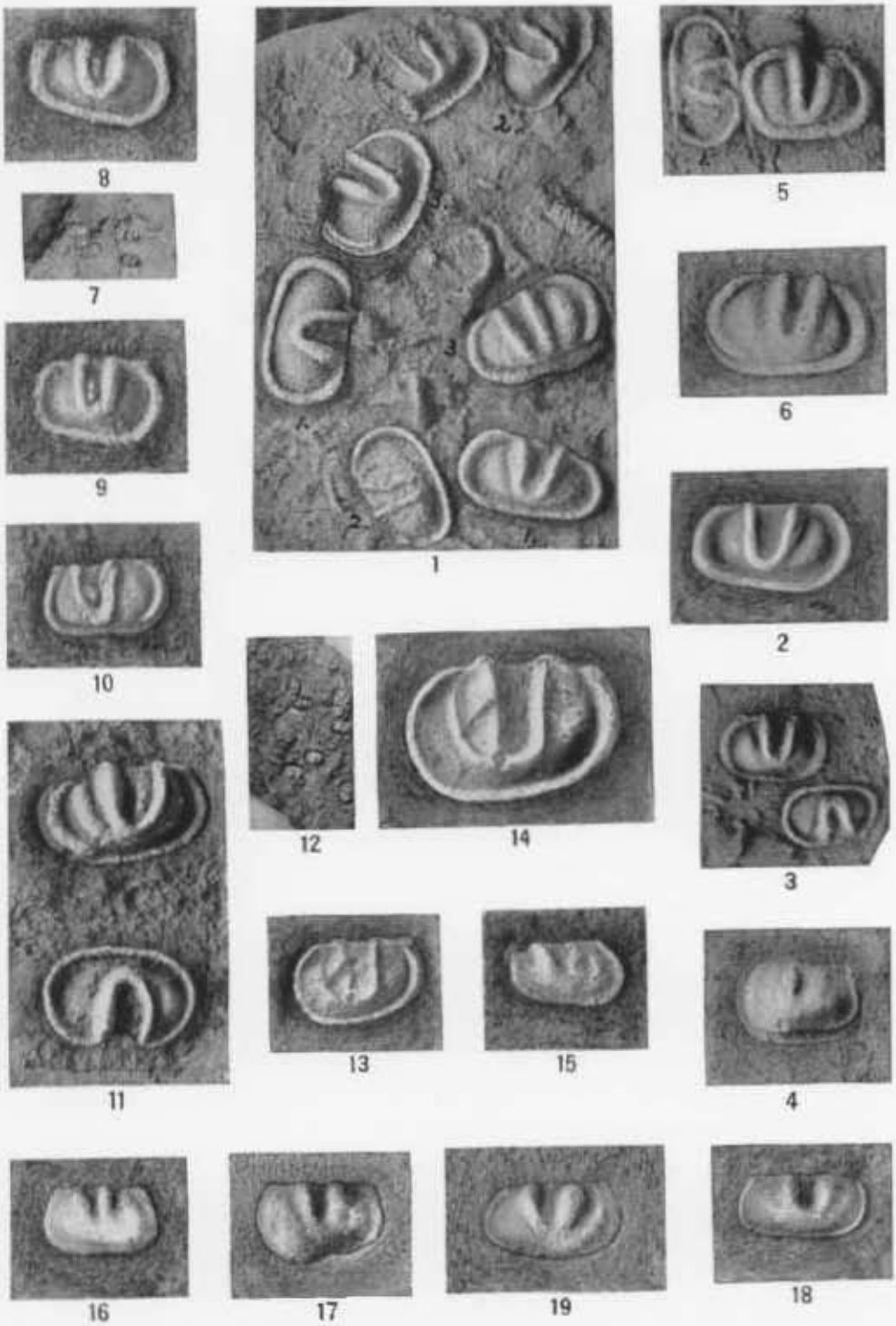
Gutta percha squeeze, × 8, with right valve, female, in upper part and left valve, male.
Near base Upper Clinton (122 feet below Keefer sandstone), Near Six-Mile House, Md.

FIGS. 12-14. ZYGOSELLA CRISTATA n. sp. 572

12. Surface of slab with valve, natural size.
13, 14. The type specimen, a male right valve, × 8 and × 12.
    Upper Clinton (*Mastigobolbina typus* zone), 29 feet beneath Keefer sandstone. Near Six-Mile House, Md.

FIGS. 15-19. MASTIGOBOLBINA VIRGINIA n. sp. 627

15. Cast of interior left valve, probably female, × 8. The anterior end is too narrow and the dorsal angle too prominent in this specimen to be admitted without question into this species. It may belong to *M. vanuxemi*.
    Lower part Upper Clinton. Wills Creek, Cumberland, Md.
16. Cast exterior left valve, male, × 8. The outline in this also is different from the typical form and there is a peculiar, perhaps abnormal, thickening of the lower half of the posterior lobe.
17. Cast of exterior, right valve, female, × 8. This specimen and the original of fig. 18 are the types of the species.
18. Cast of interior, left valve, male, × 8, of the typical form.
    Lower part Upper Clinton. Big Stone Gap, Va.
19. Cast of interior left valve, male, × 8. The dorsal and ventral sides of this specimen are more nearly parallel than in the typical form of the species.
    Lower part Upper Clinton. Gap 1½ miles northwest of Warm Springs, Va.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLVI

PAGE

FIGS. 1-6. BONNEMAIA CELSA n. sp. 581

1. Right valve, male, × 8.

Upper Clinton (*Mastigobolbina typus* zone), 32 feet beneath base of Keefer sandstone, Flintstone, Md.

2, 3. Left valve, male, natural size and × 8.

4-6. Dorsal, lateral and ventral edge views of same, × 8.

Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.

FIGS. 7-9. BONNEMAIA CRASSA n. sp. 582

7, 8. Testiferous right valve, male, natural size and × 8.

9. Ventral edge view of same, × 8.

Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.

FIGS. 10-15. BONNEMAIA OBLIQUA n. sp. 584

10, 11. Gutta percha squeeze of large left valve, male, × 1 and × 8.

Upper Clinton (*Bonnemaia rudis* zone). Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.

12. Natural cast of interior, left valve, male, × 8.

13. Natural cast interior right valve, male, × 8.

14. Natural cast interior, right valve, female, × 8.

Lower part of Upper Clinton, Wills Creek, Cumberland, Md.

15. Rough natural casts in sandstone of interior right male and left female valves, × 8. The brood pouch and adjacent parts of the female (upper figure) have been broken away.

Upper Clinton. State Line east of Rickard Mt., Williamsport quadrangle, Md.

FIGS. 16-18. BONNEMAIA PERLONGA n. sp. 593

16. The type specimens, natural size, preserved in coarse sandstone.

17. Gutta percha squeeze of exterior of male valve, × 8. The roughened surface in this and the following figure is due to the coarseness of grain of the sandy matrix.

18. Gutta percha squeeze of exterior of imperfect left valve, female, × 8.

Upper Clinton. One mile west of Stone Cabin Gap, Williamsport quadrangle, Md.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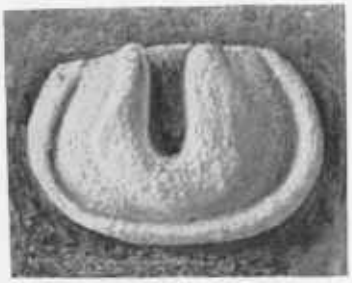
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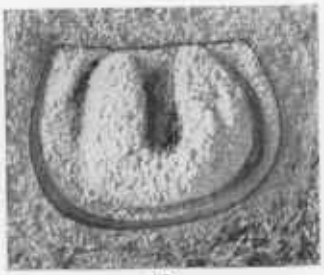
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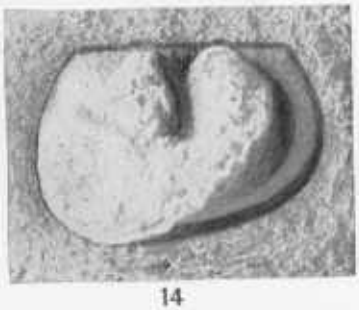
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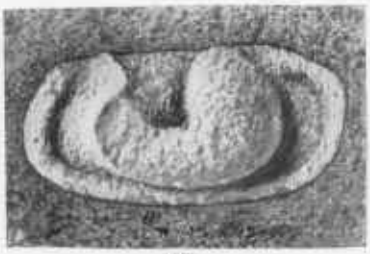
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLVII

PAGE

FIGS. 1-6. BONNEMAIA RUDIS n. sp. 580

1. Left valve, male, × 8.
2. A single valve, natural size.
3. Right valve, male, × 8.
4. Left valve, female, × 6.
5. Natural molds, × 4, on a slab of fine grained sandstone, containing numerous valves of *B. rudis*, *B. fissa*, *B.* cf. *longa*, *Mastigobolbina bifida* and other ostracoda commonly found in this zone.
6. Natural cast of the interior, right valve, female, × 8.

Lower part of Upper Clinton. (*Bonnemaia rudis* zone) Mulberry Gap, Powell Mt., 5 miles northwest Sneedville, Tenn.

FIGS. 7-9. BONNEMAIA FISSA n. sp. 585

7. Gutta percha cast of the exterior of three valves, natural size, the middle one being of this species, the other of *B. rudis*. The exterior molds of same specimens are shown, × 4, in the middle of the upper fourth of fig. 5.
8. Two of the same specimens, × 8, the one on the left showing the character of a typical male left valve, of *B. fissa*.
9. Male left valve, × 8.

Upper Clinton (*Bonnemaia rudis* zone). Mulberry Gap, Powell Mt., 5 miles northwest Sneedville, Tenn.

FIGS. 10-12. BONNEMAIA LONGA n. sp. 591

10. Gutta percha squeeze of right valve, male, × 8. Holotype.

Upper Clinton (*Mastigobolbina typus* zone), Wills Creek, Cumberland, Md.

11, 12. Gutta percha squeeze of large left valve, female, natural size and × 8. Original preserved in shale and somewhat crushed. Doubtfully referred to this species, the median sulcus being abnormally wide and varying in other features from the holotype.

