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W. E. Wrather, *Director*

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Ostracoda from the Permian of the Glass Mountains, Texas

By I. G. SOHN

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

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A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

OSTRACODA FROM THE PERMIAN OF THE GLASS MOUNTAINS, TEXAS

By I. G. SOHN

ABSTRACT

This paper discusses and illustrates 17 species of ostracodes from the uppermost part of the Leonard formation or lowermost part of the Word formation and 1 species from the Wolfcamp and Leonard formations in the Glass Mountains, Texas. Also, 1 species from the Pennsylvanian of Oklahoma is illustrated for comparison. Thirteen of these species are new, and 1 unnamed. These are distributed in the following 14 genera, 5 of which are new: *Bairdia*? McCoy, *Ceratobairdia*, n. gen., *Kirkbya* Jones, *Coronakirkbya*, n. gen., *Knightina* Kellett, *Amphisites* Girty, *Polytylites* Cooper, *Kellettina* Swartz, *Semipetatus*, n. gen., *Kindlella*, n. gen., *Miltonella* Sohn, *Sanniolus*, n. gen., *Coryellina* Bradfield, *Roundyella* Bradfield.

The Kellettininae, a new subfamily of the Kirkbyidae, is proposed. The genus *Kirkbya* is revised and as a result of this revision, is now restricted in known stratigraphic range to Paleozoic rocks younger than the Devonian.

The morphology of the marginal rims in Kirkbyidae is studied by means of serial polished surfaces.

INTRODUCTION

This is a study of a Permian ostracode faunule from 1 locality of latest Leonard or earliest Word age in the Glass Mountains, Texas, and of comparative material of Pennsylvanian and Permian age from 11 other localities. The material in which the faunule was found is residue from limestone leached with acid to remove silicified fossils, and was made available by G. A. Cooper of the U. S. National Museum. Although most of Cooper's samples that I examined contain ostracodes, the specimens are few and are poorly preserved because of coarse replacement by silica. Only the sample from locality USNM 703c contains well-preserved specimens in relative abundance.

This paper discusses 17 species from this locality, 13 of which are new and 1 is unnamed. They are distributed in 14 genera, 10 of which are new to this faunule, and 4 of these 10 are new genera. The ostracodes from this locality are the subject of a paper by Irving B. Hamilton (1942), who described 12 new and 1 unnamed species distributed in 8 genera, 1 of which was new. Sohn (1950) added 3 new species to this fauna and described 2 new genera.

The comparative material studied is of Pennsylvanian and Permian age and came from 7 localities in Texas

and from 1 locality each in Kansas, Missouri, Oklahoma, and Wyoming. The stratigraphic range of some of the species from USNM locality 703c was thus extended both in time and in space. One new genus that occurs in both the Wolfcamp and Leonard formations is described, and the systematic position of a Pennsylvanian species is discussed.

Study of this fauna began in 1946 and is based on the pickings of about 5 pounds of insoluble residue which passed through a 10-mesh screen and was retained on a 100-mesh screen (Sohn, 1950, p. 33). In addition to the species described here, specimens representing several species of Hollinidae, Kloedenellidae, additional Bairdiidae, and at least one species each of *Glyptopleura*, and *Microcheilinella* have been found and will be described later.

ACKNOWLEDGMENTS

I am grateful to Mrs. Betty Kellett Nadeau with whom I discussed some of the problems, and to F. M. Swain who critically read the manuscript. Bibliographic work was facilitated by an illustrated card catalog and synonymy index of Paleozoic Ostracoda, current to approximately 1945, which was compiled by C. L. Cooper. The photographs are by H. N. Shupe and the drawings by Carolyn Bartlett and Elinor Stromberg.

ENVIRONMENTAL CONTROL

The Ostracoda as a group are reputed to be tolerant to variable ecological conditions, and are inferred to have lived even in environments unfavorable to most other organisms (Ulrich and Bassler, 1923, p. 279). Because faunas of approximately similar age differ in aspect, individual genera, and probably species within the same genus, must have been relatively sensitive to their environment and flourished only in areas that were favorable to their development. The optimum ecological conditions for the development of Ostracoda have not yet been determined for most of the living representatives of the group. Consequently, it is premature to infer these factors for fossil forms. In addition

tion, the following factors tend to mask some of these conditions in fossil assemblages:

1. Ostracodes are mobile and can move into unfavorable environments where they may be preserved as fossils. An area in which the environment is favorable for the development of ostracodes can thus supply an abundance of individuals to an unfavorable area nearby where the organisms, though unable to survive, accumulate as fossils (Ellison, 1951, fig. 3, p. 219).

2. Plankton taken in a townt by the writer in 1951 at high tide in Woods Hole Passage, Woods Hole, Mass., contain live benthonic ostracodes. The ostracodes must have been carried with the pieces of seaweed on which they crawl and were distributed presumably also to areas where the environment is not favorable for their development.

3. The small size and buoyancy of dead ostracodes facilitate their wide distribution by currents.

These factors, by helping to distribute geographically the organisms that live at a given time (Ulrich and Bassler, 1923, p. 279) even while masking their normal habits, enhance the use of Ostracoda in determining stratigraphic correlation.

New species are described in this paper on the premises that individual variation is the rule rather than the exception, and that two closely related species probably did not exist in the same ecologic niche. It is recognized, however, that it is difficult to apply the above premises in a valid way because, as stated previously (Sohn, 1950, p. 33), it is not known whether the biota is endemic or was washed into the place of burial. The number of ostracode genera present in the fauna suggests that it is possibly a mixture of both native and foreign elements; consequently, two related species that were separated by an ecological barrier may have become mixed in burial. If that be the case, then the conceptions of the new species, *Ceratobairdia dorsospinosa* and *Kindlella fissiloba*, and possibly others are too broad, and a future study will result in each being revised into two or more species.

OSTRACODA FROM USNM LOCALITY 703c

(Latest Leonard or earliest Word age)

Suborder Platycopa

Family Cytherellidae:

Alveus depressus Hamilton, 1942

Cavellina ellipticalis Hamilton, 1942

Suborder Podocopa

Family Bairdiidae

Bairdia guadalupiana Hamilton, 1942

permiana Hamilton, 1942

? *pruniseminata*, n. sp.

rhomboidalis Hamilton, 1942

subfusiformis Hamilton, 1942

? aff. *B. spinosa* Cooper, 1946

Ceratobairdia dorsospinosa, n. gen., n. sp.

wordensis (Hamilton), 1942

Bythocypris sp. Hamilton, 1942

Family Healdiidae

Healdia unispinosa Hamilton, 1942

vidriensis Hamilton, 1942

Suborder unknown

Family Leperditellidae

Paraparchites marathonsensis Hamilton, 1942

Family Kirkbyidae

Subfamily Kirkbyinae

Aurikirkbya auriformis Sohn, 1950

barbarae Sohn, 1950

wordensis (Hamilton), 1942

Coronokirkbya fimbriata, n. gen., n. sp.

Kirkbya sp.

Knightina? cuestaforma, n. sp.

? *macknighti*, n. sp.

Subfamily Amphissitinae

Amphissites cf. *A. centranotus* (Ulrich and Bassler), 1906

knighti, n. sp.

Subfamily Kellettininae, n. subfam.

Kellettina vidriensis Hamilton, 1942

Kindlella centrinoda, n. gen., n. sp.

fissiloba, n. sp.

Family Miltonellidae

Miltonella shupei Sohn, 1950

Sanniolus sigmoides, n. gen., n. sp.

Family Primitiidae

Coryellina indicata, n. sp.

Family uncertain

Roundyella dorsopapillosa, n. sp.

AGE OF THE FAUNA

The ostracodes described in this paper do not shed any light on the absolute or relative age of sample 703c in terms of the standard stratigraphic column. Sample 703a is latest Leonard in age and is from the youngest rocks in which *Semipetanus* n. gen. is found. This sample and 703c, considered as either late Leonard or early Word in age, are very close to each other in terms of absolute time. The absence of *Semipetanus* in 703c and younger rocks may be interpreted as due either to a very sensitive environmental control of the distribution of this genus or to the fact that this generic stock became numerically so rare by the time the rocks of sample 703c were deposited that, for stratigraphic purposes, the genus may be considered to have died out before that time. However, it is hazardous at present to put too much weight on the absence of *Semipetanus* from the faunules of sample 703c and younger rocks, because the distribution of this genus in time and space is not yet known.

METHOD OF SECTIONING OSTRACODES

The specimens were oriented with a hot needle in warm canada balsam, then ground on a sharpening stone and polished on a piece of lithographic limestone.

Glycerin is a better wetting medium than water because its higher refractive index facilitates examination of the specimen and also because it does not evaporate. Coloring the specimen with ink or malachite green (Henbest, 1931) helped distinguish the specimen from the cementing matrix. Polished surfaces are preferred to thin sections in this work, because they have the advantage of showing the continuation of structures with depth. It was found advantageous in some instances to remove the canada balsam from the periphery of the polished surface with a fine brush dipped in xylol. The sections were drawn with the aid of a camera lucida. When it was desirable to show the location of the plane of the polished surface in a lateral view of the specimen, the canada balsam was warmed and the specimen posed so that the part that remained after grinding could be superposed by means of a camera lucida on a photograph of a lateral view of the same or a similar specimen. By this method a progressive series of sections of the same specimen were obtained as indicated on plate 2, figure 11.

METHOD OF MEASUREMENT

The specimens were oriented in the manner described by Sohn (1950, p. 34), and were measured with a screw micrometer eyepiece in a monocular microscope. By rotating the eyepiece within the tube, the horizontal hair was alined in any desired plane on the specimen. Consequently, the resultant measurement was always perpendicular to an arbitrary reference line. By this method all the specimens of the same species were measured along approximately the same axes. A small error in alining the horizontal cross hair may have been introduced, but variation in measurement due to this error is relatively insignificant for purposes of comparison of the size of individuals within a given species.

DESCRIPTION OF FOSSIL-COLLECTING LOCALITIES

U. S. GEOLOGICAL SURVEY LOCALITIES

- USGS 2969 green.¹ Limestone supposed by Girty to be equivalent to sandstone of the Delaware Mountain formation. Delaware Mountains, 30 miles northeast of Van Horn. Van Horn quadrangle, Culberson County, Tex. Collected by G. B. Richardson, September 23, 1903.
- USGS 4030 blue. Finis shale member of the Graham formation. Ten miles southeast of Graham, cut in shale bank on road to Mineral Wells, Young County, Tex. Collected by G. H. Girty and P. V. Roundy, June 14, 1922.
- USGS 6463 blue. Wreford limestone. Top part of limestone quarry on Crusher Hill, northwest of Strong City, Cottonwood Falls quadrangle, Chase County, Kan. Collected by G. H. Girty and P. V. Roundy, September 26, 1925.

- USGS 6599 blue. Union Dairy member of the Hoxbar formation. SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$, sec. 6, T. 5 S., R. 2 E., Carter County, Okla. Collected by C. W. Tomlinson, C. L. Cooper, R. K. Guthrie, and G. H. Girty, May 19, 1929.
- USGS 7012 green. Pennsylvanian (probably Canyon formation). Roadside about 4 miles west-southwest of Lampasas. Sulphur Creek road to Llano, Lampasas quadrangle, Lampasas County, Tex. Collected by J. A. Taff and E. O. Ulrich, 1902.
- USGS 12213 blue. Phosphoria formation, equivalent to E member of Montana section. Calcareous sandstone exposed along Tosi Creek, SE $\frac{1}{4}$ sec. 17, T. 39 N., R. 110 W., Sublette County, Wyo. Collected by J. E. Smedley, August 1950.

U. S. NATIONAL MUSEUM LOCALITIES

- USNM J-18. Silicified limestone of Wolfcamp or Leonard formation. 2,700 feet S. 53°E. of hill 5300, Altuda quadrangle, Brewster County, Tex. Collected by G. A. Cooper, June 18, 1950.
- USNM 701. Wolfcamp formation, upper 15 feet of limestone bed no. 2 of P. B. King's Wolfcamp section (1930, p. 55), 0.4 miles up canyon from mouth, Wolfcamp Hills, about 15 miles by road northeast of Marathon County, Tex. Collected by G. A. Cooper, 1940, 1941, 1945, 1948, 1950.
- USNM 703a. Uppermost Leonard formation, *Aulosteges* beds on line of section of USNM 703c. On northwest side of road between road fork and sheep tank, near Old Word Ranch, 17 or 18 miles north-northeast of Marathon, Hess Canyon quadrangle, Brewster County, Tex. Collected by G. A. Cooper, 1941-50.
- USNM 703c. Uppermost part of Leonard or lowermost part of Word formation. Dark, platy limestone, that is G. A. Cooper's "sponge bed," which is probably equivalent to P. B. King's (1930, p. 143) first limestone of section 24. Crest of slope on north side of road, about one-quarter mile southwest of road fork near Old Word Ranch, 17 or 18 miles north-northeast of Marathon, Hess Canyon quadrangle, Brewster County, Tex. Collected by G. A. Cooper and N. D. Newell, 1941, 1945.
- USNM 706. Word formation. Limestone of P. B. King's (1930, p. 72) section 23, bed 10. Southeast slope of Hess Canyon, 4 miles N. 36°E. of Hess ranch, Hess Canyon quadrangle, Brewster County, Tex. Collected by G. A. Cooper, 1941-50.

OTHER LOCALITIES

- Knight's (1928, p. 337) locality 38. Shale parting in "Brown lime" in Labette shale exposed in south bank of creek east of Price Road and south of Ladue Road, St. Louis County, Mo. (see Knight, 1934, p. 434).

DESCRIPTIVE PALEONTOLOGY

Suborder *PODOCOPA* Sars, 1866

Family *BAIRDIIDAE* Sars, 1887

The family Bairdiidae is placed in the Podocopa by inference. Paleozoic Bairdiidae have well-developed marginal areas (pl. 1, figs. 28, 29), and because living representatives of the same general shape and structure are classified as Podocopa on the basis of their anatomy, it is reasonably safe to assume that the fossil group probably had similar anatomical features.

¹"Green" and "blue" after U. S. Geological Survey locality numbers refer to the color of the labels that identify the master catalog from which these localities are quoted.

Müller (1908, p. 99) erected the family Nesideidae for the same group, relegating *Bairdia* McCoy to the status of a junior subjective synonym of *Nesidea* Costa, 1846. The fact that this is due to his inadvertent listing of McCoy, 1844 as McCoy, 1862 (Müller, 1912, p. 241) is shown in his reference (1912, p. X, and corrigenda, p. 398).

Genus BAIRDIA McCoy, 1844

Type species: *Bairdia curta* McCoy, 1844, A synopsis of the characters of the Carboniferous limestone fossils of Ireland, p. 164, pl. 23, fig. 6.

History of the genus.—In 1844, McCoy erected the genus *Bairdia* to include two species, *curtus* and *gracilis*. The illustration of the holotype of the type species is based on a specimen partly imbedded in limestone of Carboniferous age from County Longford, Ireland. A tracing of the type is reproduced as plate 2, figures 1a, b. Jones (1859, p. 151) removed the original specimen from its limestone matrix and refigured the holotype (Jones, 1870, p. 185, pl. 61, figs. 1a,b), outline tracings of which are here reproduced (pl. 2, figs. 2a,b). The same illustrations were used by Jones and Kirkby (1896, p. 196, 197, pl. 12, figs. 21a,b); and a larger scale drawing of allegedly the same specimen which, however, differs in detail, is shown by them in their discussion of the genus (Jones and Kirkby, 1879, pl. 28, fig. 1). A tracing of this last figure also is reproduced here (pl. 2, fig. 3). McCoy does not identify the view of his figure 1b, but Jones (1870, explanation of pl. 61) calls figure 2b "ventral edge of the same valve" and in 1896 this view is called "edge view." The discrepancy between McCoy's figure, which represents a complete carapace, and Jones' figures, which are of single valves, suggests that more than one specimen may be concerned.