Upper Clinton (*Mastigobolbina typus* zone), 29 feet below Keefer sandstone, Sir Johns Run (Devil's Nose), Md.

FIG. 13. BONNEMAIA TRANSITA VAR. TRANSVERSA n. var. 588

Left valve, male, × 8, representing a longish variety that at first suggested possibly closer relations to *B. longa*.

Upper Clinton (*Bonnemaia rudis* zone). Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.

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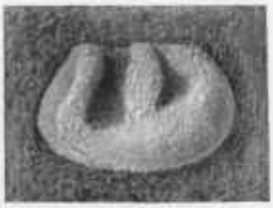

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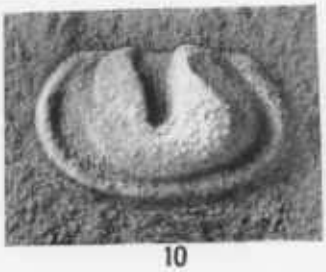

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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLVIII

PAGE

FIGS. 1-4. BONNEMAIA PULCHELLA n. sp. 587

1. Several valves, natural size, the middle one only of this species.
2. Natural cast of right valve, male, × 8.
   Upper Clinton (*Bonnemaia rudis* zone), Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.
3. The holotype, a natural cast of the interior of a right valve, male, × 8.
4. Natural cast of interior of left valve, male, × 8.
   Basal part Upper Clinton, Wills Creek, Cumberland, Md.

FIGS. 5-7. BONNEMAIA NOTHA n. sp. 594

5. Sandstone fragment with valves, natural size.
6. Gutta percha squeeze of exterior right valve, male, × 8.
7. Three valves, two males (right and left) and one (right) female, × 8, regarded as types of the species.
   Middle Clinton (*Mastigobolbina lata* zone) Gap, Gate City, Va.

FIGS. 8-11. BONNEMAIA TRANSITA n. sp. 588

8. A right male valve, natural size.
9. Right male valve, cast of interior, × 8, with height of posterior half slightly greater than usual.
10. Gutta percha squeeze of exterior of another right valve, male, × 8.
11. Right valve, female, × 8.
    Upper Clinton (*Bonnemaia rudis* zone), Mulberry Gap, Powell Mt., 5 miles northwest of Sneedville, Tenn.

FIGS. 12-13. BONNEMAIA TRANSITA VAR. GRANDIS n. var. 588

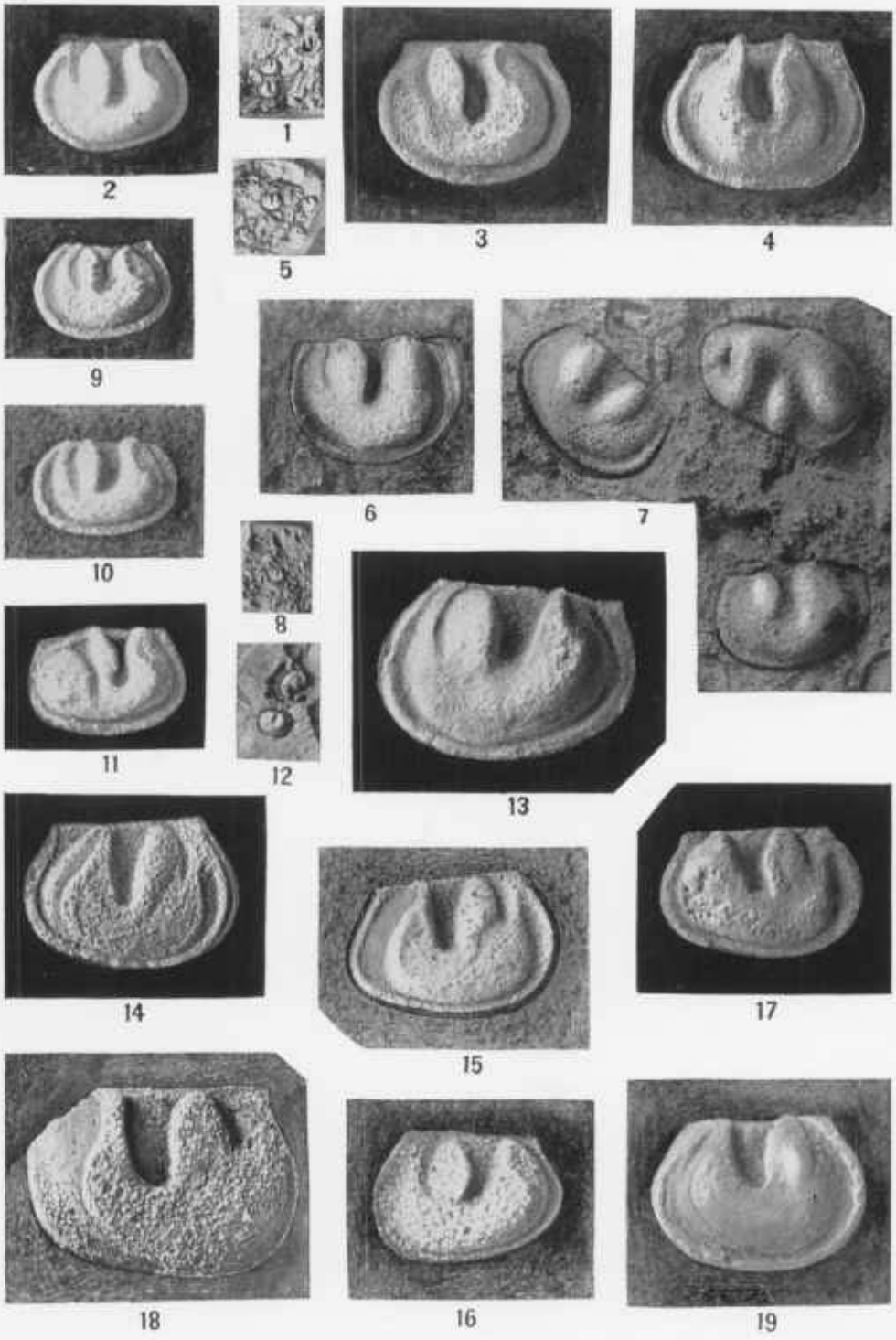
12. Casts of interior in shale of two valves, natural size, the upper of the two being of *B. oblonga*, the lower of this variety.
13. The lower of the two specimens shown in fig. 12, a right valve, male, × 8. This valve is much larger than usual and differs slightly in other respects from typical *B. transita*. Probably represents a distinct species.
    Upper Clinton, 29 feet beneath Keefer sandstone, Sir Johns Run (Devil's Nose), Md.

FIGS. 14-18. BONNEMAIA OBLONGA n. sp. 583

14, 15. Gutta percha squeeze and natural cast, × 8, of left valves, male.
    Upper Clinton, 29 feet beneath Keefer sandstone, Sir Johns Run (Devil's Nose), Md.
16. Natural cast of interior, right valve, male, × 6.
17. Cast of interior, left valve, male, × 8.
18. Cast of interior, left valve, female, × 8.
    Upper Clinton. One mile southeast of Big Stone Gap, Va.

FIG. 19. BONNEMAIA cf. CRASSA n. sp. 582

Testiferous left valve, male, × 8, doubtfully referred to this species.
Upper Clinton, Hollidaysburg, Pa.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE XLIX

PAGE

FIGS. 1-6. *Mastigobolbina typus* n. sp. 602

1. Fragment of sandstone with numerous molds of this and other species of ostracods, natural size.
2. Gutta percha cast of the same, natural size.
3. Gutta percha cast of two male valves of the variety *angulata*, × 6, associated with two valves of the smaller ostracode *Zygoscella vallata* and with *Tentaculites*.
4. Gutta percha casts of two left female valves, × 6, associated with a valve of *Zygoscella vallata* and one of *Bonnemaia* sp.

   Upper Clinton (*Mastigobolbina typus* zone), 29 feet below Keefer sandstone. Near Six-Mile House, Md.
5. Testiferous left valve, female, × 8, with flagellum broken away.

   Upper Clinton (*Mastigobolbina typus* zone), Lakemont, Pa.
6. Cast of interior of left valve, male, × 6.

   Upper Clinton (*Mastigobolbina typus* zone), 23 feet below Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.
7. Testiferous left valve of female, × 8, with flagellum preserved.

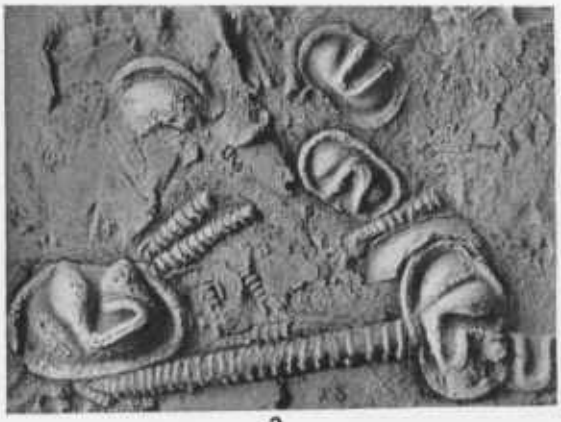
   Upper Clinton (*Mastigobolbina typus* zone), Lakemont, Pa.
8. Inner side of ventral edge of female right valve, × 20, showing thin ridges and furrows used in locking the closed valves.

   Upper Clinton (*Mastigobolbina typus* zone), Hollidaysburg, Pa.
9. Right valve, female, × 8, with ventral curve of flagellum broader than usual.
10. Right valve, male, × 6, with summits of median and anterior lobes broken but otherwise in excellent preservation.

    Upper Clinton (*Mastigobolbina typus* zone), Lakemont, Pa.
11. Imperfect testiferous left valve, female, × 6.

    Upper Clinton (*Mastigobolbina typus* zone), 23 feet below Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.
12. Gutta percha squeeze of mold, left valve of male, × 6, of variety *angulata* showing the characteristic elbow-like angulation of the ventral extremity of the flagellum and the low convexity of the valves.
13. Squeeze of mold of left valve, female, × 6.
14. Ventral edge view of same, × 6.
15, 16. Left valve of female and dorsal edge view, × 6, of a doubtful specimen which is relatively too short and the form and course of the flagellum different from *M. typa*. The specimen may be a female valve of *M. intermedia* or a similar species.