McCoy's original description: "Shell elongate, fusiform, suddenly tapering at both ends; a very short proportion of the valve overlaps the abdominal margin," is so broad that more than 200 Paleozoic and many younger species have been placed in this genus. Many of the post-Paleozoic species assigned to *Bairdia* belong to several distinct genera, including *Anchistrocheles* Brady and Norman, 1889 emendated Brady, 1890 (type species by monotypy *Cythere? acerosa* Brady, 1868, p. 419, pl. 31, figs. 55-58). The number, shape, and arrangement of individual muscle scars that form the adductor muscle scar pattern are not reliable taxonomic criteria in this group. I have observed that they sometimes differ in detail in opposing valves of the same specimen, as illustrated without comment by Müller (1908, pl. 14, figs. 1, 2, 7, 8), and Sylvester-Bradley (1950, fig. 2). Until such time as the genus is revised, I follow Kellett's (1934, p. 121-123) conception of the genus.

Bairdia, as noted by Hamilton (1942, p. 712), is one of the most abundantly represented genera in the insol-

uble residue of locality 703c. This superabundance of specimens presents two difficulties: the difficulty of determining growth stages within each species, and of specific assignment of the smaller valve, which can be similar in two species that have markedly different larger valves. In addition to the species described by Hamilton, two species, though not relatively abundant, are very distinctive. One is available in a series of growth stages; the other is represented by two specimens. They are only tentatively referred to *Bairdia*, because this genus is much too inclusive. Future work will probably restrict *Bairdia* to thin elongate species similar to the type species.

***Bairdia? pruniseminata* Sohn, n. sp.**

Figures 1a-d, 2; plate 1, figures 1-7

Carapace subglobose, lateral outline rounded in anterior half, acuminate in posterior half; anterior margin rounded, junction with dorsal margin in dorsal third of greatest height; posterior margin blunt, beak at ventral third of greatest height. Greatest convexity at approximate center and below midheight; greatest height just behind the anterior third of the valve. Ventral margin incised, shell margin straight; overlap slightly sinuous along venter. Dorsal margin straight, slopes backward. Hingeline straight, slightly incised. Although the left valve is much larger, the overlap is very slight along hinge; it is greatest along dorsoposterior margin, and very slight along the ventral half of the carapace.

The hinge consists of a groove with terminal platforms on the larger valve upon which the dorsal ridge of the right valve rests. Duplicature well developed, anterior vestibule very narrow, absent in most specimens (see pl. 1, fig. 7). Muscle scar area observed in one right valve. This area is round, and consists of raised knobs.

Surface of the valve covered with widely spaced pustules; rows of much smaller beadlike spines are present on end margins of both valves.

Discussion.—Several growth stages are represented (fig. 1). The smaller instars are less inflated and consequently the venter is narrower. Their greatest width is posterior to center and the posterior apex is lower on the valve than it is on the larger instars.

Except for complete carapaces (fig. 1; pl. 1, figs. 2, 4) measurements were made on the inside of the valves with the cross hair parallel to the dorsal margin. Because of the dorsal and ventral overhang, the height measured was not always the same, and its measurement is less reliable than that of the length. This factor is reflected by the spread along the height axis on the graph (fig. 2).

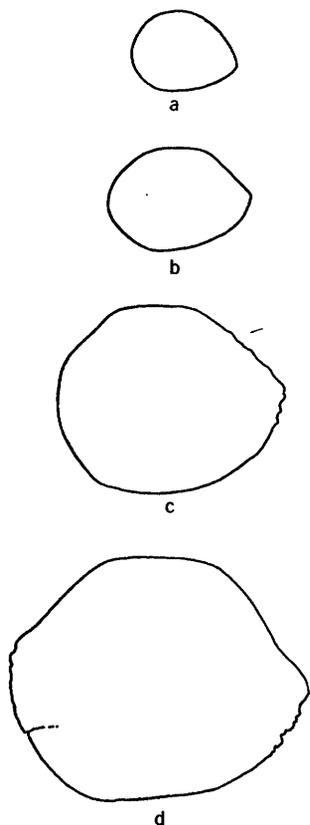


FIGURE 1.—*Bairdia? pruniseminata* Sohn, n. sp. a-d are camera lucida drawings approximately $\times 24$ of lateral outlines of left valves representing stages of growth. Paratypes USNM 118443-118446.

Several of the other species in the faunule occur in sufficient numbers and variations of size to permit construction of graphs showing the ratio of length to height. The reason for not publishing these graphs is that although they do show growth trends, they do not prove conspecificity. The following statement regarding Foraminifera, quoted from Newell, Chronic, and Roberts (1949, p. 175), is equally true for Ostracoda:

Two species of entirely unrelated genera or two species of the same genus widely divergent in certain characters can be shown to have a nearly identical arithmetic linear regression of form ratio. The probabilities of conspecificity within a suite of fusulinids must be appraised qualitatively, but the clarity of presentation of quantitative characters of such a group is improved greatly by the use of a few relatively simple statistical techniques.

Specimens of *Bairdia? pruniseminata* are easily separated from all other species in the faunule by means of their round anterior outlines, pustulose ornamentation, and beaded end margins. Conspecificity of these specimens is determined on qualitative criteria, and it is reasonably certain that this graph (fig. 2) represents a growth series of the same species.

Measurement:

	Length (mm)	Height (mm)
Holotype, USNM 118400, pl. 1, fig. 4	1.31	1.01
Paratype, USNM 118399, pl. 1, fig. 2	.99	.73
Paratype, USNM 118401, pl. 1, fig. 7	1.28	.97
Paratype, USNM 118443, fig. 1a	.58	.39
Paratype, USNM 118444, fig. 1b	.83	.54
Paratype, USNM 118445, fig. 1c	1.28	1.00
Paratype, USNM 118446, fig. 1d	1.64	1.17

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18), to uppermost Leonard or lowermost Word formation (USNM loc. 703c).

***Bairdia? aff. B. spinosa* Cooper, 1946**

Plate 1, figures 12-18

Bairdia spinosa Cooper, 1946, Illinois Geol. Survey Bull. 70, p. 52, pl. 3, figs. 44-46, Shoal Creek zone of McLeansboro formation (Pennsylvanian).

Differs from *Bairdia spinosa* in having a straight dorsal margin, curved ventral margin, rounded junction at anterior and dorsal margins, and in more convex dorsal outline. The wartlike spines are thicker and fewer.

Only two specimens are available.

Measurements:

	Length (mm)	Height (mm)
Figured specimen, pl. 1, fig. 12 USNM 118490	0.92	0.48
Figured specimen, pl. 1, fig. 16 USNM 118491	.76	.44

Occurrence.—Known only from USNM loc. 703c.

Genus CERATOBairdia Sohn, n. gen.

Type species: *Ceratobairdia dorsospinosa* Sohn, n. sp.

Bairdiidae that have flat venters and ventrolateral ridges or alae. Alae extend the entire length of the venter or are confined to posterior part. They terminate in small ridges or in well-developed backward-pointing spines. Larger valve bears dorsal spines or knobs. Hinge consists of two grooves separated by a bar in the left valve, and in the right valve consists of a bar, below which is a well-developed groove. This groove is bounded ventrally by the valve surface.

Discussion.—*Bairdia wordensis* Hamilton, 1942, and possibly the species mentioned by Kellett in Stephenson (1947, p. 578), belong to this genus.

Bairdia monstrabilis Cooper, 1946, from the Pennsylvanian, has a flat venter and a "sharp thin ridge parallel to the venter." It is excluded from *Ceratobairdia* because the ridge does not terminate in posterior spines and the larger valve does not have dorsal nodes or spines.

In discussing the genus *Triebelina* Van den Bold, 1946, Stephenson (1947, p. 578) quotes Betty Kellett Nadeau:

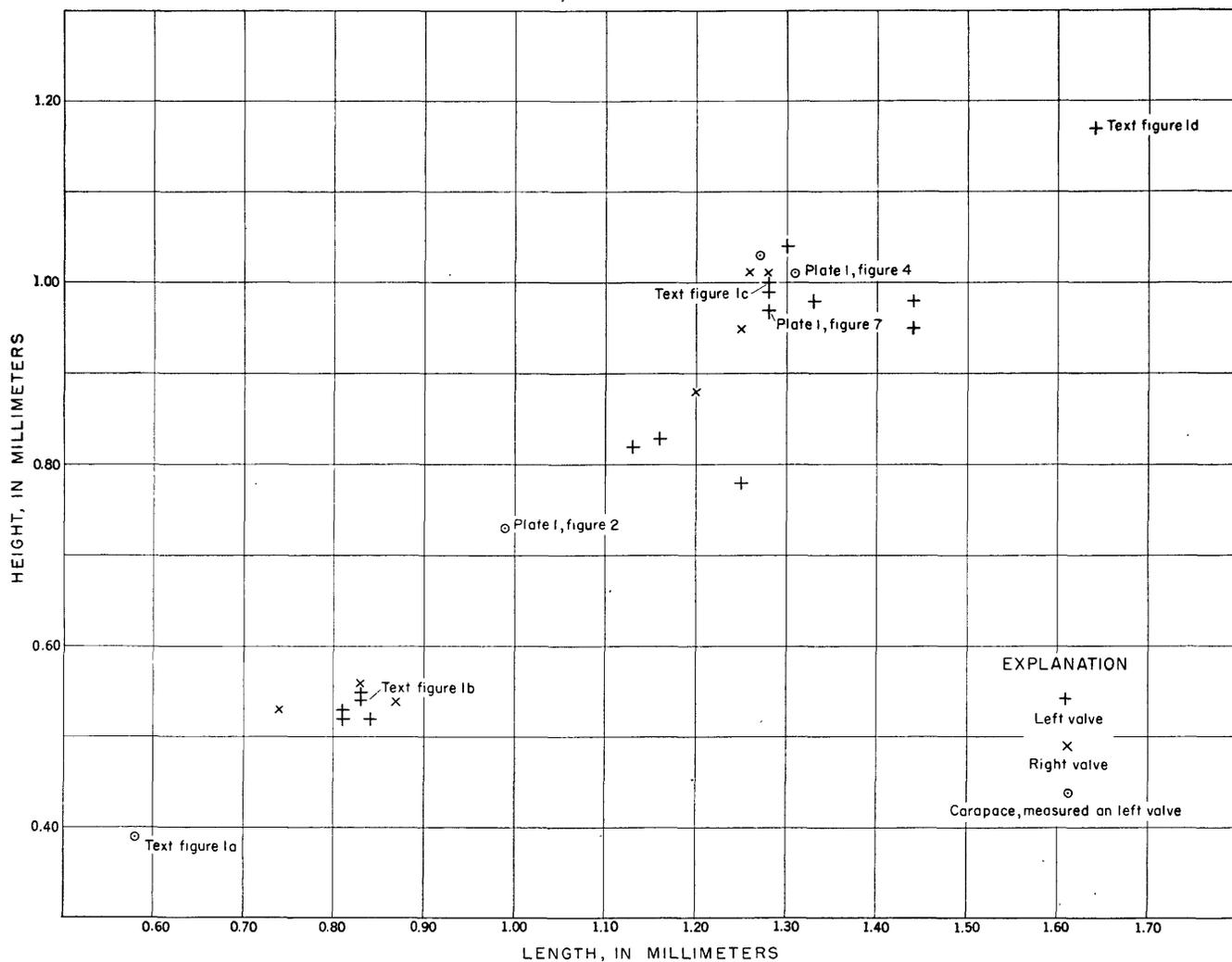


FIGURE 2.—The relation of greatest length to greatest height of successive growth stages of *Bairdia? pruniseminata*, n. sp.

*** The crested *Bairdia wordensis* Hamilton (1942, pl. 110, figs. 4a, b) and a closely related upper Leonard species may also be related to *Triebelina*, which they resemble except for the presence of fine hinge teeth ***.

I have two left valves and a complete carapace of living ostracodes collected near Saipan by P. E. Cloud, Jr., that are tentatively identified as *Triebelina sertata* Triebel, 1948. The valves of *Triebelina* are symmetrical in the sense that both have ridges and knobs; *Ceratobairdia* has asymmetrical valves, for only the left valve has dorsal protuberances. The hinge of the right valve from the complete carapace of *Triebelina* has a widening of the extreme ends of the hinge ridge but no differentiation into teeth, thus agreeing with Triebel's specimen (1948, p. 20, fig. 2c). The hinge bar of the right valve of *Ceratobairdia* does not widen at the ends; it is a continuation of the valve margins.

Morphologic criteria of specific value in this genus are: type and size of lateral alae, number and position of dorsal protuberances, and, as pointed out by Kellett (1934, p. 123) with reference to Paleozoic *Bairdia*,

position of extremities in relation to the midheight of the valve.

Geologic range.—Permian.

Ceratobairdia dorsospinosa Sohn, n. sp.

plate 1, figures 27–32; plate 2, figures 17, 19

Carapace large, thick-walled, anterior extremity pointed above midheight; posterior extremity acuminate, located in ventral third of valve height. Dorsal margin arched in left valve, more gently curved in right valve. Venter flat, strongly alate; alae extend along most of the venter, terminate in backward-pointing spines. Overlap strong along both sides of the hinge, weak along the venter where the valve margin is slightly bowed in the anterior half. End view subtriangular, greatest convexity near midheight, hinge line incised, dorsal margin of right valve slightly lower than that of left valve. The left valve has either one or two strong spines on the dorsal margin.

Hinge of left valve (pl. 2, fig. 17) consists of a straight dorsal groove, a ridge which is a continuation of the margin of the valve, and a ventral groove with smooth terminal sockets that represent the platform of the valve. Hinge of the right valve (pl. 2, fig. 19) consists of a narrow bar that fits into the opposing dorsal groove, a groove, and a ventral bar which is a continuation of the margin of the valve and which rests on the ventral platform of the opposing valve. The ventral bar does not widen at the extremities as does the opposing groove. Duplicature well developed, with a wide anterior marginal area.

The flange is bent inward on the anterior marginal areas and extends upward to the anterior beak in a straighter line than the anterior margin does, thus forming a narrow and shallow elongate loculus. This loculus is more pronounced on the right valve (compare pl. 2, figs. 17, 19), on which its ventral terminus is reflected on the outside of the valve as a small bump (pl. 1, fig. 30).

Van Veen (1934, p. 116-121, pls. 7, 8) described and illustrated *Bairdia biloculata* Van Veen and *B. dentifera* Van Veen from the Maestrichtian of Holland that have similar loculi on both end margins. The Cretaceous species are excluded from *Ceratobairdia* because of the absence of spines and alae. The loculus is present also in *C. wordensis* (Hamilton), 1942, and in *Bairdia rhomboidalis* Hamilton, 1942, both of which are concomitant with the new species.

Neither of the two spines on any valve is in the same relative position as the single spine on valves that have only one. Consequently, the double-spined individuals are not the result of the addition of an extra spine to the carapace. In spite of this fundamental difference, the coexistence of single- and double-spined individuals and their similarity in all other respects suggest that they are conspecific.

Measurements: (Cross hair parallel to ventral ala.)

	Length (mm)	Height (mm)	Con- vexity (mm)
Holotype, carapace, USNM 118391, pl. 1, fig. 32.....	1. 55	¹ 1. 01	0. 95
Paratype, right valve, USNM 118389, pl. 1, fig. 30.....	1. 52	. 88	-----
Paratype, left valve, USNM 118435, pl. 1, fig. 27.....	1. 44	1. 07	-----
Paratype, left valve, USNM 118390, pl. 1, fig. 31.....	1. 52	1. 02	-----
Paratype, USNM 118390a carapace, spine broken.....	1. 53	-----	. 94

¹ Including spine.

Occurrence.—Known only from USNM loc. 703c.

Suborder unknown²

To obtain possible clues as to the classification of the Beyrichiacea, the superfamily into which all the lobed, frilled, and straight-backed ostracode families are currently assigned, specimens of a number of kirkbyid and related genera were sectioned. The majority of the post-Paleozoic marine ostracodes that lack an anterior notch belong to the suborder Podocopa. Because many of these genera have well-developed marginal areas, the presence of such structures in the kirkbyids would be a valuable clue as to their classification, but none was observed.

Although the sections do not disclose any clues to aid in their suprafamily classification, they do reveal the nature of the hinge, the overlap, and the presence of a considerable variation in the nature of the marginal rims, and in the thickness of the shell margin. These are illustrated on plates 2 and 4.

Family KIRKBYIDAE Ulrich and Bassler, 1906

Reticulate, straight-backed ostracodes, hingement consists of ridge and groove, with or without terminal dentition; free margin of one valve rabbeted to receive opposing valve; one or more marginal rims.

A survey of the literature shows that at least 34 genera have been referred to this family. Several genera have been removed from this family and assigned to other, in part unrelated, families. All genera that have been assigned but later removed from Kirkbyidae are listed at the end of this discussion. The reasons for those that are removed in the present study are stated; and until the proper grouping of some is determined, they are classified as "position uncertain."

The family Kirkbyidae is divisible into three subfamilies: Kirkbyiane Cooper, (1941), smooth or lobed but without nodes and with a typical subventral "kirkbyan pit"; Amphissitinae Knight (1928), with nodes and with the "kirkbyan pit" usually carved into the posterior ventral portion of the central node; and Kellettininae, new subfamily, with or without nodes, but without a well-defined "kirkbyan pit."

The salient features of this family are the marginal rims and hingement. Several groups of ostracodes have

² After this paper was completed, G. Henningsmoen (1953, Classification of Paleozoic straight-hinged ostracodes: Særtrykk av Norsk geologisk tidsskrift, v. 31, p. 185-288) established the suborder Paleocopa for the superfamilies Beyrichiacea and Leperditacea. His classification of the Kirkbyidae is essentially similar to the one used in this paper.

marginal rims whose function has not as yet been ascertained, and it is possible that these structures developed independently in several phylogenetic stocks. Sections through the valves across the marginal rims show several interesting features. *Kirkbya* and *Amphisites* have relatively narrow rims; *Aurikirkbya*, *Semipetasus*, n. gen., *Kindlella*, n. gen., and *Kellettina* have more massive rims. Certain silicified specimens of *Aurikirkbya* and *Kellettina* show areas within the rim that differ in texture from the rest of the specimen. These are indicated by broken lines on plate 4, figures 10, 15, 17, and 21. Figures 10 and 11 (pl. 4) are sections of the same specimen of *Aurikirkbya barbarae* Sohn, 1950, several microns apart. Figure 10 does not show any indication of the structure observed in figure 11. In *Kellettina*, figure 20 does not show the structures observed in figures 15 and 17. These may represent chambers separated by septa which are reflected on the external surface of the marginal rim by raised sections or flutings (pl. 3, fig. 42). Lateral sections through the frill of *Kellettina vidriensis* Hamilton suggest that these flutings represent the external expression of septa. Similar sections through calcareous specimens of *Kellettina montosa* (Knight), 1928, and *K. robusta* (Kellett), 1933, and silicified specimens of *Aurikirkbya* and *Kindlella* for an unknown reason do not show septa. The new genus *Coronakirkbya* has two frills that consist of tubules (pl. 5, figs. 1-6) and similar tubules are suggested on the inner rim of *Semipetasus signatus* n. sp. (pl. 5, figs. 7, 8). It is not known whether all the genera in Kirkbyidae and possibly in other frilled ostracode families had the same type of frills that are modified in fossilization, or whether there were tubular, massive, and septate frills in the Ostracoda.

Two subfamilies in this group, Amphisittinae and Kirkbyinae, have a so-called kirkbyan pit. This pit was noted by Jones in the original description of *Kirkbya* who commented as follows (Jones in Kirkby, 1859, p. 137):

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

The pit is reflected on the inside of the valve as a smooth knob (pl. 3, figs. 3, 29) apparently similar in structure to the knobs developed in the area of the muscle attachment in other groups of fossil ostracodes, as well as in living genera such as *Ilyocypris* (Triebel, 1941, pl. 1, figs. 1*b*, 4*b*). The kirkbyan pit differs from the area of muscle attachment in living and other fossil ostracode groups in two features: The pit is usually bordered on the outside of the valve by a smooth rim, and even the best preserved specimens

show only one knob on the inside of the valve without any trace of areas of attachment of accessory muscles such as described in living *Cypridopsis* by Kesling (1951, figs. 5, 5*a*) and demonstrated in fossil forms by Swartz (1949, pl. 66, fig. 4) and Scott (1951, p. 323). In two specimens of an unidentified species of *Kirkbya* from the Pennsylvanian of Texas (USGS loc. 7012 green) there is an exterior smooth knob, rather than a pit, standing above the reticulations of the valves, and represented by a concavity on the insides of the valves. It may be significant that specimens of *Kirkbya canyonensis* Harlton, 1929, in the same collection have normal pits. I am grateful to Betty Kellett Nadeau for pointing out to me (oral communication) the fact that *K. laciniata* Knight, 1928, is characterized by a knob instead of a pit; however, Knight did not have many specimens of this species. Only one specimen out of hundreds of *Aurikirkbya wordensis* (Hamilton), 1942 from USNM locality 703c (USNM 118492) has a knob filling the pit. This suggests that the knobs replacing pits in some specimens are adventitious and not morphologic structures. Because this pit is so distinctive, it is considered here among the criteria to distinguish two of the subfamilies in the Kirkbyidae, even though the function of this structure as the place of attachment of adductor muscles is inferred and as yet not proven.

The family Cardiniferellidae Sohn, 1953, has a kirkbyan pit but differs from Kirkbyidae in hingement and in the absence of marginal rims.

GENERA EXCLUDED FROM KIRKBYIDAE

The following 21 genera that have been placed in the Kirkbyidae were either previously removed or are here removed from that family because, so far as can be determined from the type specimens, figures, or descriptions of the type species, they do not have the characters ascribed to the family.

Aechminella Harlton, 1933: *A. trispinosa*, Harlton, 1933, the holotype (USNM 85544) has no pit, no marginal rim, and the surface is not reticulated.

Allostraca Bassler, 1932: *A. fimbriata* Bassler, 1932, the holotype (USNM 80504) has no pit, and the surface is not reticulated.

Balantoides Morey, 1935: *B. quadrilobatus* Morey, 1935, has no pit and no marginal rims; placed in Drepanellidae by Zaspelova, 1952.

Brillius Brayer, 1952: *B. distortus* Brayer, 1952, has a pit above midheight, probably not kirkbyan; no marginal rims.

Budnianella Bouček, 1936: *B. caroli* Bouček, 1936, has no pit and no marginal rims.

Carbonita Strand, 1928: *Carbonia agnes* Jones, 1870, has a curved dorsum, no pit, no marginal rims.

Cornigella Warthin, 1930: *C. minuta* Warthin, 1930, has been placed in Drepanellidae.

Discoidella Croneis and Gale, 1938: *D. simplex* Croneis and Gale, 1938, is not an ostracode.

Gillina Coryell and Johnson, 1939: *G. vitharri* Coryell and Johnson, 1939, has no pit, no marginal rims, is nonreticulate; placed in Kloedenellidae by Agnew, 1942.

Glyptopleurina Coryell, 1928: *G. montifera* Coryell, 1928, has no pit, no marginal rim, and the surface is not reticulated.

Graphiodactylus Roth, 1929: *Kirkbya lindahli arkansana* Girty, 1910, is placed in Graphiodactylidae by Kellett (1936, p. 773-775) = Quasillitidae Coryell and Malkin, 1936.

Kirkbyella Coryell and Booth, 1933: *K. typa* Coryell and Booth, 1933, has no pit and no marginal rims.

Kirkbyellina Kummerow, 1939: *K. styliolata* Kummerow, 1939, has no pit and no marginal rims.

Macronotella Ulrich, 1894: *M. scofieldi* Ulrich, 1894, placed in Leperditellidae by Kay (1940, p. 244).

Mauriyella Ulrich and Bassler, 1923: *M. mammillata* Ulrich and Bassler, 1923, holotype (USNM 41668) and one paratype do not have a pit or marginal rims.

Öpikella Thorslund, 1940: *Ö. waerensis* Thorslund, 1940, tentatively placed in Leperditellidae by Agnew, 1942.

Roundyella Bradfield, 1935: *Amphissites simplicissimus* Knight, 1928, has no pit, no marginal rims; see Cooper (1946, pl. 17, fig. 30).

Savagella Geis, 1932: the holotype and paratypes of *Kirkbya lindahli* Ulrich, 1891 (USNM 41356) show a vertically elongate muscle scar instead of a kirkyban pit, differs in hingement from Kirkbyidae.

Verrucosella Croneis and Gale, 1938: *V. golcondensis* Croneis and Gale, 1938, placed in *Cornigella* (Drepanellidae) by Cooper, 1941.

Workmanella Croneis and Gale, 1938: *W. distincta* Croneis and Gale, 1938, placed in *Tetrasacculus* (Primitiidae) by Cooper, 1941.

Youngiella Jones and Kirkby, 1895: *Y. rectidorsalis* (Jones and Kirkby). 1886 has been placed in Youngiellidae Kellett, 1933.

Subfamily KIRKBYINAE Cooper, 1941

Because Cooper (1941, p. 47) established the Amphissitinae as a subfamily in Kirkbyidae, he automatically established also Kirkbyinae to include those genera not removed by him into Amphissitinae. Kirkbyinae is here restricted to include those genera that have the following features:

Kirkbyidae that are smooth or lobed, that have well-developed kirkyban pits, and that are without nodes or carinae.

At present this subfamily contains the following three genera:

- Aurikirkbya* Sohn, 1950
- Coronakirkbya* Sohn, n. gen.
- Kirkbya* Jones, 1859

Three other genera are tentatively placed in this subfamily:³

- Kirkbyites* Johnson, 1936
- Knightina* Kellett, 1933
- Sinusuella* Spizharsky (1939?)

³ After this paper was completed, Kesling (1952, Ostracods of the families Leperditellidae, Primitiidae, Drepanellidae, Aechminidae, and Kirkbyidae from the middle Devonian Bell shale of Michigan: Michigan Univ., Mus. Paleontology Contr., v. 10, no. 2, p. 21-44, 5 plates) established the new genera *Arcyzona* and *Chironiptrum* without describing or illustrating their hingements. If the hinges of these genera are kirkyban, they belong in this subfamily.

Genus AURIKIRKBYA Sohn, 1950

Type species: *Kirkbya wordensis* Hamilton, 1942, Jour. Paleontology, v. 16, p. 713.

The shell wall of the venter bounded by the marginal rims in this genus as seen in polished section is very thick (pl. 4, figs. 9-11, 21), while in *Kirkbya* this area is not thicker than the rest of the valve (pl. 2, figs. 9, 10). These are additional characteristics distinguishing the two genera and indicate that *K. canyonensis* Harlton (pl. 2, fig. 10) was erroneously assigned to *Aurikirkbya* by Sohn (1950, p. 36).

At Betty Kellett Nadeau's suggestion I sectioned a right valve of a specimen of *Kirkbya wymani* Kellett, 1933, from the Wreford limestone, Cottonwood Falls quadrangle, Kansas (USGS loc. 6463 blue) of approximately the same size as a paratype (USNM 85450a) which is the original of her figure 26 (Kellett, 1933, pl. 15). This specimen shows that the shell wall of the venter between the marginal rims is thicker than the wall of the rest of the carapace, thus confirming its assignment to *Aurikirkbya* (Sohn, 1950, p. 36).

Genus KIRKBYA Jones, 1859

Type species: *Dithyrocaris permiana* Jones, 1850, in King, A monograph of the Permian fossils of England: Paleontogr. Soc. London, p. 66, pl. 18, figs. 1c, d.

Jones (1850, p. 66) gave the specific name *permiana* to an imperfectly preserved specimen from crystalline limestone in the upper or higher member of the Permian at or near Byer's Quarry, County of Durham, England, which he assigned to the Phyllopod *Dithyrocaris*. Later, Jones (1854, p. 103) referred to the species as *Ceratiocaris? permiana*. Kirkby (1858, p. 318) obtained better preserved material at Tunstall Hill from the shell-limestone in the lower member of the Permian in Durham, and recognizing that it represented an ostracode, described and figured it (p. 434-438, pl. 11, figs. 5-13) as *Leperditia? permiana* (Jones). The next year Kirkby (1859, p. 129-133, pl. 8A, figs. 1-3, 5, 6; pl. 10, figs. 5-13) at Jones' request, published a revised description of the species and incorporated comments by Jones. In this paper he referred this species to the new genus *Kirkbya* which he credited to Jones. Kirkby's discussion is followed by "Remarks by T. Rupert Jones" (p. 133-137), in which the generic characters of *Kirkbya* are stated (p. 136-137). Like many of the classical genera, *Kirkbya* was used in a broad sense; Jones and Kirkby (1885, p. 174-191, pl. 3) described and illustrated 13 species and varieties of *Kirkbya* of which only 1, *K. permiana*, is retained by Bassler and Kellett (1934) in this genus. At the present time 34 of more than 77 species assigned to this genus have subsequently been removed to 14 other genera. The

species *permiana* as originally defined probably includes several distinct species. Kellett (1933, p. 85) designated the original of Jones' (1850) figure 1a as the holotype of *K. permiana*.

A redefinition of the species should be made by examination of the original specimen if available, supplemented by topotype material, or collections from the same stratigraphic horizon.

The genus *Kirkbya* is here provisionally restricted in geologic range to rocks of Mississippian through Permian age. Valid species of this genus are not recorded from rocks of Middle Devonian and older age. The ostracode faunas of Late Devonian and early Mississippian rocks, however, are not as yet known; consequently species of this genus may have existed in Late Devonian time. It is a useful genus because of its abundance and worldwide distribution. A provisional diagnosis follows:

Elongate Kirkbyinae, greatest length at or near the dorsal margin; posterior cardinal angle acute. Lateral surface of valve devoid of nodes, ridges, and costae; is either evenly convex or with a posterior shoulder that slopes steeply backward and gently forward. Kirkbyan pit at or anterior to midlength, on the ventral half of the valve.