    Upper Clinton, 77 feet beneath top of Keefer sandstone. Six-Mile House, Md.



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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE L

PAGE

FIGS. 1-4. MASTIGOBOLBINA TRIPLICATA (Fœrste) 605

1, 2. Two testiferous right valves, male, × 8.

3. Left male valve, × 8.

4. Right valve of female, × 8.

Upper Clinton (*Mastigobolbina typus* zone), Lakemont, Pa.

FIG. 5. MASTIGOBOLBINA TYPUS PRÆNUNTIA n. var 602

The holotype—a left valve, × 12.

Near base of Upper Clinton (*Bonnemala rudis* zone). Mulberry Gap, Powell Mountain, 5 miles northwest Sneedville, Tenn.

FIGS. 6-10. MASTIGOBOLBINA ACUTA n. sp 607

6. A right valve, female, × 8.

7, 8. Left valve of female, × 8, with ventral edge view of same. The inner edge of the broad pouch is so nearly straight and the post ventral part so full in this specimen that it is doubtfully referred here. Possibly it belongs with *M. intermedia*.

9. Testiferous right valve of male, × 8.

Upper Clinton (*Mastigobolbina typus* zone). Lakemont, Pa.

10. Male right valve, × 8, of incomplete specimen representing a variety.

Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.

FIG. 11. MASTIGOBOLBINA ROTUNDA n. sp 610

The type specimen, a left valve, male, × 12.

Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.

FIGS. 12-15. MASTIGOBOLBINA INTERMEDIA n. sp 609

12. Testiferous left valve, male, × 12.

13, 14. Two left valves, male, × 12, with part of shell broken away.

15. Left valve of female, × 12.

Upper Clinton (*Mastigobolbina typus* zone). Lakemont, Pa.

FIGS. 16-17. MASTIGOBOLBINA TRILOBATA n. sp 612

16. Testiferous left valve, male, × 12.

17. Right valve, male, × 12, also preserving test.

Upper Clinton (*Mastigobolbina typus* zone). Lakemont, Pa.

FIGS. 18-20. MASTIGOBOLBINA ARCTILINEATA n. sp 613

18, 19. Two views, × 6 and × 12, of the type specimen, a testiferous left valve, male.

Upper Clinton (*Mastigobolbina typus* zone), 23 feet beneath Keefer sandstone, 1½ miles east of Great Cacapon, W. Va.

20. Cast of the interior in limestone, × 12, a small left valve, male.

Upper Clinton (*Mastigobolbina typus* zone). Lakemont, Pa.

FIG. 21. MASTIGOBOLBINA GLABRA n. sp 614

A perfect left valve, male, × 12.

Upper Clinton, (*Mastigobolbina typus* zone). Lakemont, Pa.

FIGS. 22, 23. MASTIGOBOLBINA PUNCTATA n. sp 615

The holotype, × 8 and × 20, a perfect left valve, male, showing the punctate surface.

Upper Clinton (*Mastigobolbina typus* zone). Lakemont, Pa.


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ARTHROPODA-CRUSTACEA-OSTRACODA.

PAGE

FIGS. 1-11. MASTIGOBOLBINA LATA (Hall) (see also Plate LII, Figs 5, 6).. 620

1. Gutta percha squeeze, left valve, × 8, from a natural mold in rather coarse-grained sandstone.
   Middle Clinton (*Mastigobolbina lata* zone), 120 feet above base, Cumberland, Md.
2. Gutta percha squeeze of left valve, male, × 8. The natural mold from which this was prepared, retains some of the ferruginous replacement of the shell.
3. Gutta percha squeeze, × 8, of male valve with produced dorsal extremity of anterior lobe.
4. Cast of interior, left valve, male, × 8.
   Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.
5. Gutta percha squeeze, right valve, × 8.
   Middle Clinton (*Mastigobolbina lata* zone), 120 feet above base, Cumberland, Md.
6. Left valve, male, × 8, from Hall's type lot. This specimen is uncommonly elongate and the crest of the anterior lobe is poorly defined. In both respects it reminds of *M. vanuxemi* to which it should perhaps be referred.
7. 8. Natural casts of interior, right and left female valves. × 8.
9. Left valve, female, × 8, from original types.
10. Surface of Hall's original type slab, × 2. 1, types as here restricted, casts of the interior of a right and a left valve of the male and a mold of the exterior of a female; 2, casts of the exterior, left valves, males.
11. Gutta percha squeeze of right valve, male, × 8, prepared from cleanest natural mold available and therefore best showing the exterior of the valves.
    Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.

FIGS. 12-17. MASTIGOBOLBINA LATA NANA n. var..... 626

12, 13. Two right valves, × 8, distorted, mainly shortened, by pressure. The larger may belong to the typical variety of the species or to *M. declivis*.
14. Natural cast of left female valve, × 8.
15. Gutta percha squeeze of a large right valve, male, × 8, reduced in height by pressure.
    Middle Clinton (*Zygobolbina emaciata* zone), Toll-gate, Cove Gap, Tuscarora Mt., 4½ miles northwest of Mercersburg, Pa.
16, 17. Gutta percha squeezes of male right and left valves, × 8. The small size of the species is indicated by comparison with the incompletely exposed valve of *M. lata* lying beside it in the upper figure.
    Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.

FIGS. 18-20. MASTIGOBOLBINA CLARKEI n. sp..... 629

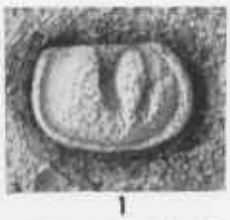
18. Natural size, view of surface of sandstone slab with impressions of valves of this and other species of its zone. *M. lata* is represented but most of the impressions are of *Zygobolbina conradi*.
19. Right valve, male, × 8, figured by Ulrich and Bassler in 1908 as *Beyrichia lata* Hall, and also left valve of female of *M. lata*.
    Middle Clinton (*Mastigobolbina lata* zone), New Hartford, N. Y.
20. Right valve of male, × 8.
    Middle Clinton (*Mastigobolbina lata* zone), Three-fourths mile south of Reedsville, Pa.

FIGS. 21-23. MASTIGOBOLBINA ULTIMA n. sp..... 618

21. Gutta percha squeeze, large left valve, male, × 8.
22. Small left valve, male, × 8.
23. Left valve, female, ×8.
    Upper Clinton (*Bonnemaia rudis* zone), 102 feet beneath top of Keefer sandstone. Near Six-Mile House, Md.

FIG. 24. MASTIGOBOLBINA MICULA n. sp..... 616

Gutta percha squeeze, left valve, male, × 8.
Upper Clinton (*Bonnemaia rudis* zone), 102 feet below top of Keefer sandstone. Near Six-Mile House, Md.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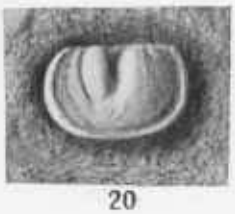
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LII

PAGE

FIGS. 1-4. MASTIGOBOLBINA VANUXEMI n. sp. 627

1. Natural cast of the interior of a right valve, × 8.
2. Natural cast of the interior of a smaller left valve, × 8.
   Middle Clinton (*Mastigobolbina lata* zone). New Hartford, N. Y.
3. Surface of sandstone slab, natural size, showing numerous specimens of *M. vanuxemi* and *M. lata*.
   Middle Clinton (*Mastigobolbina lata* zone). 120 feet above Tuscarora sandstone, Cumberland, Md.
4. Gutta percha squeeze of right valve, male, of a variety, × 8.
   Middle Clinton, 100 feet above iron-ore bed (*Mastigobolbina lata* zone), Cumberland Gap, Tenn.

FIGS. 5, 6. MASTIGOBOLBINA LATA (Hall) Ulrich and Bassler. (See also Plate LI, Figs. 1-11) 620

5. Natural cast of interior, right valve, male, × 8. The specimen is uncommonly large for the species but has suffered slight abrasion of the anterior lobe and loss of the crest of the ridge.
6. Gutta percha squeeze of large left valve, male, × 8. Differences between this and Fig. 5 are mainly because this shows the exterior of the valve whereas that is a cast of the inner surface.
   Middle Clinton (*Mastigobolbina lata* zone), 120 feet above top of Tuscarora sandstone, Cumberland, Md.

FIGS. 7-10. MASTIGOBOLBINA DECLIVIS n. sp. 630

7. Gutta percha squeeze, exterior, right valve, male, × 8.
8. Natural cast of interior, right valve, male, × 8.
9. Several valves, natural size.
10. Gutta percha squeeze, exterior left valve, male, × 8. Specimen slightly distorted by pressure and tilted so as to depress the anterior border and narrow the steep slope of the anterior lobe.
    Middle Clinton (*Zygobolbina emaciata* zone), Cove Gap, Tuscarora Mountain, 4½ miles northwest of Mercersburg, Pa.

FIGS. 11-16. MASTIGOBOLBINA MODESTA n. sp. 611

11. Gutta percha squeeze of right valve, male, × 8.
    Middle Clinton (*Mastigobolbina lata* zone), New River, 1 mile west of Narrows, Va.
12. Squeeze of exterior of two right and one left valve, × 8.
13. Natural cast of interior, × 8, retaining impression of the high and thin border on the posterior side.
14. Valves, natural size.
15. Gutta percha squeeze of ventral two-thirds of exterior male left valve, × 8, showing the strongly bowed and prominent flagellum.
    Middle Clinton (*Mastigobolbina lata* zone). Gap, 1½ miles northwest of Warm Springs, Va.
16. Natural cast, interior left valve, female, × 8.
    Middle Clinton (*Mastigobolbina lata* zone), New River, 1 mile west of Narrows, Va.

FIGS. 17-20. MASTIGOBOLBINA (?) BIFIDA n. sp. 617

17 and 19. Gutta percha squeezes, exterior right and left valves, respectively, males, × 8.
18. Squeeze, exterior left valve, female, × 8, the dorsal edge and post dorsal region wanting and tilted so as to show more of the ventral slope.
20. Gutta percha squeeze, exterior left valve, female, × 8, showing the brood pouch lying within the elevated borders.
    Upper Clinton (*Nodomania rudis* zone), Mulberry Gap, Powell Mountain, 5 miles northwest of Sneedville, Tenn.