In discussing the recorded range of Paleozoic ostracode genera Sohn (1951a, p. 34) listed *Kirkbya* among those genera having more than five species listed from rocks older than the Mississippian. The following three Devonian species were removed to *Pyxiprimitia* Swartz, 1936 (Primitiidae) by Warthin (1937, cards 89, 90, 104):

Kirkbya cimbula Ulrich, 1900

Kirkbya? dubia Tolmachoff, 1926

Kirkbya germana Ulrich, 1900

According to the above diagnosis, the remaining pre-Mississippian species are here removed from *Kirkbya* for the following reasons:

K. fibula Jones and Holl, 1869, Silurian, has a sulcus instead of a kirkbyan pit, the lateral surface is crossed by a ridge, and the outline is circular. This species is probably related to the Carboniferous genus *Denisonia* Croneis and Bristol, 1939.

K.? loriei Bonnema, 1910, Devonian, surface with ridges like *Glyptopleura* Girty, 1910.

K. minima Kummerow, 1924, Silurian, the sulcus that is not a pit is above midheight. This species probably belongs in *Pyxiprimitia* Swartz, 1936.

Kirkbya sp.

Plate 2, figures 4, 9; plate 3, figures 1-3

Carapace elongate, narrow, in lateral view; dorsal and ventral margins subparallel, the ventral margin is straight in the figured specimen, slightly sinuate in a

smaller specimen. Anterior cardinal angle approximately 90°, posterior cardinal angle acute. Surface of the valve reticulated, modified by subdued lobation. Posterior shoulder bounded by a steep hind wall from dorsal margin to midheight where shoulder extends forward just above midheight as a subdued lobe paralleling the dorsal margin. Lobe slopes gently dorsally and more steeply ventrally; it curves upward parallel to the anterior margin, being slightly wider at the posterior shoulder. Pit carved into lobe at, or just anterior to, midlength.

Remarks.—The specimens on hand are similar in outline to *K. permiana* (Jones), 1850 as figured by Kirkby (1859, pls. VIII A, X). They differ, however, in having the subdued lobation, not shown on any of Kirkby's specimens, but mentioned by him (1859, p. 131):

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

The lobation on the specimens at hand are not so prominent as that of specimens of the same size belonging to *Aurikirkbya*, and the ventral area is much thinner, having two distinct ridges.

Kirkbya elongata Cooper, 1941, from the Paint Creek formation (Chester) of Illinois is similar in outline and in size to the specimens on hand, but it does not have the lobation of the Permian specimens.

Because only two specimens, both obviously immature instars, (see Cooper, 1946, p. 104) are available, it is deemed advisable not to name this species at the present time.

Measurements:

	Length (mm)	Height (mm)
Figured specimen, USNM 118419, pl. 3, fig. 2...	0.96	0.39
Sectioned specimen, USNM 118420, pl. 2, fig. 9-	.77	.35

Occurrence.—Known only from USNM loc. 703c.

Genus CORONAKIRKBYA Sohn, n. gen.

Type species: *C. fimbriata* Sohn, n. sp.

Large, centrally lobed Kirkbyinae with two marginal frills, spined cardinal angles, and large kirkbyan pit, surrounded by a rim, not reflected as a knob on the inside of the valve.

Discussion.—This genus resembles in outline the Lower Paleozoic genus *Eurychilina* Ulrich, 1889, (Beyrichiidae) from which it differs in having a kirkbyan pit instead of a sulcus, and in the structure of the marginal frills. The hingement, reticulated surface, and frill place this genus in Kirkbyidae, and the large kirkbyan pit and lobation in the subfamily Kirkbyinae in which it differs from the other genera in outline, in having a single curved lobe situated in the central third of the valve and in having hollow spines at the cardinal angles.

Beyrichiopsis pulcra Bassler, 1932, from the Ridgetop shale of Tennessee (Mississippian) is based on an internal mold (USNM 80502) of what appears to be a *Coronakirkbya* and, pending supplementary topotype material in order to establish all the characters of this species, is here provisionally classified as *Coronakirkbya? pulcra* (Bassler), 1932. *Kirkbya permiana* Kummerow, 1939 (not *K. permiana* (Jones), 1850) is also based on an internal mold and also probably belongs in *Coronakirkbya*.

Geologic range.—Mississippian (?) through Permian.

Coronakirkbya fimbriata Sohn, n. sp.

Plate 5, figures 1–6

Carapace subsemicircular in lateral view, greatest length in dorsal quarter of valve, greatest height at center. Most convex portion of lobe in middle of valve, above midheight. Lobe outlined by smaller reticulations, starts on relatively tumid lateral surface of valve near dorsal margin in posterior third of valve; curves around an undefined sulcus, extending downward and forward almost to midlength where it touches large rimmed kirkbyan pit, then curves upward terminating well below dorsal margin.

Outer frill extends perpendicular to venter near the contact of the valves, parallels free margins; inner frill, separated from outer by four reticulations in center of venter, converges to outer frill at cardinal angles where both are terminated by a thick spine, extends up and out from the valve so that margin of frill parallels outer frill.

Discussion.—This species is relatively rare; only five left valves and several fragments are available. The hinge of the right valve is inferred to consist of a tongue that fits into groove of the opposing valve; it very likely did not have strong terminal dentition like species in *Aurikirkbya* because the left valve does not have well-developed terminal sockets. The small reticulations on the lobe are reminiscent of certain species in *Amphissites* in which the central node has reticulations smaller than the rest of the valve (pl. 3, figs. 15, 18, 20).

Measurements: (on inside of valve)

	Hinge length (mm)	Height (mm)
Paratype, USNM 118486, pl. 5, fig. 1-----	1.4	0.69
Holotype, USNM 118487, pl. 5, fig. 3-----	1.7	.90
Paratype, USNM 118488, pl. 5, fig. 5-----	1.8	.83

Occurrence.—Known only from USNM loc. 703c.

Genus **KNIGHTINA** Kellett, 1933

Knightina Kellett, 1933, Journal of Paleontology, v. 7, p. 97–99.

Type species: *Amphissites allorismoides* Knight, 1928, Jour. Paleontology, v. 2, p. 265, 266, pl. 32, figs. 10a–c; pl. 34, fig. 4.

The orientation of the genus is here reversed 180°, making the highest and widest portion posterior. Hinge consists of a faint groove in the left valve and a corresponding ridge in the opposing valve. Rabbeted edge of the overlapping valve continues up to the dorsal margin and extends over both ends of the slightly grooved margin without thickening into cardinal teeth, differing in this respect from *Kirkbya*, which has terminal dentition. The type species has an inner ridge called inner flange by Kellett (1933, p. 98), and carina by Cooper (1946, p. 107, 108). This ridge is separated from the outer ridge (outer flange of Kellett) by three rows of reticulations (pl. 2, fig. 6). The distance between the two ridges varies in different species of this genus.

Knightina bassleri Kellett, 1933 (not *K. bassleri* Upson, 1933); *K. fiddleri* Payne, 1937; *K. fiddleri* var. *oblonga* Payne, 1937; and *K.? mcknighti*, n. sp. do not have an inner ridge. All these species have a kirkbyan pit that is better developed than the pit in double-ridged species. Future work may indicate that these species form a distinct group differing from *Knightina*. Because these species have a well-developed kirkbyan pit, *Knightina* is provisionally placed in Kirkbyinae. If the genus is split, the group without the well-developed pit would more properly belong with the *Kellettinae*.

The writer examined topotype specimens through the kindness of J. Brookes Knight.

Knightina? macknighti Sohn, n. sp.

Plate 2, figures 7, 8; plate 3, figures 4–12

Carapace subovate in lateral view; ends subround; ventral margin straight to slightly concave; free margins bordered by a thick narrow flange. Posterior shoulder well defined, valve surface devoid of any other lobation. Posterior slope of shoulder steep, making angle of about 90° with the surface of the valve behind shoulder and extending ventrally from slightly above hinge line to about height of muscle scar pit; anterior

slope of shoulder varies with individuals and perhaps with sex; it joins elevated part of valve surface in some individuals without any perceptible break; in other individuals the shoulder extends slightly above the valve surface and has a short anterior slope (pl. 3, fig. 12). Muscle scar pit three times the size of surface reticulations, subovate, with the slightly greater axis pointing to posterior cardinal angle. Shallow, poorly-defined groove extends below pit and subparallel to ventral margin from bottom of posterior shoulder to front margin of elevated part of valve. Surface of valves reticulated; size of reticulations varies with specimens. Inner marginal ridge lacking (pl. 2, figs. 7, 8).

Edge view of carapace, arrow-shaped. Anterior end blunt, followed by short anterior slope of the valves that makes an angle of about 45° with the plane of the contact margins, in turn followed by subparallel sides of the valves, and then by slopes of about 90° where the posterior shoulders terminate. The shaft of the arrow is represented by the narrow surface of the valve behind the posterior shoulder.

Right valve overlaps left only slightly; rabbeted to receive smaller valve. Hinge consists of a groove in straight dorsal margin of left valve and a corresponding ridge on right valve.

Discussion.—This species falls in the category of those that do not have an inner marginal ridge but that do have a well-developed kirkbyan pit and are now tentatively assigned to *Knightina*.

This species is named in honor of E. T. McKnight, U. S. Geological Survey.

<i>Measurements:</i> (Parallel to dorsal margin)	Length (mm)	Height (mm)
Holotype, carapace, USNM 118393, pl. 3, fig. 4.	1. 02	0. 50
Paratype, carapace, USNM 118394, pl. 3, fig. 7.	. 82	. 44
Paratype, right valve, USNM 118395, pl. 3, fig. 12.	. 91	. 49
Paratype, left valve, USNM 118396, pl. 3, fig. 11.	1. 17	. 66

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Knightina? cuestaforma Sohn, n. sp.

Plate 2, figures 5, 11, 14-16, 18; plate 3, figures 28-33

Large, wedge-shaped in cross section; steplike surface slopes from dorsal margin making a 30° angle with plane of contact margin. Sloping shoulder oval in lateral view, extends ventrally about two-thirds of valve height, terminated by cuestalike steep wall. End margins equally round, reticulations small. Three marginal ridges, innermost consists of a row of hollow tubes (pl. 3, figs. 28, 30). Pit large, situated anterior to midlength, reflected on inside of valve as smooth knob carved into cuesta wall (pl. 3, fig. 29).

This species very likely represents a new genus differing from *Knightina* in size, shape, ornamentation,

and marginal rims, and is tentatively referred to *Knightina*. A smaller specimen (pl. 2, fig. 5) has a more acute posterior cardinal angle.

Measurements: (on the inside of valve, parallel to dorsal margin)

	Length (mm)	Height (mm)
Holotype, left valve, USNM 118386, pl. 3, fig. 29.	1. 55	0. 61
Paratype, left valve, USNM 118387a.	1. 37	. 59
Paratype, left valve, USNM 118387, pl. 2, fig. 5.	1. 22	. 54

Occurrence.—Known only from USNM loc. 703c.

Subfamily AMPHISSITINAE Knight, 1928

Cooper (1941, p. 47) established, without description, the subfamily Amphisitinae to include the following genera:

- Amphisites* Girty, 1910
- Balantoides* Morey, 1935
- Ectodemites* Cooper, 1941
- Knightina* Kellett, 1933
- Polytylites* Cooper, 1941
- Ulrichia?* [part] Jones, 1890

The name Amphisitidae had previously been used by Knight (1928, p. 266). Because subfamilies have the same status as families in zoological nomenclature, the Amphisitinae are credited to Knight.

This subfamily is here defined as follows: Kirkbyidae with one or more nodes; kirkbyan pit well developed, usually carved into central node.

This definition excludes *Knightina*, and *Balantoides*. The true position of *Ulrichia* is not determinable at present because of lack of adequate representatives of the type species. *Ulrichia conradi* Jones, 1890, is assigned to Drepanellidae by Swartz (1936, p. 553). Some species referred to this genus probably belong to genera in the subfamily Kellettininae.

The genus *Kegelites* Coryell and Booth, 1933, belongs in this subfamily.

Genus AMPHISSITES Girty, 1910

Amphisites Girty, 1910, New York Acad. Sci. Annals, v. 20, pt. 2, p. 235.—Roundy, 1926, U. S. Geol. Survey, Prof. Paper 146, p. 7.—Knight, 1928 [part], Jour. Paleontology, v. 2, no. 3, p. 246-252, 258-259.—Roth, 1929 [part], Wagner Free Inst. Science, publ. v. 1, p. 31-36.—Warthin, 1930, Oklahoma Geol. Survey, Bull. 53, p. 63.—Geis, 1932, [part], Jour. Paleontology, v. 6, no. 2, p. 153-155, 162.—Kellett, 1933, [part], Jour. Paleontology, v. 7, no. 1, p. 93.—Upson, 1933, [part], Nebraska Geol. Survey, Bull. 8, 2d ser., p. 41.—Bradfield, 1935, [part], Bull. Amer. Paleontology, v. 22, no. 73, p. 54.—Cooper, C. L., 1941, Illinois Geol. Survey, Rept. Inv. no. 77, p. 48.

Binodella Bradfield, 1935, Bull. Amer. Paleontology, v. 22, no. 73, p. 140.

?*Albanella* Harris and Lalieker, 1932, Am. Midland Naturalist, v. 13, no. 6, p. 397.

Cooper (1941, p. 47-48) restricted the genus to species similar to the type, *Amphisites rugosus* Girty, 1910, and erected two new genera, *Ectodemites* and *Polytylites* for

species that differ from the type. *Amphissites*, as restricted, contains species that have a median node flanked on both sides by carinae. The carinae may or may not superpose elongated nodes; they are connected by a convex dorsal ridge (carina) subparallel to the hinge line and joining the hinge near the cardinal angles, thus outlining a narrow shieldlike area in dorsal view. Two marginal rims parallel the free margin and join at the cardinal angles.

According to Cooper, *Ectodemites* contains those species previously referred to *Amphissites* that do not have a well-defined central node and associated carinae. *Polytylites* embraces those species with a central node in which the associated carinae develop into two round or elongated nodes in the dorsal extremities, and the dorsal ridge is absent. *Polytylites* is undoubtedly a valid genus, but *Ectodemites* grades in one direction into *Amphissites* and in another into *Kegelites* Coryell and Booth, 1933. It is here recognized as a valid genus pending future study.⁴

The orientation of this genus has been a matter of considerable controversy, but Girty's orientation is followed here. The hinge structure has been adequately described and illustrated by Roth, who reversed Girty's orientation. The following description of the hinge is taken from Roth (1929, p. 33):

* * * Just under each cardinal angle on the left valve the flange suddenly develops into a very prominent and thick protuberance which assumes the proportion of a tooth. These teeth mark the termination of the flange. (See [Roth's] pl. 2, figs. 12*d* and 12*e*.) Their development is somewhat variable and is relatively faint in some of the simpler forms. The right valve has a socket just under each cardinal angle which receives the tooth on the left valve. These sockets are quite variable in development. Along the hinge line the right valve has a groove and the left valve has a flange which fits into this groove. * * *

This genus is either a "form genus" or a very stable and nonplastic group. One species, *Amphissites centronotus* (Ulrich and Bassler), 1906, is recorded and figured from strata ranging in age from late Pennsylvanian to Permian. Because of the persistence in characters considered diagnostic for this species, it is reasonable to assume that a slight modification of those characters probably represents a significant difference in the structure of the soft parts, and slight variations in ornamentation can therefore be used as criteria for differentiating species.

Sections through specimens of *Amphissites centronotus* (pl. 4, fig. 18) and *A. cf. A. centronotus* (pl. 4, figs. 1-3)

⁴ After this paper was completed E. N. Polenova (1952, Ostracoda of the upper part of the Jivetski formation of the Russian Platform, in *Microfauna of the U. S. S. R.*, Pt. 5: *Trudy Vsesoyuznogo Neftyanogo Nauchno-Issledovatel'skogo Geologo-Razvedochnogo Instituta (VNIGRI)*. (All-Union Petroleum Explor. and Geol. Research Inst., Trans., Leningrad-Moscow), n. ser., no. 60, p. 65-156, 15 pls. [Russian] studied *Amphissites* and *Ectodemites* from the Lower Carboniferous and Devonian of Russia and concluded (p. 114) that *Ectodemites* and *Polytylites* are subgenera of *Amphissites*. I do not agree with this classification.

show that the carinae and ridges are surface structures and are not reflected on the inside of the valve. The central node, however, is reflected on the inside of the valve. These features are important clues in classifying internal molds thought to belong to this genus; thus *Binodella* Bradfield (1935, p. 140) is very likely an internal mold of *Amphissites*. The reported granulose or reticulated surface of *Binodella* is explainable by the fact that a series of transverse sections through a paratype specimen of the type species, *A. rugosus* Girty, 1910 show the inner surface of the valve to be uneven because of the expression of the surface reticulation. This can be seen also on the section of *A. cf. A. centronotus* (pl. 4, fig. 3) especially near the posterior carina.

Amphissites cf. A. centronotus (Ulrich and Bassler), 1906

Plate 3, figures 15-21; plate 4, figures 1-3

Kirkbya centronota Ulrich and Bassler, 1906, U. S. Nat. Mus. Proc., v. 30, p. 159, pl. 11, figs. 16, 17. Cottonwood shales, Kansas.

Amphissites centronota (Ulrich and Bassler), Harlton, 1927, Jour. Paleontology, v. 1, p. 207, pl. 32, figs. 10*a*, *b*. Hoxbar formation, Oklahoma.

Amphissites centronotus (Ulrich and Bassler), Knight, 1928, Jour. Paleontology, v. 2, p. 259, pl. 32, figs. 6*a-e*; pl. 34, fig. 2. Ft. Scott limestone, and Labette shale, Missouri.—Delo, 1930, *ibid.*, v. 4, p. 160, pl. 12, fig. 9. Upper Carboniferous, Texas.—Warthin, 1930, Oklahoma Geol. Survey Bull. 53, p. 66, pl. 5, figs. 4*a-c*. Marmaton formation, Oklahoma.—Coryell and Billings, 1932, *Am. Midland Naturalist*, v. 13, no. 4, p. 184, pl. 18, fig. 9. Wayland shale, Texas.—Coryell and Sample, 1932, *ibid.*, no. 5, p. 258, pl. 25, fig. 1. East Mountain shale, Texas.—Coryell and Booth, 1933, *ibid.*, v. 15, no. 3, p. 260, pl. 3, figs. 1, 2. Wayland shale, Young County, Texas.—Kellelt, 1933, Jour. Paleontology, v. 7, p. 95, pl. 16, figs. 16-22. Wreford formation, Geary County, Kansas.—Upson, 1933, Nebraska Geol. Survey Bull. 8, p. 42, pl. 3, figs. 7*a-c*. Florena-Cottonwood contact, Kansas.—Bradfield, 1935, Bull. Am. Paleontology, v. 22, p. 59, pl. 4, fig. 3. Deese formation, Oklahoma.—Johnson, 1936, Nebraska Geol. Survey, Paper no. 11, p. 30, pl. 3, figs. 12-14. Island Creek shale, Nebraska.—Scott and Borger, 1941, Jour. Paleontology, v. 15, p. 354, pl. 49, fig. 7. Macoupin limestone (McLeansboro formation), Illinois.—Cooper, 1946, Illinois Geol. Survey Bull. 70, p. 98, pl. 15, figs. 19-20. La-Salle limestone, Illinois.

The synonymy lists only those references that contain illustrations, and the localities are those from which specimens have been figured. It shows the species *Amphissites centronotus* as ranging in stratigraphic age from the Hoxbar formation (Pennsylvanian) through the Chase group (Permian).

The holotype (USNM 35628), seven specimens from the same locality as the holotype that are very likely paratypes, and all the figured specimens of this species, except Harlton, 1927, show the node to be reticulated with smaller meshes than those on the valve surface. This fact was noted first by Bradfield. The species

exhibits considerable individual variation in the shape of the central node; the specimen figured on plate 3, figure 19 has a pointed node, and the specimen on plate 3, figure 21 has a rounded node. The lateral outline varies with individuals because the size of the marginal rims vary, owing to the state of preservation and also because of ontogenetic development. Some of the specimens from the Glass Mountains, Texas, have a spine at the posterior cardinal angle of the left valve similar to the one figured by Scott and Borger, 1941.

<i>Measurements:</i>	Greatest length (mm)	Greatest height (mm)
Figured specimen, USNM 118422, pl. 3, fig. 15.	0.88	0.54
Figured specimen, USNM 118423, pl. 3, fig. 20.	1.10	.61
Unfigured specimen	.73	.41
Do.....	.81	.48
Do.....	.87	.47
Do.....	.92	.51
Do.....	1.0	.57
Do.....	1.0	.57

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Amphissites knighti Sohn, n. sp.

Plate 3, figures 13, 14

Anterior carina curves backwards at midheight of valve terminating at muscle scar pit. Muscle scar pit oval, longer axis pointing to posterior cardinal angle, located at base of poorly defined oval-shaped central node. Reticulations on node the same size as those of the rest of the valve.

Discussion.—This species differs from *A. girtyi* Knight, 1928, in having a larger central node. The reticulations of the node in Knight's species are smaller than those of the rest of the valve.

This species is named in honor of J. Brookes Knight.

<i>Measurements:</i>	Length (mm)	Height (mm)
Holotype, USNM 118418, pl. 3, fig. 13.....	0.77	0.4
Paratype, USNM 118418a.....	Broken	.37

Occurrence.—Known only from USNM loc. 703c.

Genus POLYTYLITES Cooper, 1941

Polytylites Cooper, 1941, Illinois Geol. Survey Rept. Inv. no. 77, p. 51.

Type species: *P. geniculatus* Cooper, 1941, Illinois Geol. Survey Rept. Inv. no. 77, p. 52, 53, pl. 10, figs. 34-37.

Amphissitinae with swellings in dorsal extremities. The inner ridge in this genus can be very thin and exceptionally wide, and may be imperfectly preserved or missing. Silicified specimens of a species in this

genus from the Helms formation (Mississippian) of Texas suggest that this ridge is really a septate frill.

Geologic range.—Mississippian through Permian.

Polytylites digitatus Sohn, n. sp.

Plate 3, figures 34-36

Differs from all the known species of this genus in arrangement of nodes and in having a slightly concave ventral margin. Posterior node fingerlike, extends out and up on the lateral surface of the valve, and projects above the hinge margin; anterior node subdued, central node very high in dorsal view. Pit elongate, carved into posterior ventral part of central node. Greatest height of valve excluding the nodes is in the anterior third; greatest length at midheight.

Remarks.—Because of their large size, the nodes are usually broken, and complete specimens are rare. Specimens without the distinctive nodes are recognized by the slightly concave ventral margin. The holotype is very likely an immature instar.

Measurements:

	Greatest length (mm)	Hinge length (mm)	Greatest height (mm)
Holotype, USNM 118417, pl. 3, fig. 36.	0.81	0.70	0.41
Paratype, USNM 118414a, a left valve.	.90	.78	.44
Paratype, USNM 118414, a right valve, pl. 3, fig. 34.....	.88	.82	.47

Occurrence.—Known only from USNM loc. 703c.

Subfamily KELLETTININAE Sohn, n. subfam.

Differs from Kirkbyinae in lacking a well-defined subventral kirkbyan pit.

Discussion.—According to Alexander (1933, p. 7), the muscle scar pattern was used first by Lienenklaus in differentiating family groups. Schweyer (1940, p. 172) and Triebel (1950, p. 114) considered the pattern as an important criterion in determining family relationship. The kirkbyan pit is inferred to be the place of attachment of the adductor muscle. If this assumption is correct the pit is apparently the result of some morphologic difference in the manner of attachment of the ligaments joining the adductor muscles to the shell, as compared to specimens that lack the pit. This pit is consistent in several genera, while a second group of genera which is similar in all other respects to the Kirkbyinae had a different type of attachment of the ligaments to the shell that did not result in the formation of a large well-defined pit. This second group may have been utterly different from the Kirkbyinae and, based on soft parts, may actually belong to one or more unrelated families. Because of the homeo-

morphy of the carapace, however, they are placed within the same family as the Kirkbyinae. Representatives of this second group are found concomitant with genera that have the diagnostic pit.

The following genera are here assigned to this subfamily:

Kellettina Swartz, 1936
Kindtella, n. gen.
Semipetasus, n. gen.

The following additional genera are tentatively placed in the Kellettininae:

Editia Brayer, 1952
Strepula Jones and Holl, 1886

Genus *KELLETTINA* Swartz, 1936

Kellettina Swartz, 1936, Jour. Paleontology, v. 10, no. 7, p. 585.—Cooper, 1946, Illinois Geol. Survey, Bull. 70, p. 103.
Ulrichia Knight, 1928, Jour. Paleontology, v. 2, p. 252–253.—Roth and Skinner, 1930, Jour. Paleontology, v. 4, p. 349.—Warthin, 1930, Oklahoma Geol. Survey Bull. 53, p. 62.—Coryell and Osorio, 1932, Am. Midland Naturalist, v. 13, no. 2, p. 31.—Upson, 1933, Nebraska Geol. Survey Bull. 8, ser. 2, p. 45.—Kellett, 1933, Jour. Paleontology, v. 7, p. 92.—Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 53.—Johnson, 1936, Nebraska Geol. Survey, Paper no. 11, p. 34.
 Type species: *Ulrichia robusta* Kellett, 1933, Jour. Paleontology, v. 7, p. 92, pl. 15, figs. 33–40, 42.

Kellettininae having two unequal large nodes on each side of the approximate midlength of the valves. The nodes do not extend ventrally to the marginal rim.

Kellett, in discussing the type species, stated (1933, p. 92) that a pit can rarely be found. A collection of *Kellettina robusta* (Kellett), 1933 from the Graham formation, Texas (USGS loc. 4030 blue) shows in many of the specimens a nonreticulated area, about twice the size of the neighboring reticules situated in the posterior ventral part of the anterior node (present orientation) which may represent the muscle scar. This is not the same structure as the pit in Kirkbyinae and Amphissitinae. Topotypes of *K. vidriensis* Hamilton, 1942, lack a nonreticulated area, and do not have the internal node reflecting a muscle scar. The holotype of *Ulrichia binoda* Roth and Skinner, 1930 (USNM 103026), the holotype and paratypes of *K. robusta* (Kellett), 1933, (USNM 85499, 85499a-e), and paratypes of *K. montosa* (Knight), 1928 (USNM 116711) do not have a kirkbyan pit. Because related genera also do not have a well-defined pit, the new subfamily, Kellettinae, is erected for this group.

Kellettina is here oriented with the acute cardinal angle posterior. This orientation makes the more tumid node posterior to center and the higher part of the valve anterior.

In addition to the type species, the following are referred to *Kellettina*:

Ulrichia binoda Roth and Skinner, 1930, Jour. Paleontology, v. 4, p. 349–351, pl. 28, figs. 1–4.

Ulrichia montosa Knight, 1928, Jour. Paleontology, v. 2, p. 252–253, pl. 32, figs. 1a-b; pl. 33, fig. 1.

Ulrichia bituberculata? Batalina, 1924, [not (McCoy), 1844], Russia Geologicheskii Komitet, Izv. (Comité Geol. Bull.) 43, no. 1, p. 1320–1322, 1334–1335, pl. 22, figs. 1–3; pl. 23, figs. 1–6. In the English summary, Batalina (p. 1334) lists *Ulrichia bituberculata* McCoy, var. *striata* as new. Because he does not describe this variety it is considered here as a nomen nudum.

Kellettina vidriensis Hamilton, 1942.

Geologic range.—Lower Carboniferous of Russia?; Pennsylvanian and Permian.

Kellettina vidriensis Hamilton, 1942

Plate 2, figure 13; plate 3, figures 37–44; plate 4, figures 15, 17, 20

Kellettina vidriensis Hamilton, 1942, Jour. Paleontology, v. 16, p. 714, pl. 110, fig. 9.

Cooper (1946, p. 103–104) referred this species to *Kellettina robusta* (Kellett) because he did not consider “the small variation in the character of the frill described by Hamilton” to be a specific distinction. Besides this variation in the frill, *K. robusta* has a raised carina just below the nodes. I examined 55 specimens, some of which are perfectly preserved, representing various stages of growth of *K. vidriensis*, without finding a trace of this carina. Twenty-three of 37 specimens of *K. robusta* (USGS loc. 4030 blue) show this carina; the remaining specimens either do not have this feature preserved or are covered with matrix so that it cannot be observed. *K. vidriensis* is consequently considered as a valid species.

The figured specimens were chosen to illustrate a series representing probably four stages of growth of the species. Comparison with Kellett's illustration of a growth series of *K. robusta* (1933, pl. 15, figs. 33–40) shows that the posterior cardinal angle of *K. vidriensis* is more acute.

Measurements:

USNM no.	Length (mm)	Height (mm)
118403, pl. 3, fig. 37	0.76	0.34
118404, pl. 3, fig. 38	.95	.38
118404, pl. 3, fig. 39	1.02	.50
118405, pl. 3, fig. 40	1.36	.59
118406, pl. 3, fig. 42	1.43	.62
118407, pl. 3, fig. 44	1.64	.62

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Genus *SEMIPETASUS* Sohn, n. gen.

Type species: *S. signatus* Sohn, n. sp.

Large Kellettininae with confluent elongate lobes. Hinge consists of tongue and groove with minute terminal dentition.

Discussion.—*Semipetasus* differs from *Aurikirkbya* Sohn (subfamily Kirkbyinae) in having a more elongate outline, in configuration of lobes, and in absence of well-developed kirkbyan pit. The hingement of this genus is weakly developed as compared to the strong hinge and terminal dentition of *Aurikirkbya*.

Geologic range.—Wolfcamp formation (USNM loc. 701) through Leonard formation (USNM loc. 703a).

Semipetasus signatus Sohn, n. sp.

Plate 4, figure 12; plate 5, figures 7, 8

Carapace elongate in lateral outline, hinge straight, anterior margin curved, ventral margin slightly concave in the middle, posterior margin straight, making acute angle with dorsal margin. Venter V-shaped; marginal rim thick, apparently septate, makes an angle of 30° with lateral surface of valve at contact margin. Surface of valve with a sigmoidal-shaped lobe starting at anterior quarter of greatest length for dorsal quarter of the valve height. Lobe then makes an angle of 120° and trends back and upward to dorsal margin, assuming a nodelike aspect at hinge line near posterior third of valve length, and trends down and forward for about two-thirds the valve height, resulting in a straight posterior shoulder.

Left valve with a very shallow groove along free margins into which bevelled edge of right valve fits; this edge terminates at the hinge in minute teeth. Reticulations consist of fine wavy lines parallel to margins with irregularly spaced vertical lines.