FIG. 21. PLETHOBOLBINA TYPICALIS n. sp. (See also Plate LIII, Figs. 28-33.) 636

Left valve, × 12.
Upper Clinton (*Mastigobolbina typus* zone), 1½ miles east of Great Cacapon, W. Va.


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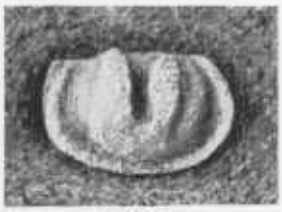
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LIII

PAGE

FIGS. 1-7. MASTIGOBOLBINA RETIFERA n. sp. 634

1. Valve, natural size.
2. Perfect natural mold, exterior left valve, male, × 8.
3. Testiferous left valve, male, × 8, showing surface reticulation. The lobes were injured in freeing the specimen from the matrix.
4. Testiferous right valve, male, × 8, exhibiting border and lower half of surface.
5. Partial cast of interior of left valve, female, × 8, with indications of the exterior surface punctation.
6. Cast interior right valve, male, × 8, showing form of post median lobe and course of crest of anterior lobe along its inner side.
7. Similar cast right valve, female, × 8, with border lacking.

Top of Lower Clinton, 8 feet above main ore seam, ½ mile northwest of Frankstown, Pa.

FIGS. 8-12. MASTIGOBOLBINA INCIPIENS n. sp. 632

8. Valve, natural size.
9. Gutta percha squeeze, × 8, of right, male valve retaining, showing duplex character of border.
10. Cast interior left valve, male, × 8.
11. Similar cast of female left valve, × 8. As in Fig. 10, most of the border is wanting.
12. Anterior two-thirds of cast interior of left valve, × 20, showing muscular scars. The marginal depression is made by the inner border. The hollow base of the wide outer border makes the low intramarginal ridge in which parts of both are shown.

Top of Lower Clinton, 8 feet above main ore seam, ½ mile northwest of Frankstown, Pa.

FIGS. 13-17. MASTIGOBOLBINA PRODUCTA n. sp. 633

13. Cast interior male left valve, × 8, somewhat shorter than usual.
14. Interior cast of right male valve of the elongate typical form, × 8.
15. Inner side of male left valve, × 8. The outer border extends into the matrix from the dark line on the inner edge of the light colored impression of the inner border.
16. Gutta percha squeeze of original, Fig. 15, × 8.
17. Cast interior right valve, male, × 8, retaining a bit of the ventral border.

Top of Lower Clinton, 8 feet above main ore seam, ½ mile northwest of Frankstown, Pa.

FIGS. 18-20. PLETHOBOLBINA ORNATA n. sp. 636

18, 19. The type specimen, a left valve, × 8 and × 20, showing the finely reticulated surface.
20. Same valve, natural size.

Upper Clinton (*Mastigobolbina typus* zone), 2 miles west of Hollidaysburg, Pa.

FIGS. 21, 22. PLETHOBOLBINA CORNIGERA n. sp. 637

The type specimen, × 8, and natural size, showing the characteristic horn-like node on the dorsal edge.

Upper Clinton (*Mastigobolbina typus* zone), 2 miles west of Hollidaysburg, Pa.

FIGS. 23, 24. PLETHOBOLBINA CRIBRARIA n. sp. 637

Right and left valves, × 12, illustrating outline and reticulate surface.

Lower Clinton, 57 feet above top of Tuscarora sandstone, Cumberland, Md.

FIGS. 25-27. PLETHOBOLBINA SULCATA n. sp. 638

25, 26. Right and left valves, × 12, both slightly distorted.
27. Valve, natural size.

Middle Clinton (*Zygobolbina emaciata* zone), Toll-Gate, Cove Gap, 4½ miles northwest Mercersburg, Pa.

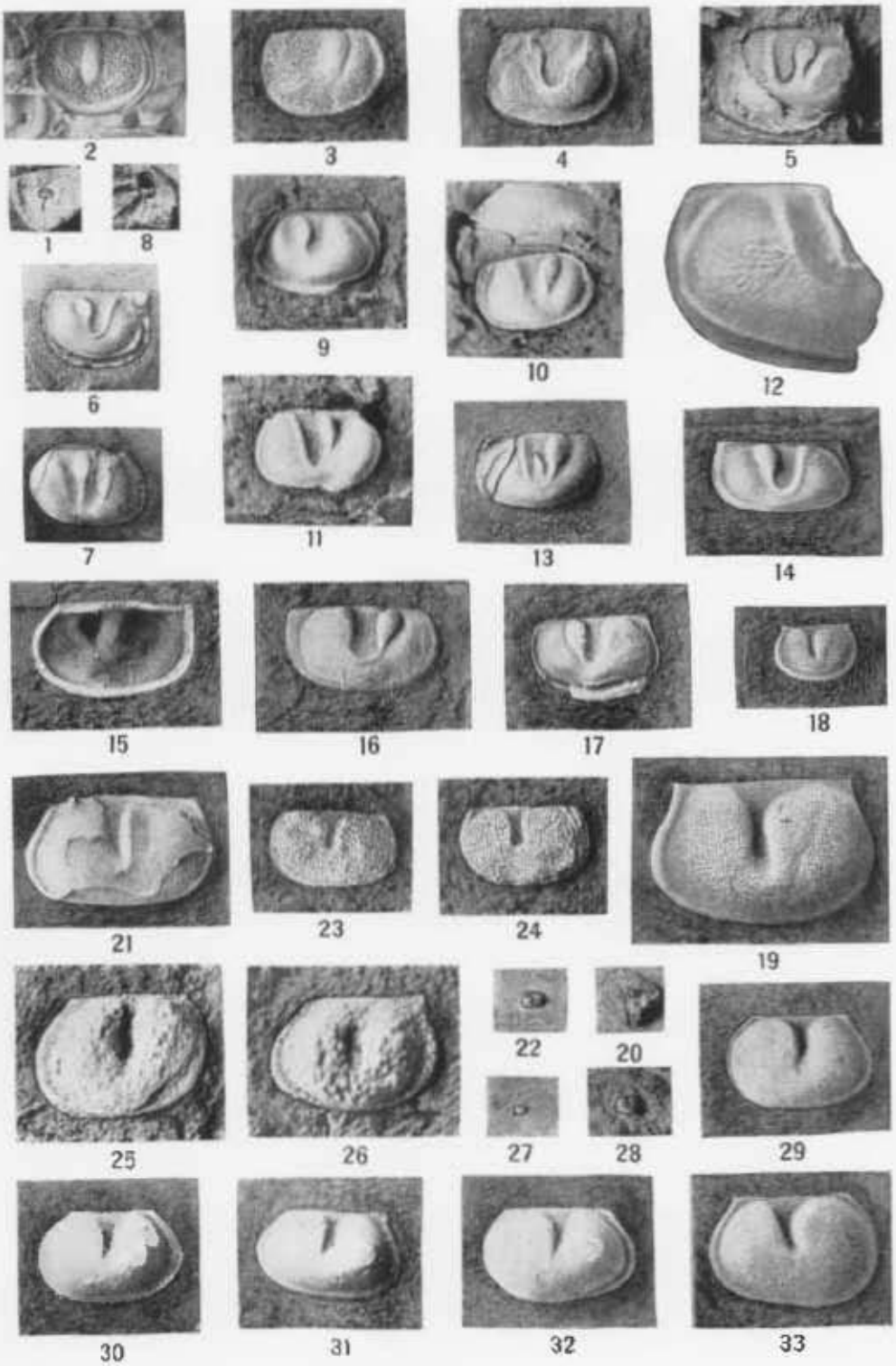
FIGS. 28-33. PLETHOBOLBINA TYPICALIS n. sp. 635

28. Average valve, natural size.
29. Quite perfect, small right valve, × 6.
30, 31. Two right valves, × 6.

Upper Clinton (*Mastigobolbina typus* zone), Lakemont, Pa.

32. Nearly perfect right valve, × 6, fuller than usual in the post ventral quarter and possibly a female.
33. Large left valve (female ?), × 6, with shell partly denuded. (See also Pl. LII, Fig. 21.)

Upper Clinton (*Mastigobolbina typus* zone), 1½ miles east of Great Cacapon, W. Va.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LIV

PAGE

FIGS. 1, 2. ZYGOBEYRICHIA REGINA n. sp. 645

1. Left valve, female, × 12.
2. Typical male left valve, × 12, exhibiting the border and the almost straight ventral edge.

Tonoloway formation (upper part), Keyser, W. Va.

FIGS. 3-5. ZYGOBEYRICHIA TONOLOWAYENSIS n. sp. 645

3. Male left valve, × 12, showing convex ventral outline.
4. Another male left valve, × 12.
5. Right valve, × 12.

Tonoloway formation (upper part), Keyser, W. Va.

FIGS. 6-8. ZYGOBEYRICHIA VENTRICORNIS n. sp. 646

6, 7. Right and left valves, male, of typical form, × 12.

Wills Creek formation (182 feet above base), Flintstone, Md.

8. Two male left valves, × 12.

Wills Creek formation (45 feet above base), Pinto, Md.

FIGS. 9, 10. ZYGOBEYRICHIA VENTRICORNIS OBSOLETA n. var. 646

Two male right valves of this variety, × 12, characterized by the absence of the ventral node. These two differ from each other in the relative length of the hinge line.

Wills Creek formation (187 feet above base), 3 miles west of Hancock, Md.

FIG. 11. ZYGOBEYRICHIA VENTRICORNIS var. 646

A small left valve, × 12, with a peculiar ventral elevation, provisionally referred here.

Tonoloway limestone (upper part), Keyser, W. Va.

FIG. 12. ZYGOBEYRICHIA MODESTA n. sp. 647

Male left valve, × 20.

Tonoloway formation (128 feet above base), Grasshopper Run, near Hancock, Md.

FIGS. 13, 14. ZYGOBEYRICHIA INCIPIENS n. sp. 646

Two male left valves, × 12, upon which the species is founded and showing the ventral obsolescence of the border.

Wills Creek formation (45 feet above base), Pinto, Md.

FIGS. 15-18. ZYGOBEYRICHIA VENTRIPUNCTATA n. sp. 645

15. Limestone fragment, × 6, showing abundance of this ostracode.
16. Female left valve, × 12, showing decided punctæ on brood pouch.
17. Male left valve, × 12.
18. Female right valve, × 12.

Tonoloway formation (upper part), Keyser, W. Va.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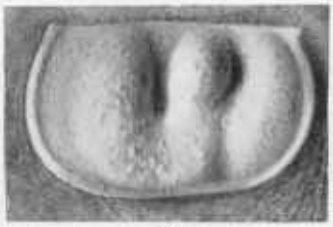
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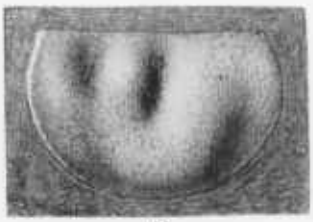
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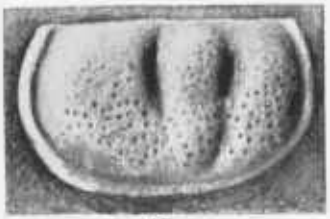
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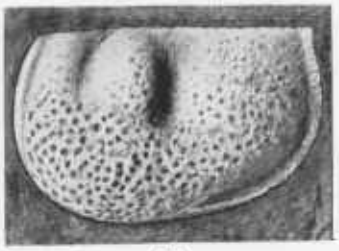
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LV

PAGE

FIGS. 1-5. KYAMMODES TRICORNIA n. sp. 644

1, 2. Right valves of male and female, respectively, × 16.

3, 4. Right and left valves of male, × 16.

5. Variety with shorter hinge line, × 16.

McKenzie formation (77-82 feet below top), Flintstone, Md.

FIGS. 6-10. WELLERIA OBLIQUA n. sp. 643

6. Slightly shortened left valve of male, × 12.

7. Left valve, × 12.

8. Typical left valve of male, × 12.

9. Surface of slab, × 6, illustrating abundance of this species.

10. Left valve of female, × 12, showing the overhanging ventral pouch.

Tonoloway formation (lower part). Keyser, W. Va., and Grasshopper Run, 5 miles above Hancock, Md. (Figs. 6, 10).

FIGS. 11, 12. WELLERIA OBLIQUA LONGULA n. var. 642

11. A left valve of male, × 12, on slab with *Dizygopleura halli*.

12. A small specimen, × 20, doubtfully referred to this variety.

Tonoloway formation (lower part), Keyser, W. Va.

FIG. 13. WELLERIA OBLIQUA BREVIS n. var. 642

Right valve, × 12, showing dorsally converging terminal outlines and relatively short form.

Tonoloway formation (lower part), Keyser, W. Va.

FIGS. 14-16. KYAMMODES SWARTZI n. sp. 643

14, 15. Two right valves, × 12, showing subpentagonal form and projecting ventral slope.

16. Left valve, × 12, illustrating shortness of sulci.

Tonoloway formation (lower part), Grasshopper Run, 5 miles above Hancock, Md.

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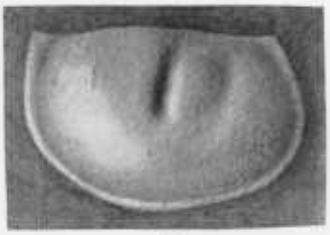

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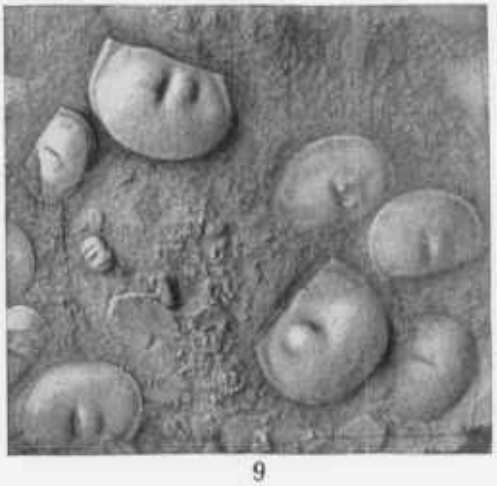

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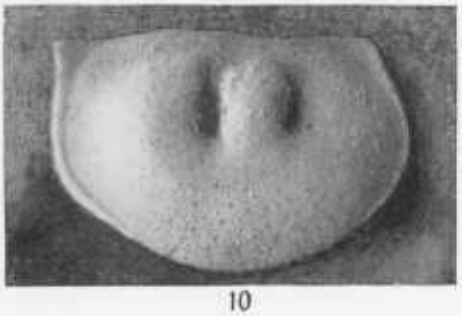

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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LVI

PAGE

FIGS. 1, 2. DREPANELLINA MODESTA n. sp. 649
Right and left valves, × 12, upon which this species is founded.
Upper Clinton (*Drepanellina clarki* zone), Cumberland, Md.

FIG. 3. DREPANELLINA (?) SIMPLEX n. sp. 649
The type, a right valve, × 20, showing resemblance to *Kyamenoides*.
Upper Clinton (*Drepanellina clarki* zone), Lakemont, Pa.

FIG. 4. DREPANELLINA CLAYPOLEI n. sp. 650
Right valve, × 12, illustrating oblique shape and sharp anterior dorsal angle.
Upper Clinton, Juniata Co., Pa.

FIGS. 5, 6. DREPANELLINA VENTRALIS n. sp. 650
5. Typical left valve, × 20, exhibiting transverse ventral elevation.
6. Left valve, × 20, of a variety with slightly shorter hinge and inturned angles.
Upper Clinton (*Drepanellina clarki* zone), 34 feet above Keefer sandstone at Rose Hill, Md.

FIGS. 7-9. DREPANELLINA CONFLUENS n. sp. 649
7. Right valve of female, × 12.
8. A shortened example, male, × 12.
9. Typical left valve, male, × 12, showing confluence of two anterior lobes.
Silurian, Mt. Wissick, Temiscouta Lake, Quebec.

FIGS. 10-13. DREPANELLINA CLARKI n. sp. 648
10. Slightly imperfect right valve, male, × 12.
11. Left valve, male, × 12.
12. Well preserved right valve, male, × 12.
13. Left valve, female, × 12.
Upper Clinton (*Drepanellina clarki* zone, 5 feet below top), Cumberland, Md.

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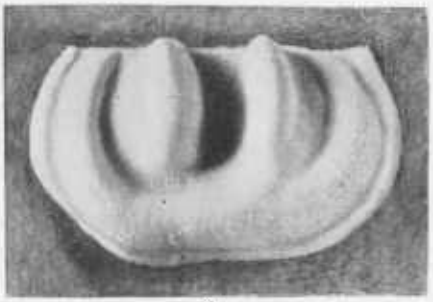

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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LVII

PAGE

FIGS. 1-4. EUKLOEDENELLA INDIVISA n. sp. 668
1, 2. Right side of two complete carapaces, × 16.
3, 4. Ventral and dorsal edge views of complete example, × 16.
McKenzie formation (30 feet above base), Flintstone, Md.

FIGS. 5-7. EUKLOEDENELLA UMBONATA n. sp. 668
Right side of three complete carapaces, × 16, exhibiting slight variations but all showing the prominent anterodorsal quarter.
McKenzie formation (30 feet above base), Flintstone, Md.

FIGS. 8-12. EUKLOEDENELLA UMBILICATA n. sp. 669
8. Young specimen, × 16, showing punctate surface and portion of surface, × 50.
9. Right side of complete carapace, × 16.
10. Ventral edge view of complete carapace, × 16, the right valve above.
11. Dorsal edge view of another example, × 16.
12. Left side of complete carapace, × 16, showing overlap of right valve.
McKenzie formation (30 feet above base), Flintstone, Md.

FIG. 13. EUKLOEDENELLA UMBILICATA CUNTA n. var. 669
Right valve and outline edge view, × 20.
Wills Creek formation (45 feet above base), Pinto, Md.

FIGS. 14-17. EUKLOEDENELLA PRIMITIOIDES n. sp. 670
14. Right valve of complete carapace, × 16.
15, 16. Left side of two complete specimens, × 16.
17. Right side of small complete example, × 16.
McKenzie formation (30 feet above base), Flintstone, Md.