Discussion.—The holotype, a left valve, and four paratypes do not have well-preserved hingement, but a large suite of better preserved specimens from USNM locality J-18 shows that the left valve has a dorsal groove without terminal sockets into which the ridge of the right valve fits.

Measurements (on the inside of valve):

	Hinge length (mm)	Greatest height perpendicular to hinge (mm)
Holotype, USNM 118411, pl. 5, fig. 7	2.26	0.90
Paratype, USNM 118411a, left valve (broken)	2.33	1.00
Paratype, USNM 118411b, right valve	2.70	1.04
Paratype, USNM 118411c, right valve	2.40	.98
Paratype, USNM 118411d, right valve	2.00	.80

Geologic range.—Wolfcamp and Leonard formations, but not in the Word formation.

Genus *KINDLELLA* Sohn, n. gen.

Type species: *K. fissiloba* Sohn, n. sp.

Subovate, bilobed Kellettininae, lobes extend below midheight of carapace. Posterior cardinal angle obtuse. Hinge similar to that of *Amphissites*. Reticulations approximately the same size on entire surface, except one row of larger holes that border the shallow marginal ridge.

Discussion.—This genus differs from *Kellettina* Swartz in that the lobes extend below midheight instead of being nodes that are situated above midheight. *Kindlella* possesses a shallow marginal ridge instead of a deep septate ridge present in *Kellettina*.

Ulrichia minuta Harris and Lalicker, 1932, probably belongs to this genus. Batalina (1924, p. 1320-1322, 1334-1335) compared his *Ulrichia bituberculata* from the Lower Carboniferous of Russia with *Ulrichia bituberculata* (McCoy) as identified by Jones and Kirkby (1896, p. 191; pl. 12, fig. 20), and stated that the Russian specimens differed from those from Scotland in the strongly pronounced transverse striation of the valve margins. This feature is reminiscent of the septate frill in *Kellettina*. A slide from the Jones collection in the U. S. National Museum labeled "Sub Carb. Sh. West Scotland" contains unsorted ostracodes, among which are three specimens of *Ulrichia bituberculata* (McCoy) as figured by Latham (1932, p. 368, fig. 15). These belong in *Kindlella*, but the originals of Batalina's figures differ from *Kindlella bituberculata* (McCoy) from Scotland, and probably represent a species of *Kellettina*. The hinge structures of the specimens from Scotland are not similar to those figured by Levinson (1950, p. 70, figs. 8a, b.).

Kellett (1933, p. 102-103, pl. 16, figs. 5-8) described and illustrated a growth series of *Knightina minuta* (Harris and Lalicker), 1932 from the Fort Riley limestone. Her specimens (USNM 85459, 85459a-f) have lobes that are much shallower than those illustrated by Harris and Lalicker.

This genus is named in honor of Prof. Cecil H. Kindle, Department of Geology, City College of New York.

Geologic range.—Carboniferous and Permian. Coarsely silicified specimens that probably belong to this genus, but are not identifiable as to species are present in a sample of limestone from P. B. King's Word formation, limestone no. 3 (USNM loc. 706).

Kindlella fissiloba Sohn, n. sp.

Plate 2, figure 12; plate 3, figures 22-27; plate 4, figure 13

Carapace reticulate, subquadrate in lateral view, bordered by a shallow marginal flange.

Lobes have a dorsoposterior trend; both lobes project above the hinge line. Anterior lobe split by a hori-

zontal depression resulting in a subovate dorsal node and a smaller one located below the posterior ventral portion of that node; posterior lobe located farther from posterior margin than anterior lobe is from anterior margin; it is somewhat constricted in the middle but is not broken, having a continuous crest from the dorsal part to the base. The base merges with the valve surface about 2 or 3 reticulations removed from the septate inner ridge. Venter flat, consisting of a reticulated area between the inner and outer ridges. Outer ridge about the width of the walls between reticulations. Muscle scar not discernible. One valve is rabbeted to receive the bevelled edge of the smaller valve, but both valves are essentially equal.

Measurements: (parallel to dorsal margin)

	Length (mm)	Height (mm)
Holotype, USNM 118413, pl. 3, fig. 24.....	0.99	0.46
Paratype, USNM 118415, pl. 3, fig. 22.....	.98	.48
Paratype, USNM 118415a.....	.83	.40

Occurrence.—This species is known only from USNM loc. 703c.

***Kindlella centrinoda* Sohn, n. sp.**

Plate 5, figures 14–17

Differs from *Kindlella fissiloba* in that the anterior lobe has a ventral node and a curved lobe that curves around the anterior portion of that node.

Discussion.—This species is rare in locality 703c; only two specimens have been found in association with *Kindlella fissiloba*. It is, however, common in Wolfcamp or lowermost Leonard rocks (USNM loc. J-18), where it is present in various stages of growth that range in size from specimens that are smaller than the original of figure 17 (pl. 5) to those that are larger than the holotype of *K. fissiloba*.

Measurements:

	Length (mm)	Height (mm)
Holotype, USNM 118489, pl. 5, fig. 15.....	0.73	0.34
Paratype, specimen broken in handling, measurements from photograph; pl. 5, fig. 17....	.45	.3

Occurrence.—Common in Wolfcamp or lowermost Leonard formation (USNM loc. J-18); rare in uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Family MILTONELLIDAE Sohn, 1950

Genus MILTONELLA Sohn, 1950

Type species: *Miltonella shupei* Sohn, 1950.

As a result of this study, the geologic range of *Miltonella* has been extended from the Wolfcamp formation (USNM loc. 701) through Word formation (USNM loc. 706) and to the upper part of the Phosphoria formation (USGS loc. 12213 blue). The geographic occurrence includes the Delaware Mountains, Texas, and Tosi Creek, Sublette County, Wyo.

***Miltonella shupei* Sohn, 1950**

Plate 5, figures 18–21

Argilloecia sp. Girty, 1908, U. S. Geol. Survey Prof. Paper, 58, p. 510, pl. 28, figs. 12, 12a. Delaware Mountain formation, Texas.

Miltonella shupei Sohn, 1950, U. S. Geol. Survey Prof. Paper 221-C, p. 37–38, pl. 8, figs. 23–30.

The figured specimens show that the surface of the valves is reticulated and not granulose, as stated in the original description. The specimen figured by Girty, (USNM 118157) and refigured on plate 5, figure 19, is a coarsely silicified, corroded, and broken right valve of this species.

Measurements: (parallel to dorsal margin, inside of valve; fig. 19 outside of valve)

	Great- est length (mm)	Great- est height (mm)
Topotype, USNM 118427, pl. 5, fig. 20.....	1.93	1.20
Topotype, USNM 118428, pl. 5, fig. 18.....	1.54	.99
Original of Girty's <i>Argilloecia</i> sp., USNM 118157, pl. 5, fig. 19.....	2.01	1.33

Geologic range.—Wolfcamp or lowermost Leonard (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703c); Delaware Mountain formation (USGS loc. 2969 green); Phosphoria formation (USGS loc. 12213 blue).

Genus SANNIOLUS Sohn, n. gen.

Type species: *Sanniolus sigmoides* Sohn, n. sp.

Straight-backed, subovate, reticulate ostracodes with a sinelike lobe within the area outlined by a miltonellid groove; this lobe outlines two subtriangular depressions, one pointing dorsally and the other ventrally. Free margin rabbeted to receive bevelled edge of opposing valve which has a grooved dorsal margin for a tongue and groove hingement; terminal dentition suggested but not determined because of faulty preservation. Venter flat, narrow, separated from the lateral surface by a thin carina.

Although the hingement of this genus differs from *Miltonella*, it is placed in Miltonellidae because of the characteristic groove.

Jean M. Berdan pointed out to me that *Mesomphalus hartleyi* Ulrich and Bassler, 1913, from the Devonian of Maryland, placed by Bassler and Kellett (1934, p. 411) in the family Zygobolbidae, subfamily Drepanelinae, has a groove parallel to the ventral margin. *Mesomphalus* differs from the new genus in lateral outline, in the presence of a deep central sulcus bounded by a large lobe on one side and a small node on the other side, by the presence of a relatively deeper frill, and by supposedly having dimorphic forms, one of which has a sausage-shaped pouch along the ventral margin.

Geologic range.—Wolfcamp or lowest Leonard formation (USNM loc. J-18); uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Sanniolus sigmoides Sohn, n. sp.

Plate 5, figures 9-13

Subovate in lateral and dorsal views, dorsal margin straight, end margins rounded; radius of curvature of posterior margin shorter than that of anterior so that slightly concave ventral margin converges toward dorsum. Greatest height at anterior cardinal angle, greatest length parallel to dorsal margin and slightly above midheight, greatest convexity approximately at midlength and above midheight. Miltonellid groove oval in outline. Anterior portion of sinelike lobe commences as a low swelling near the dorsal margin adjacent to the miltonellid groove which it parallels along its anterior portion; it then reverses in direction, becomes more inflated, and trends diagonally toward posterior cardinal angle where lobe overhangs hinge margin. It then becomes less inflated and curves ventrally paralleling the posterior portion of miltonellid groove, and terminates at the ventral part of that groove. This lobe breaks valve surface inside of groove into two unequal subtriangular depressions; anterior depression is smaller and less definite than posterior depression, which appears to be carved out of lobe. A round nonreticulated area that is reflected on inside of valve as a smooth knob is located posterior to midlength below and behind posterior ventral portion of the diagonal part of the lobe; this probably represents the adductor muscle scar.

Discussion.—The nonreticulated area differs from a kirkbyan pit, because it is neither depressed nor surrounded by a rim.

Ontogeny.—At least 3, and possibly 4, stages of growth are represented. The only consistent measurement of length is the distance on the exterior along the greatest length bounded by two lines that touch both extremities and that are perpendicular to the dorsal margin. This distance is as follows:

Millimeters:		USNM no.
0.67	Paratype	118375, pl. 5, fig. 10
.74	do	118436
.83	do	118437
1.02	do	118438
1.03	do	118439
1.24	Holotype	118374, pl. 5, fig. 12
1.35	Paratype	118440
1.41	do	118441
1.41	do	118442

The differences in size among the 3 smallest, the next 2 larger, and the other specimens are large enough to represent growth stages; whether the 1.24 mm- and the 1.41 mm-specimens represent extremes within the limits of variation of the same instar, or of different growth stages, cannot be determined. The smallest stage (pl. 5,

fig. 9) differs from the largest (pl. 5, fig. 12) in that the posterior portion of the lobe is larger in proportion to the size of the valve, and the anterior portion of the lobe and enclosed area are less well defined than in the larger stages.

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703e).

Family PRIMITIIDAE Ulrich and Bassler, 1923

Genus CORYELLINA Bradfield, 1935

Coryellina Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 35-36.—Cooper, 1941, Illinois Geol. Survey, Rept. Inv. 77, p. 63.—Coryell and Rozanski, 1942, Jour. Paleontology, v. 16, no. 2, p. 141.—Sohn, 1951, Geol. Soc. Am. Bull. 62, p. 1482 [abs.].

Beyrichiella [part] Jones and Kirkby, 1886, Annals and Mag. Nat. History, ser. 5, v. 18, p. 260.

Kirkbyina [part] Ulrich and Bassler, 1908, U. S. Nat. Mus. Proc., v. 35, p. 322.—[part] Harlton, 1929, Tex. Univ. Bull. 2901, p. 147.—Latham, 1933, Royal Soc. Edinburgh Trans. v. 57, pt. 2, no. 12, p. 363.

Perprimitia [part] Croneis and Gutke, 1939, Denison Univ. Sci. Lab. v. 24, p. 38-39.

not *Coryellina* Kellett, 1935, Jour. Paleontology, v. 9, no. 2, p. 138= (*Coryellites* Kellett, 1936, p. 775).

Type species: *Coryellina capax* Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 36, pl. 1, figs. 11a-d.

The original conception of the genus is followed here.

This genus was established on the basis of a single carapace (Indiana Univ. Paleont. Coll. no. 2051) from the Devils Kitchen member of the Deese formation of Oklahoma, which I examined. The holotype is a complete carapace that has shell material. Four cotypes of *Coryellina inflata* (Harlton), 1929 from the Canyon group, Texas (USNM 80563) are internal molds that differ from *C. capax* Bradfield only in the outline of the posterior margin as seen in lateral view. Viewed laterally the posterior margin of *C. capax* consists of two distinct elements: an almost straight dorsoposterior half that makes about a 90° angle with the dorsal margin and terminates at the posterior spine which is situated approximately at midheight, and a straight ventroposterior portion that makes about a 120° angle with the upper portion. Viewed laterally, the posterior spine of *C. inflata* is situated in front of the posterior margin and consequently does not form a part of the lateral outline. The margin is more regular and without the pronounced angulation caused by the spine. I believe that this is probably due to the fact that shell material is not present in *C. inflata*. Carapaces with shell material of *C. inflata* will probably have the same lateral outline as *C. capax*, and the latter is most likely a junior synonym of *C. inflata*.

Beyrichiella? ventricornis Jones and Kirkby, 1886, was placed by Ulrich and Bassler (1908, p. 322) in their new

genus *Kirkbyina* (type species *Beyrichiella? reticosa* Jones and Kirkby, 1886).

The following species are assigned to *Coryellina*:

<i>Perprimitia? bicornis</i> Croneis and Gale, 1938..	Mississippian
<i>Coryellina capax</i> Bradfield, 1935= <i>Kirkbyina inflata</i> Harlton (?), 1929.....	Pennsylvanian
<i>Perprimitia elegans</i> Croneis and Gutke, 1939..	Mississippian
<i>Coryellina indicata</i> Sohn, n. sp.....	Permian
<i>Beyrichiella? ventricornis</i> Jones and Kirkby, 1886.....	Carboniferous

Coryellina kurti Coryell and Rozanski, 1942, from the Glen Dean limestone is probably a synonym of *C. ventricornis* (Jones and Kirkby), 1886 and *Coryellina indistincta* Coryell and Rozanski, 1942 is based on an internal mold of an unidentifiable genus of the *Jonesina* group.

Coryellina indicata Sohn, n. sp.

Plate 1, figures 8-11

Coryellina having the posterior lateral spine well above the midheight. The posterior margin curves forward at the cardinal angle, and the sulcus is shallower than in any of the other species.

Discussion.—In the holotype the distance between the dorsal margin and the posterior lateral spine is 30 percent of the distance between the dorsal and the ventral margins. This ratio can be expressed as ranging from 35 to 50 percent in Pennsylvanian species, and from 50 to more than 70 percent in Mississippian species. Because the contact margins are channeled, the length and height measurements are not so accurate when taken on the outside of the carapace as when taken on the inside of dissociated valves. This difference is shown below on measurements of the holotype.

Measurements:	Length (mm)	Height (mm)
Holotype USNM 118376, pl. 1, fig. 11 (outside), right valve.....	0.81	0.53
Holotype, USNM 118376, pl. 1, fig. 10 (inside), right valve.....	.75	.48
Paratype, USNM 118376a (inside), spines broken, left valve.....	.76	.46
Paratype, USNM 118376b (inside), spines broken, right valve.....	.68	.42
Paratype, USNM 118376c (inside), spines broken, right valve.....	.68	.45
Paratype, USNM 118376d (inside), spines broken, right valve.....	.70	.47
Paratype, USNM 118376e (inside), spines broken, right valve.....	.75	.47

Occurrence.—Known only, from USNM loc. 703c.