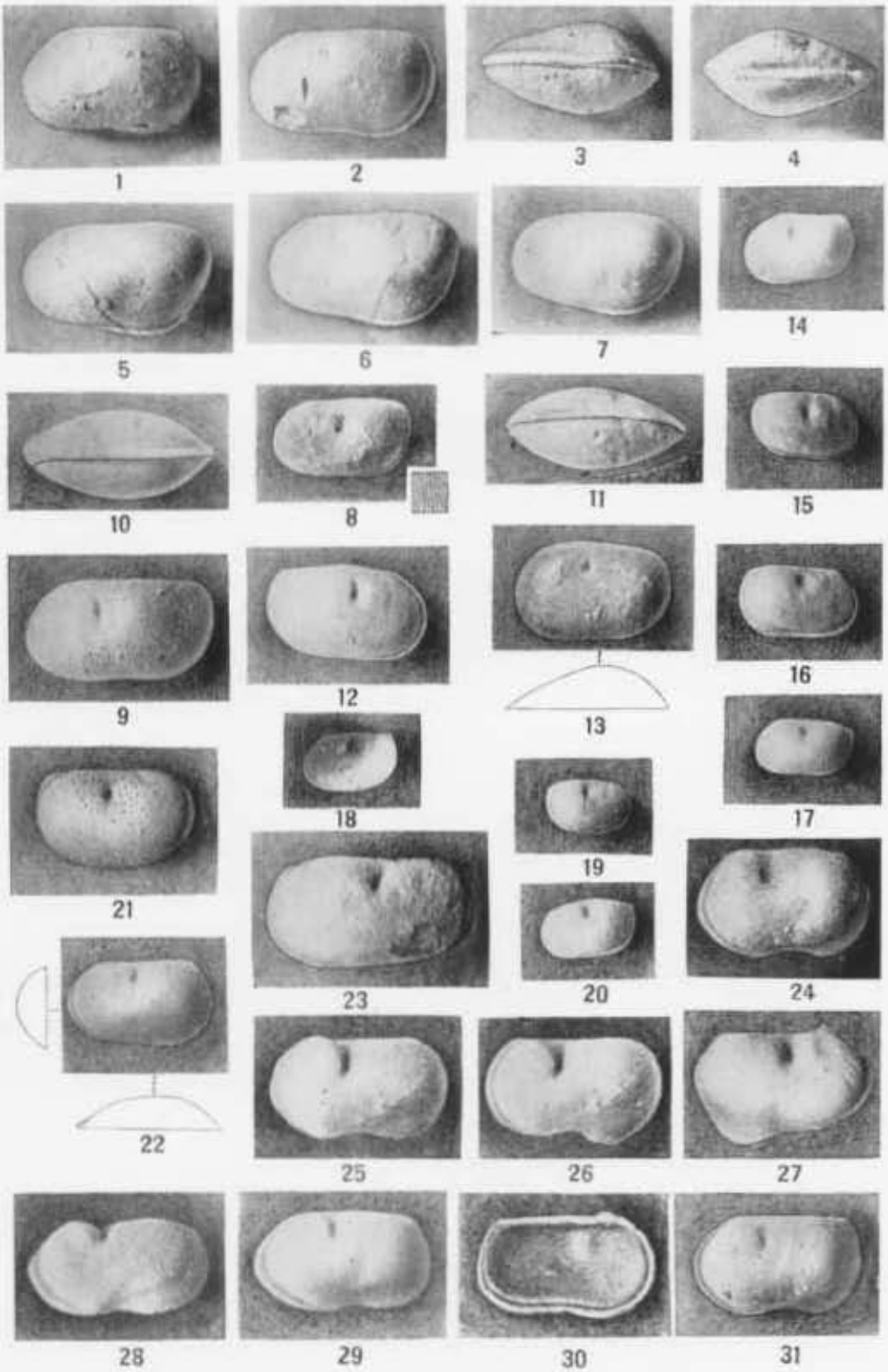
FIGS. 18-20. EUKLOEDENELLA PRIMITIOIDES MINOR n. var. 670
Right and left side of complete example of this minute ostracode, × 20.
McKenzie formation (30 feet above base), Flintstone, Md.

FIG. 21. EUKLOEDENELLA BREVIS n. sp. 670
Left view, × 20, illustrating short form and oval outline.
McKenzie formation (20 feet above base), 1½ miles east Great Cacapon, Md.

FIGS. 22, 23. EUKLOEDENELLA SIMPLEX n. sp. 671
22. The type specimen, a right valve, × 12, with ventral and lateral edge views.
23. A larger, somewhat longer left valve, × 20.
McKenzie formation (20 feet above base), 1½ miles east Great Cacapon, Md.

FIGS. 24-27. EUKLOEDENELLA SINUATA n. sp. 671
24-26. Three right valves, × 16.
27. Left valve of the same species, × 16.
McKenzie formation (77 and 82 feet below top), Flintstone, Md.

FIGS. 28-31. EUKLOEDENELLA SINUATA ANGULATA n. var. 672
28. Right valve, × 16, tilted so as to show more of ventral slope.
29. Right valve, × 16.
30. Interior of valve, × 16.
31. The holotype, × 16, upon which this variety is founded.
McKenzie formation (82 feet below top), Flintstone, Md.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LVIII

PAGE

FIG. 1. EUKLOEDENELLA SINUATA ANGULATA n. var. 672
Left valve, × 20 (see also Pl. LVII, Figs. 28-31).
McKenzie formation (82 feet below top), Flintstone, Md.

FIGS. 2-5. EUKLOEDENELLA SINUATA PROCLIVIS n. var. 672
2. Right valve, × 20.
3, 4. Two left valves, × 20, different in size but similar otherwise.
5. Interior of right valve, × 20.
McKenzie formation (lower part), Cumberland, Md.

FIG. 6. EUKLOEDENELLA DORSATA n. sp. 673
Right valve, × 16, illustrating shallow umbilical depression.
McKenzie formation (82 feet below top), Flintstone, Md.

FIGS. 7-9. EUKLOEDENELLA PUNCTILLOSA n. sp. 673
7, 8. Two right valves, × 20, showing identity of characters, and a view of the punctate surface, × 50.
McKenzie formation (25 feet below top), Cumberland, Md.
9. A left valve, × 20, possibly representing a variety.
Wills Creek formation (45 feet above base), Pinto, Md.

FIGS. 10-12. EUKLOEDENELLA SUBTORDIS n. sp. 673
10. The type specimen, a left valve, × 16, with ventral and lateral edge views.
11. Right valve, × 16.
12. A left valve, × 20, referred with doubt to this species.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.

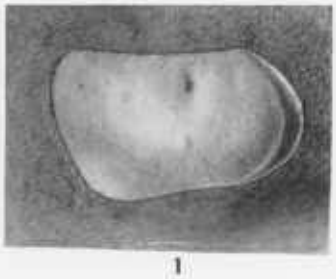
FIG. 13. EUKLOEDENELLA ABRUPTA n. sp. 674
A left valve, × 20, showing abrupt descent and flatness of crescentic border.
Upper Clinton (*Drepanellina clarki* zone), McKees Farm, 7 miles west of Lewiston, Pa.

FIG. 14. EUKLOEDENELLA LONGULA n. sp. 676
The type specimen, a right valve, × 20, and a ventral edge view of the same.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.

FIGS. 15, 16. EUKLOEDENELLA SIMILIS n. sp. 674
15. Right valve, × 20, and ventral edge view.
16. Left valve, × 20, of a larger example.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.

FIG. 17. EUKLOEDENELLA FOVEOLATA n. sp. 675
The type specimen, × 20.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.

FIG. 18. EUKLOEDENELLA RUGOSA n. sp. 675
Right valve, × 16.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.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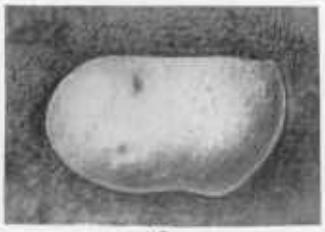
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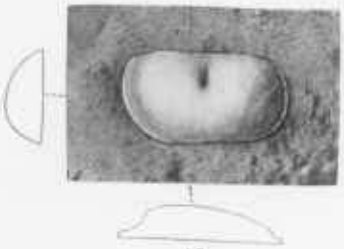
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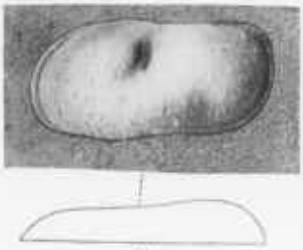
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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LIX

PAGE

FIG. 1. KLOEDENELLA OBLIQUA n. sp. 676
A right valve, × 20, illustrating the oblique form.
Tonoloway formation (lower part), Cumberland, Md.

FIG. 2. KLOEDENELLA RECTANGULARIS n. sp. 676
Right valve, × 20, exhibiting the sharp rectangular anterior end.
Tonoloway formation (lower part), Cumberland, Md.

FIG. 3. KLOEDENELLA CACAPONENSIS n. sp. 677
Right valve, × 20, with obtusely angular anterior angle.
McKenzie formation (20 feet above base), 1½ miles east Great Cacapon, Md.

FIGS. 4-9. KLOEDENELLA SCAPHA n. sp. 677
4. Right side of carapace, × 20.
5, 6. Left side of two entire carapaces, × 20, illustrating constancy of characters.
7, 8. Right side of two examples, × 20.
McKenzie formation (30 feet above base), Flintstone, Md.
9. Right valve of a large carapace, × 20.
McKenzie formation (20 feet above base), 1½ miles east of Great Cacapon, Md.

FIG. 10. KLOEDENELLA SCAPHA BREVICULA n. var. 678
Right valve, × 20, of this short variety.
McKenzie formation (50-150 feet above base), Cumberland, Md.

FIGS. 11-13. KLOEDENELLA SUBOVATA n. sp. 679
Three right valves, × 20, exhibiting characters of the species.
McKenzie formation (82 feet below top), Flintstone, Md.

FIG. 14. KLOEDENELLA NITIDA n. sp. 679
Right side of carapace, × 20, exhibiting the short furrows and characteristic outline.
McKenzie formation (middle part), Cumberland, Md.

FIGS. 15, 16. KLOEDENELLA IMMERSA n. sp. 680
15. Right side of entire carapace, × 20, showing slight overlapping of left valve.
16. Left side of carapace, × 20.
McKenzie formation (middle part), Cumberland, Md.

FIGS. 17, 18. KLOEDENELLA GIBBEROSA n. sp. 680
17. Left valve, × 16, exhibiting the characteristic crestlike ridge on dorsal margin.
McKenzie formation (82 feet below top), Flintstone, Md.
18. Right valve, × 16, with ridge wanting but that on left valve visible.
McKenzie formation (100 feet below top), Pinto, Md.

FIGS. 19, 20. KLOEDENELLA TRANSITANS n. sp. 681
Right side of two entire carapaces, × 16, showing slight difference in length.
McKenzie formation (30 feet above base), Flintstone, Md.

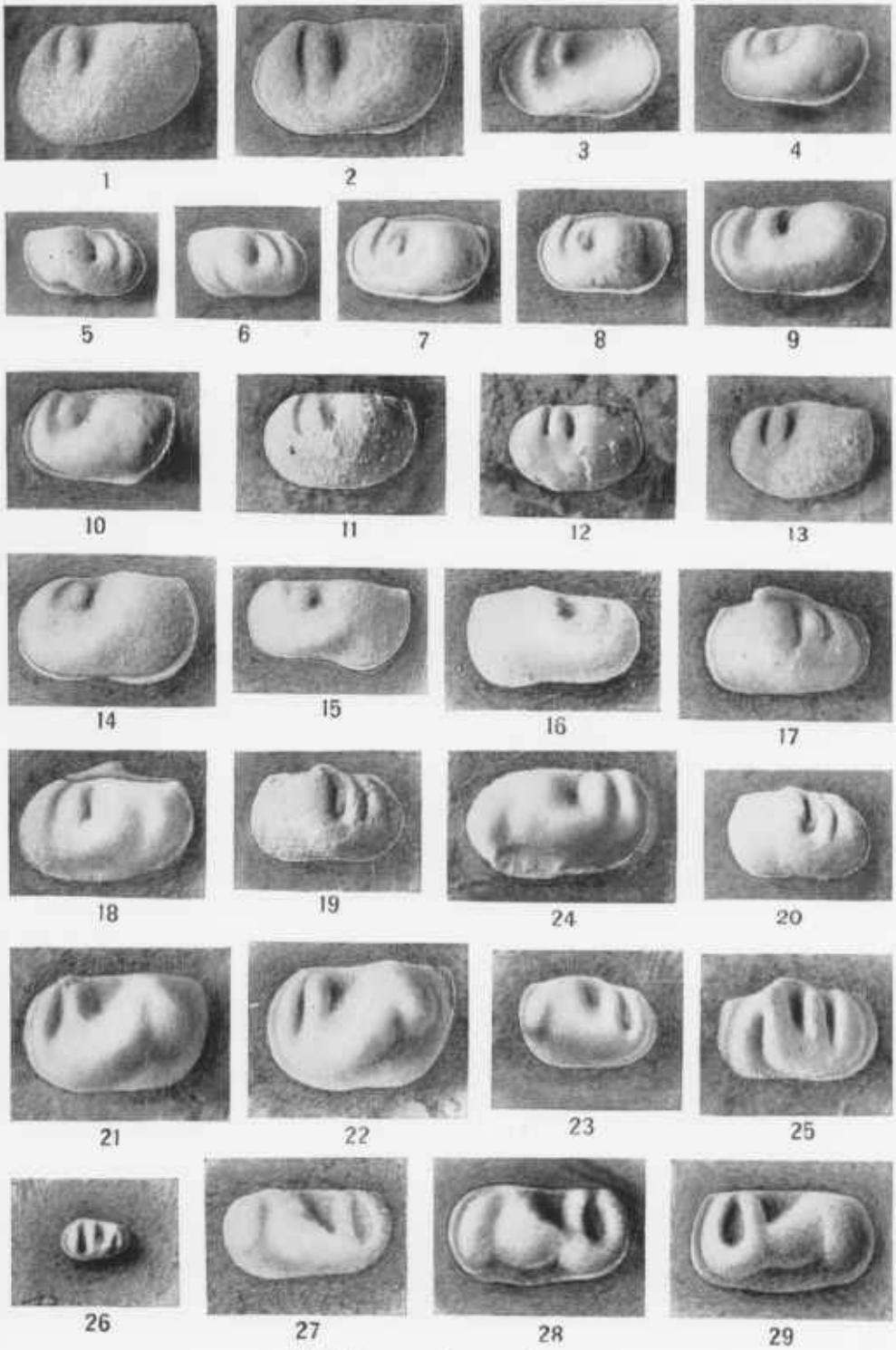
FIGS. 21-23. DIZYGOPLEURA PROUTYI n. sp. 682
21. Right valve, × 20.
22. Another right valve, × 20, showing practical identity with fig. 21.
23. A small left valve, × 20.
Upper Clinton (*Drepanellina clarki* zone), Cumberland and Pinto, Md.

FIG. 24. DIZYGOPLEURA PRICEI n. sp. 682
Left valve, × 20, exhibiting the characteristic greater length than in *D. proutyi*.
Upper Clinton (*Drepanellina clarki* zone), Pinto, Md.

FIG. 25. DIZYGOPLEURA GIBBA n. sp. 684
Left side of entire carapace, × 20.
McKenzie formation (82 feet beneath top), Flintstone, Md.

FIG. 26. DIZYGOPLEURA MINIMA n. sp. 683
Right valve, × 20, of this minute but well characterized species.
Upper Clinton (*Mastigobolbina typus* zone), Hollidaysburg, Pa.

FIGS. 27-29. DIZYGOPLEURA LACUNOSA n. sp. 683
27, 28. Two left valves, × 20, illustrating the elongate carapace.
29. Right valve, × 20.
Upper Clinton (*Drepanellina clarki* zone), McKees Farm, 7 miles west of Lewiston, Pa., and 1½ miles east of Great Cacapon, Md.



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LX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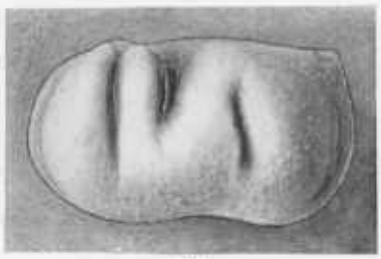
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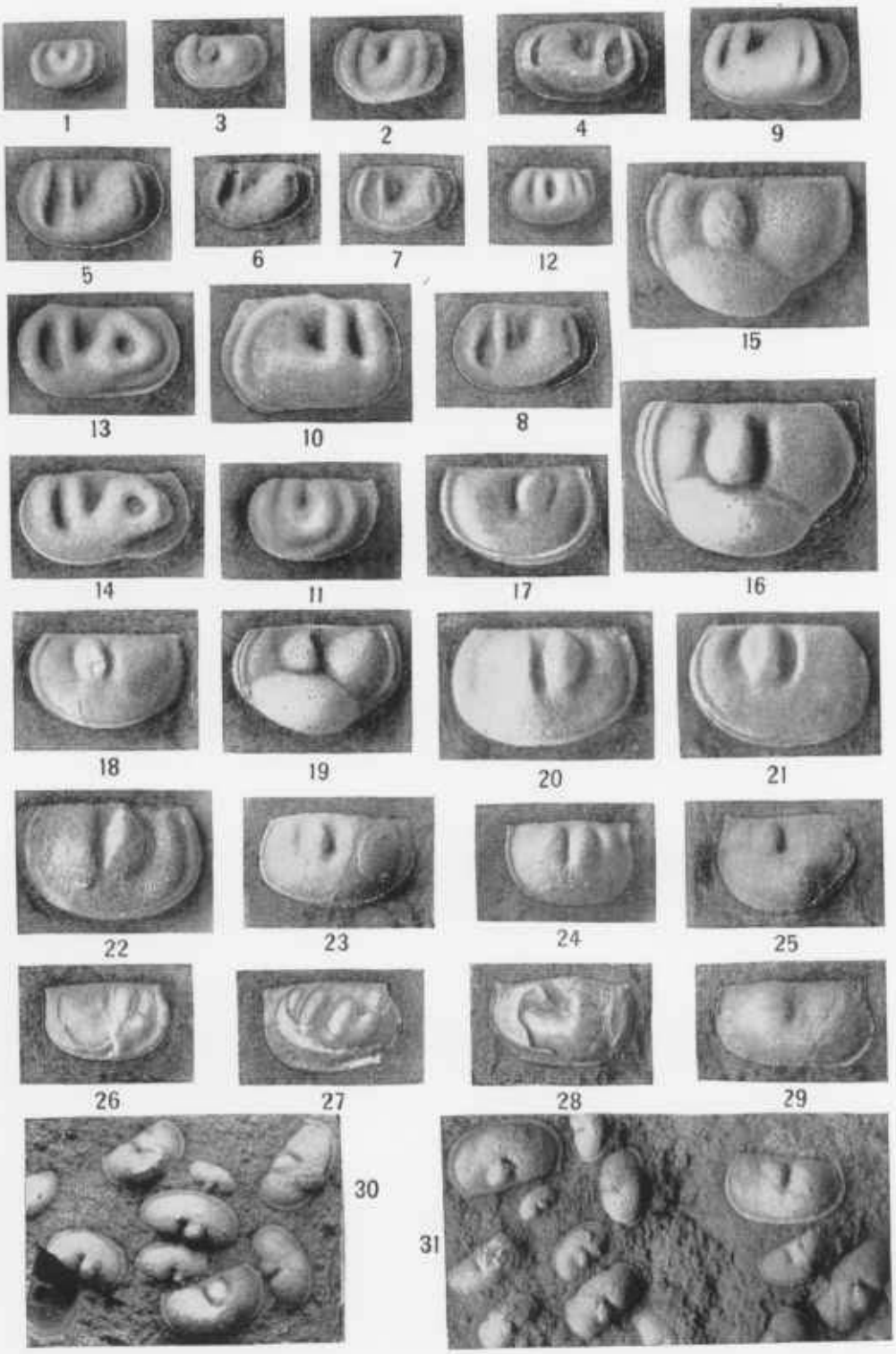
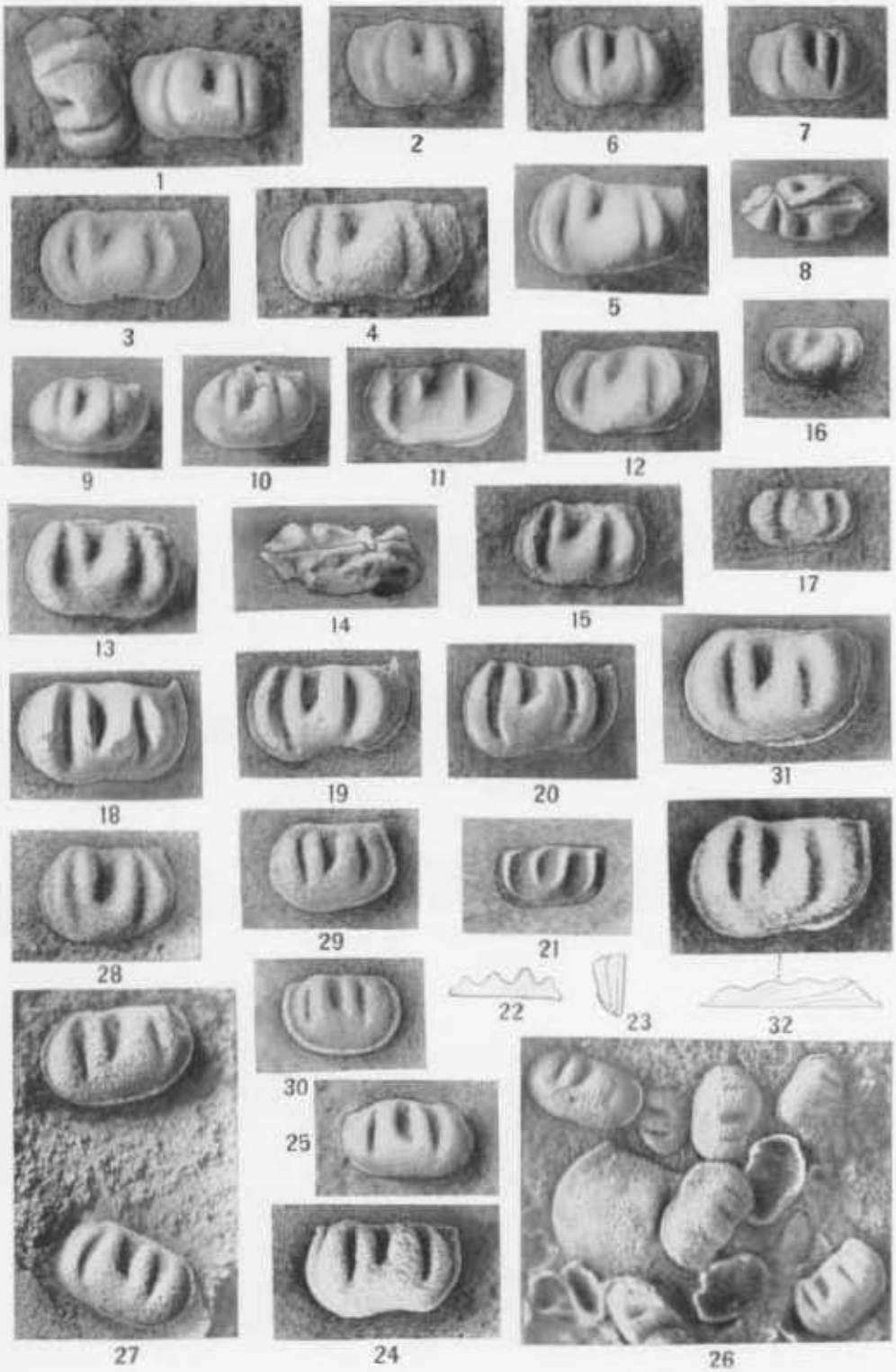
ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LXI