Family uncertain

Genus ROUNDYELLA Bradfield, 1935

- Roundyella* Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 66.—Cooper, 1946, Illinois Geol. Survey, Bull. 70, p. 108.
Amphissites [part] Knight, 1928, Jour. Paleontology, v. 2, p. 258.
Scaberina Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 67.

Type species: *Amphissites simplicissimus* Knight, 1928, Jour. Paleontology, v. 2, p. 266, pl. 32, figs. 11a-d; pl. 34, fig. 6.

Straight-backed suboblong ostracodes. Hingeline slightly incised; hinge straight, consisting of tongue and groove without terminal dentition. One valve rabbeted

along free margins to receive flanged opposing valve. Surface reticulated and with scattered papillae and spines. Muscle scar pattern round, smooth not reflected as a knob on the inside of valve. Polished surfaces of sections through paratype specimens of the type species (pl. 4, figs. 16, 19) show that this genus does not have any marginal ridges. The hinge structure is not discernible in these sections, but the rabbeted free margins are shown.

This genus does not belong in Kirkbyidae, and its family is not yet determined. Species of Devonian age assigned to *Roundyella* by Pokorny (1950, p. 544-546, 607-608) probably are not congeneric with the type. *Amphissites tenuis* Warthin, 1934, referred by Pokorny to *Roundyella*, has, according to the original description and figure, a marginal ridge which eliminates it from this genus. Coryell and Malkin (1936, p. 4) identified some middle Devonian (Hamilton) specimens as *Amphissites simplicissimus* Knight. Cooper (1946, p. 109) and Brayer (1952, p. 172) rejected the foregoing identification; so the proper assignment of Coryell and Malkin's specimens will depend on the study of topotype material. A Hamilton specimen collected by Roundy at Theford, Ontario, now in the U. S. National Museum, is similar in outline to *Roundyella*, but it is more reticulated and has a flat, thick venter in cross section (pl. 4, fig. 8), features that exclude it from this genus.

Roundyella dorsopapillosa Sohn, n. sp.

Plate 1, figures 20-26; plate 4, figures 14, 22

Differs from *Roundyella simplicissima* (Knight), 1928 in having a greater number of spines scattered on the surface of the valves and a larger backward-pointing spine in the dorsoposterior quarter. A smooth subcentral spot outlines the muscle scar area.

Measurements: (parallel to dorsal margin)	Height (mm)	Length (mm)
Holotype, USNM 118378, pl. 1, fig. 22.....	1.00	0.55
Paratype, USNM 118377, pl. 1, fig. 26.....	.98	.58

Geologic range.—Wolfcamp or lowermost Leonard formation (USNM loc. J-18) to uppermost Leonard or lowermost Word formation (USNM loc. 703c).

Roundyella nodomarginata (Bradfield), 1935

Plate 1, figure 19; plate 4, figure 23

Scaberina nodomarginata Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 67, 68, pl. 4, fig. 12a, b.

Cooper (1946, p. 108) assumed that in *Roundyella* the shell had been scoured smooth and all the spines removed, leaving only the reticulations, and that in *Scaberina* the surface reticulations are filled with matrix, leaving the protruding spines. He suggested that *Roundyella simplicissima* (Knight) and *Scaberina nodomarginata* Bradfield may be conspecific.

In order to determine whether the abrasion of spines in ostracodes can result in a reticulated pattern, paratypes of *R. simplicissima* were obtained from J. Brookes Knight and specimens of a spine-bearing, reticulated Recent ostracode from the Persian Gulf similar to the one figured by Triebel (1941, pl. 1, figs. 9, 10) as *Cythere?* sp., were obtained from R. S. Bassler. The sections through the spine of the Recent *Cythere?* (pl. 4, figs. 4-7) show that the calcified portion continues uninterrupted through the spine, and that the breaking of the spine would not leave a hole similar to the surrounding reticulations. Sections through *R. simplicissima* (pl. 4, figs. 16, 19) show the same thing. Sections through *R. nodomarginata* (Bradfield) (pl. 4, fig. 23) from the Hoxbar formation (USGS loc. 6599 blue) within one mile from the type locality show that the spines are solid, and that their abrasion would not result in a reticulated pattern.

A dozen specimens clean of matrix from Bradfield's type locality show that *Roundyella nodomarginata* (Bradfield) is a valid species. It differs from *R. dorsopapillosa*, n. sp. because its spines are more concentrated along the terminal portions of the carapace, rather than being uniformly distributed, and because it does not have the large dorsal spine of *R. dorsopapillosa*.

Measurements: (on the inside of the valve, parallel to dorsal margin)

	Length (mm)	Height (mm)
Figured specimen, USNM 118381, pl. 1, fig. 19.	0.71	0.42

Occurrence.—Hoxbar formation (USGS loc. 6599 blue).

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[Italic numbers indicate descriptions]

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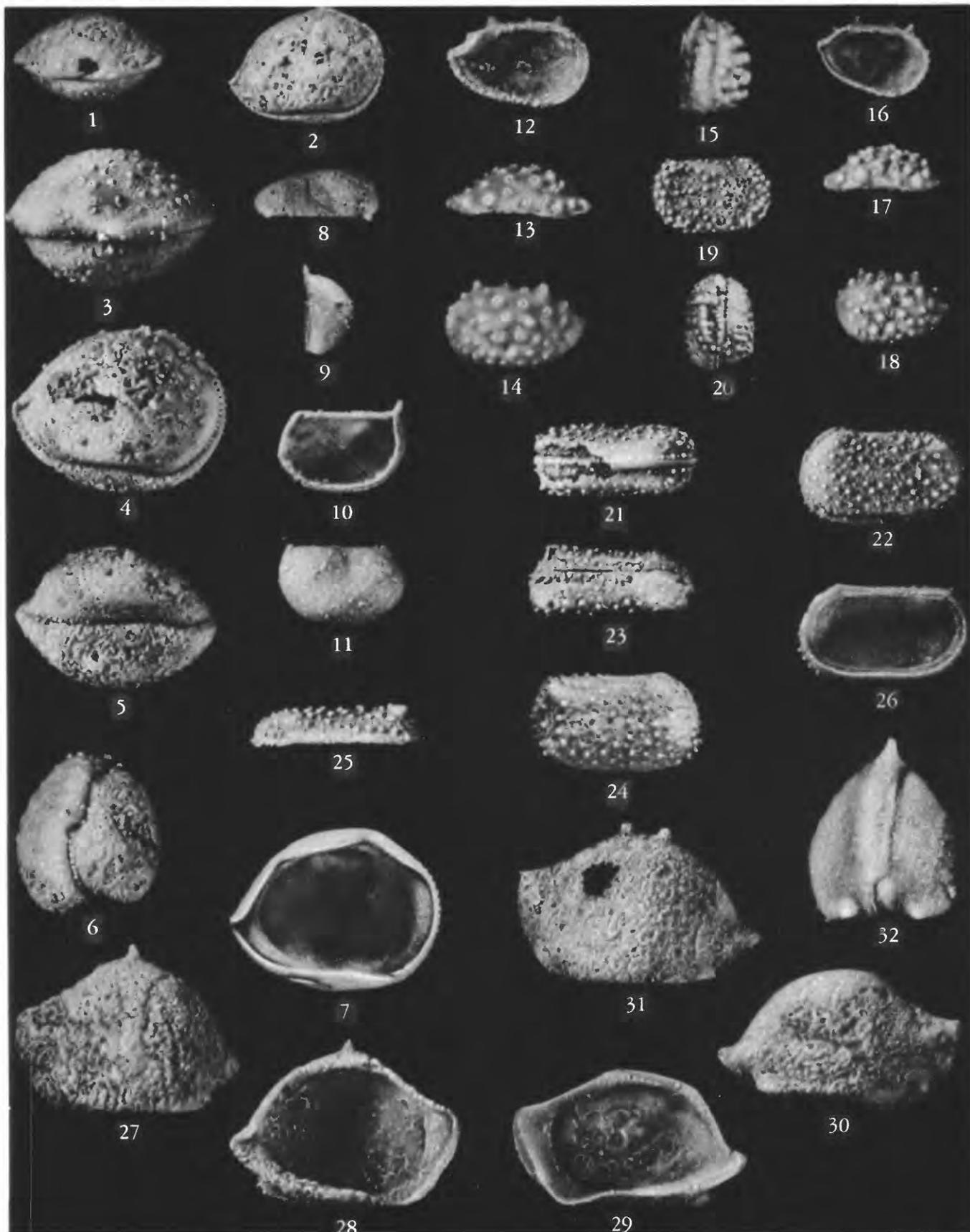
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PLATES 1-5

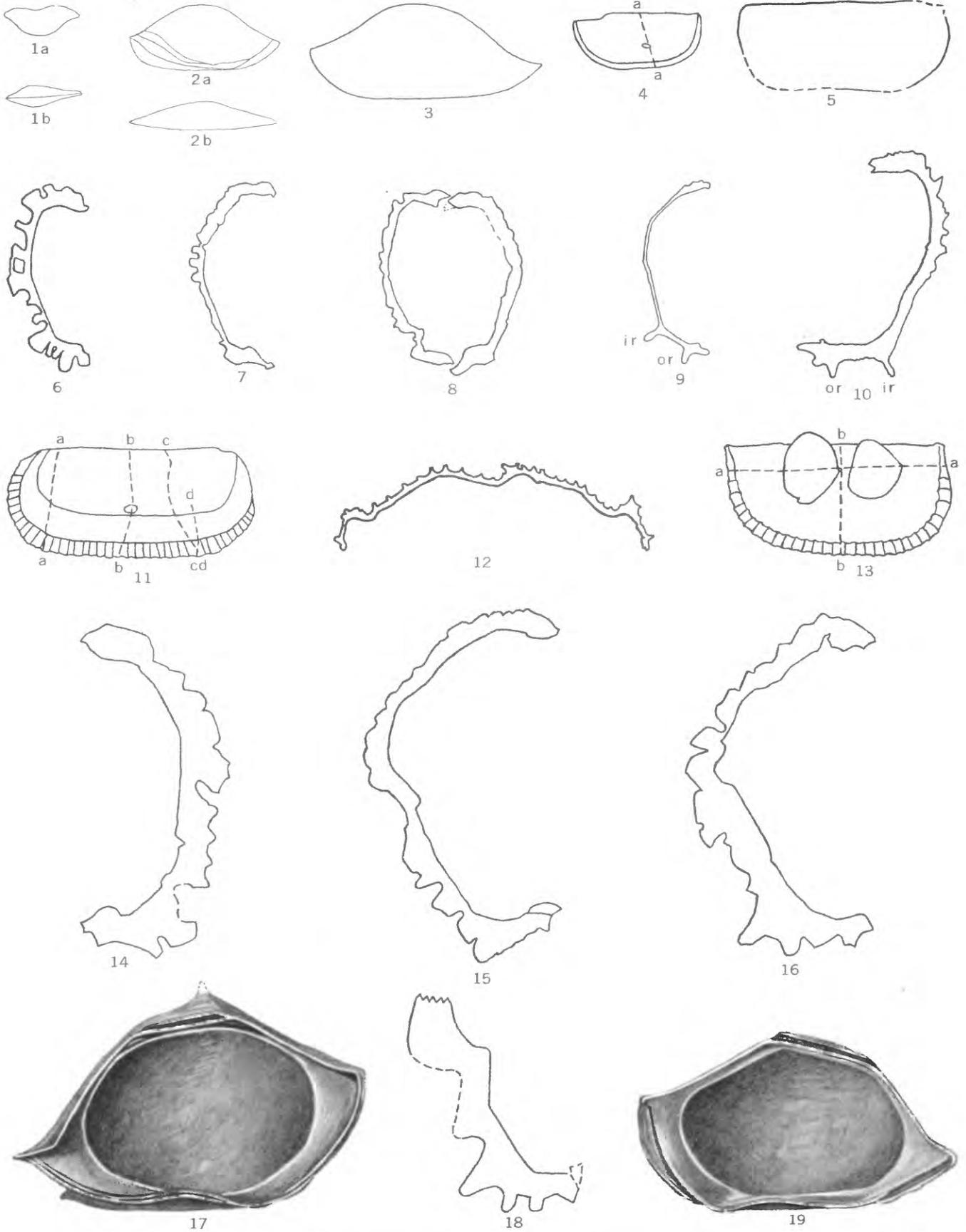
PLATE 1

[All figures approximately $\times 30$. All specimens except figure 19 are from P. B. King's (1930, p. 143) first limestone of section 24, USNM locality 703c]

- FIGURES 1-7. *Bairdia? pruniseminata* Sohn, n. sp. (p. 4).
1, 2. Dorsal and right views of carapace of immature specimen. Paratype, USNM 118399.
3-6. Dorsal, right, ventral, and posterior views of carapace. Holotype, USNM 118400.
7. Interior of left valve. Paratype, USNM 118401.
- 8-11. *Coryellina indicata* Sohn, n. sp. (p. 19).
Dorsal, posterior, interior, and exterior views of right valve. Holotype, USNM 118376.
- 12-18. *Bairdia? aff. B. spinosa* Cooper, 1946. (p. 5).
12-15. Interior, dorsal, lateral, and anterior views of a left valve. Figured specimen, USNM 118490.
16-18. Interior, dorsal, and lateral views of a smaller left valve. Figured specimen, USNM 118491.
19. *Roundyella nodomarginata* (Bradfield), 1935. (p. 19).
Right valve from USGS locality 6599 blue. Figured specimen, USNM 118381.
- 20-26. *Roundyella dorsopapillosa* Sohn, n. sp. (p. 19).
20-23. Anterior, ventral (anterior to right), left, and dorsal (anterior to right) views of carapace. Holotype, USNM 118378.
24-26. Lateral, dorsal, and interior views of right valve. Paratype, USNM 118377.
- 27-32. *Ceratobairdia dorsospinosa* Sohn, n. gen., n. sp. (p. 6).
27, 28. Exterior and interior views of left valve. Paratype, USNM 118435.
29, 30. Interior and exterior views of right valve. Paratype, USNM 118389.
31. Left valve of specimen with two spines. Paratype, USNM 118390.
32. Posterior of specimen with one spine. Holotype, USNM 118391.



PERMIAN OSTRACODES FROM THE GLASS MOUNTAINS, TEXAS, AND ONE PENNSYLVANIAN SPECIES FROM OKLAHOMA



POLISHED SECTIONS OF OSTRACODES

PLATE 2

[ir is inner ridge, or is outer ridge]

FIGURES 1a, b, 2a, b, 3. *Bairdia curta* McCoy, 1844. (p. 4).