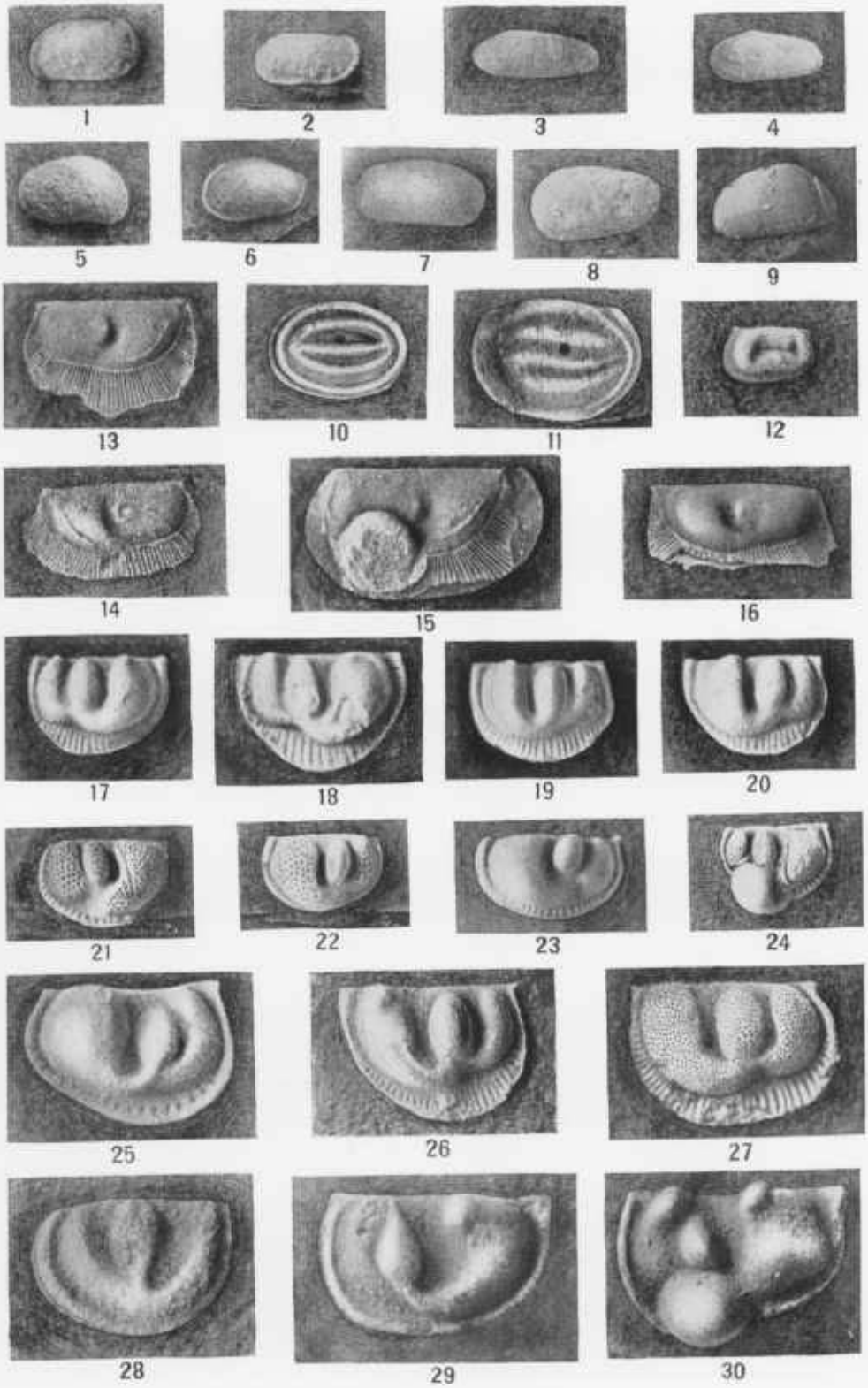
ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LXII



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LXIII



ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LXIV

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ARTHROPODA-CRUSTACEA-OSTRACODA.

PLATE LXV

All figures on this plate, × 8.

PAGE

FIGS. 1-4. ZYGOBOLBA RECTANGULA n. sp. 560

1, 2. Left valves showing the general characters of the species and particularly, when compared with *Z. twenhofeli*, the lesser fullness of the ventral part of the posterior lobe, thicker median lobe, longer and dorsally less diverging limbs of the U-shaped loop and the inferior convexity of the outer two-thirds of the anterior lobe.

3. A large right valve, tilted in posing so that the anterior edge lies below the normal plane of the valve, causing the anterior lobe to appear too narrow and the posterior lobe correspondingly too wide.

4. Smaller right valve, imperfect at antero-dorsal angle.

Gun River formation, Anticosti.

FIGS. 5-9. ZYGOBOLBA TWENHOFELI n. sp. 560

5. Left valve of typical form, possibly female, in which case the original of Fig. 7 would represent the male of the typical variety.

6. Right valve of female, doubtfully referred to this species, but possibly belonging to *Z. rectangula*.

7. Right valve approaching *Z. excavata* in the ventral reduction of the posterior lobe.

8, 9. Two left valves of a variety with ventral parts of anterior and posterior lobes full as in the typical form of the species but resembling *Z. rectangula* in the form of the antero-cardinal angle and the strong inflation of the median lobe.

Gun River formation, Anticosti.

FIGS. 10, 11. ZYGOBOLBA OBLONGA n. sp. 560

10. Right valve, male.

11. Left valve, female, showing relatively very small brood pouch which is characteristic of this species.

Lower Clinton, Hagans, Va.

FIGS. 12-26. ZYGOBOLBA INFLATA n. sp. 562

12. Left valve, male, of the short variety.

13. Right valve, female, of the short variety.

14. Right valve, male, also of the short variety.

15. Left valve, male, young, evidently of the var. *recurva*.

16, 17. Two right valves, young, of the var. *recurva*.

18. A broken left valve, probably of same variety.

Gun River formation, Anticosti.

19, 20. Two left valves, male, in shale, of the typical form of species.

21. Right valve, female, somewhat crushed, of the variety *recurva*.

Lower Clinton, Hagans, Va.

22. Left valve, male, type of the species. Closely allied to *Z. rectangula* but differs in the characters of its lobes and relatively greater height of its posterior half.

Gun River formation, Anticosti.

23, 24. Two right valves differing in proportions of length and height, the former a little shorter, the latter slightly longer than the typical form. These specimens, like those from Hagans, Va., are preserved in shale as casts of the interior, in which the lobes appear narrower than in the testiferous examples from Anticosti.

Williamson shale, Rochester, N. Y.

25. Part of the surface of a piece of shale from the Middle Clinton at Hagans, Va. *a* represents a poorly lighted exterior mold of a left valve, *b* an interior cast of a right female valve, both of this species, and *c* the mold of the exterior of a right valve of *Z. prolixa* (see Pl. LXIV, Figs. 14-17).

26. A left valve, male, the largest of the var. *recurva* observed in the collections from the Gun River formation of Anticosti. We may call it the holotype of the variety.

FIG. 27, *a*, *b*, *c*. ZYGOBOLBA CURTA n. sp. and Z. INFLATA VAR. 567

The two halves of this figure show the same three valves in different lighting. *a* represents a right female valve and *b* a much smaller left male valve of *Z. curta* (see also Pl. LXIV, Figs. 1, 2) and *c* a left valve, male, of a longish variety of *Z. inflata* like that from Rochester, N. Y., shown in Fig. 24. These were photographed as they lie on the surface of a thin piece of shale from the Lower Clinton at Hagans, Va.


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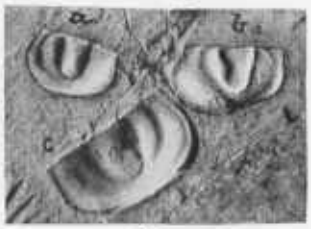
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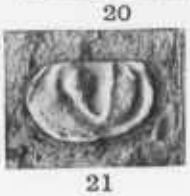
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ARTHROPODA-CRUSTACEA-OSTRACODA.