- 1a, b. Tracing of the original figure of the holotype from McCoy, 1844, plate 23, figure 6. Magnification not given.
- 2a, b. Tracing of the same (?) specimen ($\times 15$) as figured by Jones, 1870, plate 61, figures 1a, b, after removal from enclosing matrix. The lines bordering the ventral margin show progressive stages of its clearance from the limestone matrix.
3. Tracing of allegedly the same specimen ($\times 25$) as figured by Jones and Kirkby, 1879.
- 4, 9. *Kirkbya* sp. (p. 10).
4. Tracing of figure 2, plate 3 ($\times 30$) showing line of section of figure 9.
9. Anterior section through a right valve (approximately $\times 100$). Figured specimen USNM 118420. Uppermost Leonard or lowermost Word formation, USNM locality 703c.
- 5, 11, 14-16, 18. *Knightina? cuestaforma* Sohn, n. sp. (p. 12).
5. Interior outline of a smaller left valve ($\times 32$) broken where line is dashed. Paratype, USNM 118387.
11. Tracing of figure 30, plate 3 ($\times 30$) to show lines of section for the following figures 14-16, 18:
14. Line a-a of figure 11; anterior section through a left valve.
15. Line b-b of figure 11.
16. Line c-c of figure 11.
18. Line d-d of figure 11; serial posterior sections ($\times 90$) through the same valve. Paratype, USNM 118388. Uppermost Leonard or lowermost Word formation, USNM locality 703c.
6. *Knightina allorismoides* (Knight), 1928. (p. 11).
- Anterior section through a right valve (approximately $\times 90$). Paratype, USNM 118398. Knight's locality 38.
- 7, 8. *Knightina? macknighti* Sohn, n. sp. (p. 11).
- Anterior section through right valve and posterior section through carapace (approximately $\times 90$). Paratype USNM, 118397, uppermost Leonard or lowermost Word formation, USNM locality 703c.
10. *Kirkbya canyonensis* Harlton, 1929. (p. 9).
- Anterior section through a left valve (approximately $\times 90$). Figured specimen, USNM 118421. Pennsylvanian, U. S. G. S. locality 7012 green.
12. *Kindlella fissiloba* Sohn, n. gen., n. sp. (p. 16).
- Dorsal section through a left valve (approximately $\times 95$). Paratype USNM 118432. Uppermost Leonard or lowermost Word formation, USNM locality 703c.
13. *Kellettina vidriensis* Hamilton, 1942. (p. 15).
- Tracing of figure 38, plate 3, $\times 30$, to show lines of sections. Line a-a plate 4, figure 20; line b-b plate 4, figure 15.
- 17, 19. *Ceratobairdia dorsospinosa* Sohn, n. gen., n. sp. (p. 6).
- Interiors of left and right valves (approximately $\times 45$) showing hinge structures. Paratypes USNM 118392. Uppermost Leonard or lowermost Word formation, USNM locality 703c.

PLATE 3

[Magnification approximately $\times 30$. All specimens are from P. B. King's (1930, p. 143) first limestone of section 24, USNM locality 703c]

FIGURES 1-3. *Kirkbya* sp. (p. 10).

Dorsal, lateral, and interior views of right valve. Figured specimen, USNM 118419.

4-12. *Knightina? macknighti* Sohn, n. sp. (p. 11).

4-6. Right, dorsal, and ventral views of carapace. Holotype, USNM 118393.

7-9. Right, dorsal, and ventral views of smaller carapace. Paratype, USNM 118394.

10, 11. Dorsal and lateral views of left valve. Paratype, USNM 118396.

12. Right valve showing reticulations intermediate between figures 4 and 7. Paratype USNM 118395.

13-14. *Amphissites knighti* Sohn, n. sp. (p. 14).

Lateral and dorsal views of left valve. Holotype, USNM 118418.

15-21. *Amphissites* cf. *A. centronotus* (Ulrich and Bassler). 1906 (p. 13).

15-19. Right, ventral, anterior, left, and dorsal views, respectively, of a carapace. The ventral ridges shown in the photographs were broken in an unsuccessful attempt to dissociate the valves. Figured specimen, USNM 118422.

20-21. Left and dorsal views of a larger carapace. Figured specimen, USNM 118423.

22-27. *Kindella fissiloba* Sohn, n. gen., n. sp. (p. 16).

22-23. Outside and inside views of left valve. Paratype, USNM 118415.

24-27. Left, dorsal, right, and ventral views, respectively, of carapace. Holotype, USNM 118413.

28-33. *Knightina? cuestaforma* Sohn, n. sp. (p. 12).

Ventral, interior, lateral, posterior, anterior, and dorsal views, respectively, of left valve. Holotype, USNM 118386.

34-36. *Polytylites digitatus* Sohn, n. sp. (p. 14).

34. Lateral view of right valve. Paratype, USNM 118414.

35, 36. Dorsal and lateral views of left valve. Holotype, USNM 118417.

37-44. *Kellettina vidriensis* Hamilton, 1942. (p. 15).

A growth series of topotypes showing variations in outline, preservation, and relative size of nodes. Note the absence of a kirkbyan pit.

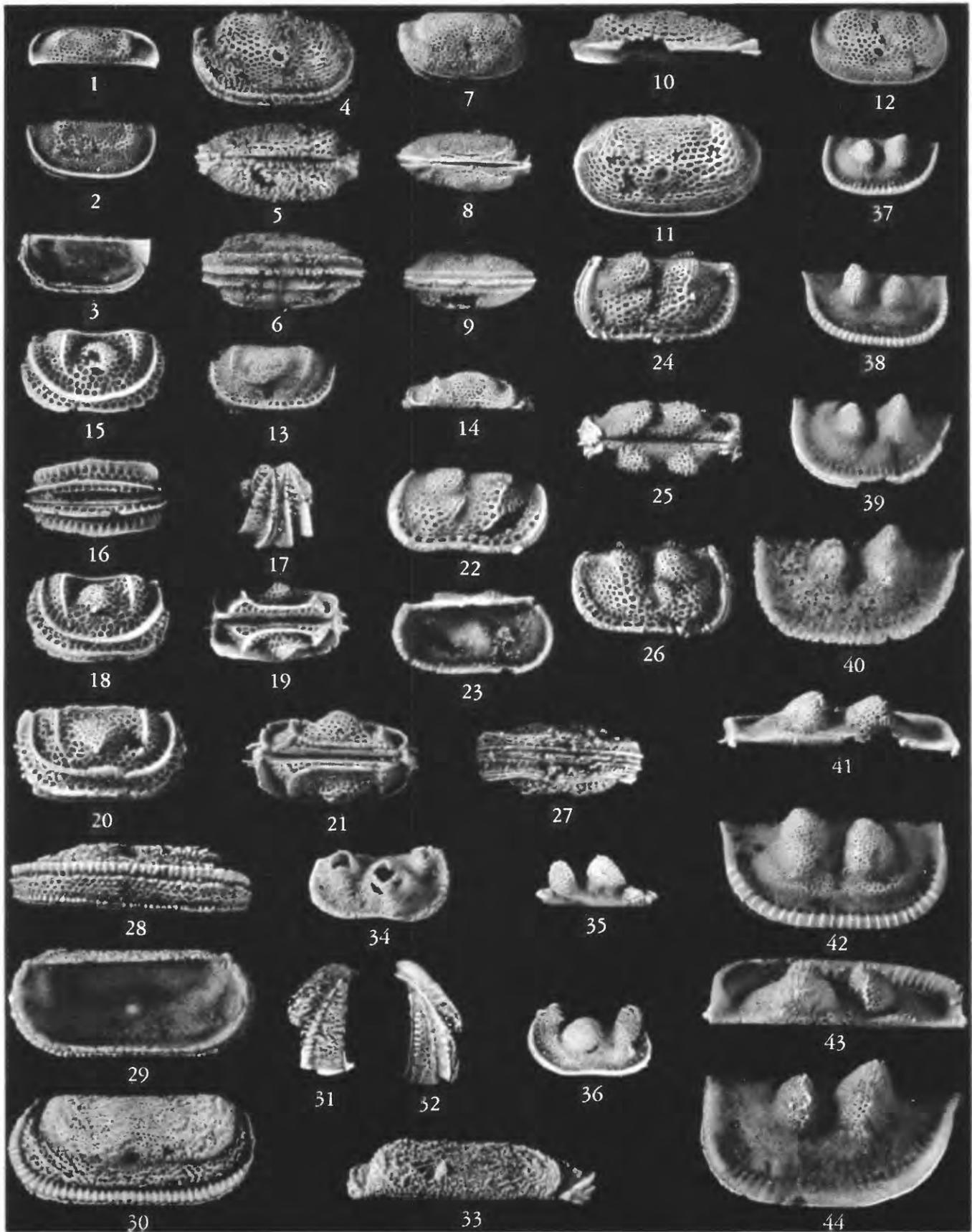
37. Left valve of a small specimen. USNM 118403.

38, 39. Left and right valves of larger growth stages. Note the difference in lateral outlines. USNM 11804.

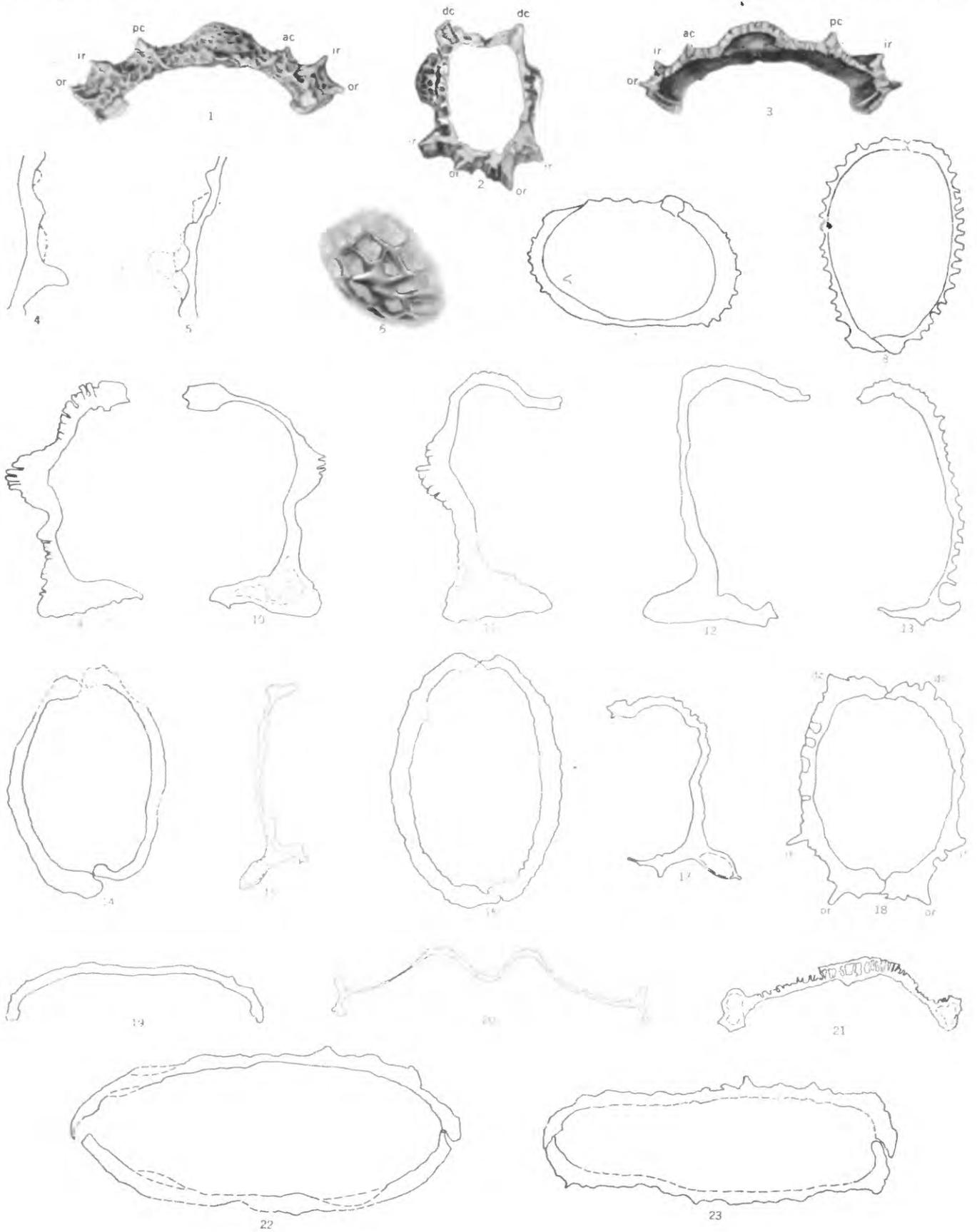
40. Left valve of still larger growth stage. USNM 118405.

41, 42. Dorsal and lateral views of right valve, probably mature individual. USNM 118406.

43, 44. Dorsal and lateral views of a left valve, probably mature individual. USNM 118407.



PERMIAN OSTRACODES FROM THE GLASS MOUNTAINS, TEXAS



POLISHED SECTIONS OF OSTRACODES

PLATE 4

[ac is anterior carina, pc is posterior carina, dc is dorsal carina, ir is inner ridge, or is outer ridge]

- Figures 1-3. *Amphissites* cf. *A. centronotus* (Ulrich and Bassler), 1906. (p. 13).
- 1, 3. Ventral and dorsal sections through a right valve (approximately $\times 48$). Figured specimen, USNM 118424.
 2. Posterior section through a carapace (approximately $\times 50$). Figured specimen, USNM 118425. Uppermost Leonard or lowermost Word formation. USNM locality 703c.
- 4-7. *Cythere?* sp. (p. 20).
- A Recent reticulated and spined ostracode from the Persian Gulf.
 4. Section ($\times 115$) through a spine.
 5. Other side of the same section (approximately $\times 115$) showing reticulations near spine; dashed lines show reticulations and spine behind the line of section. USNM 118433.
 6. Detail of spine of a second specimen, a right valve (approximately $\times 97$).
 7. Outline of the right valve (approximately $\times 43$) showing the position of the spine. USNM 118434.
8. Genus undet. aff. *Roundyella*. (p. 19).
- Anterior section through a Devonian specimen (approximately $\times 115$) from Thedford, Ontario. USNM 118385.
- 9, 21. *Aurikirbya wordensis* (Hamilton), 1942. (p. 9).
9. Posterior section through a left valve (approximately $\times 54$) at kirkbyan pit. Topotype, USNM 118429.
 21. Dorsal section through a right valve (approximately $\times 30$). Topotype, USNM 118430. Uppermost Leonard or lowermost Word formation. USNM locality 703c.
- 10, 11. *A. barbarae* Sohn, 1950. (p. 8).
- Anterior and posterior sections through a left valve (approximately $\times 40$). Topotype, USNM 118431.
 - Uppermost Leonard or lowermost Word formation. USNM locality 703c.
12. *Semipetatus signatus* Sohn, n. gen., n. sp. (p. 16).
- Anterior section through a right valve ($\times 48$). Paratype, USNM 118412. Wolfcamp or lowermost Leonard formation. USNM locality J-18.
13. *Kindlella fissiloba* Sohn, n. gen., n. sp. (p. 16).
- Anterior section through a left valve (approximately $\times 95$). Paratype, USNM 118416. Uppermost Leonard or lowermost Word formation. USNM locality 703c.
- 14, 22. *Roundyella dorsopapillosa* Sohn, n. sp. (p. 19).
14. Anterior section through a carapace (approximately $\times 110$). Paratype, USNM 118379.
 22. Dorsal section through a carapace (approximately $\times 86$). Paratype, USNM 118380. Uppermost Leonard or lowermost Word formation USNM locality 703c.
- 15, 17, 20. *Kellettina vidriensis* Hamilton, 1942. (p. 15).
15. Anterior section through a right valve (approximately $\times 45$); line of section between nodes as shown on plate 2, figure 13. Topotype, USNM 118408.
 17. Anterior section through a left valve (approximately $\times 45$); line of section through anterior node. Topotype, USNM 118409.
 20. Dorsal section through a left valve (approximately $\times 45$). Approximate line of section superposed on right valve, plate 2, figure 13. Topotype, USNM 118410. Uppermost Leonard or lowermost Word formation. USNM locality 703c.
- 16, 19. *Roundyella simplicissima* (Knight), 1928. (p. 20).
16. Anterior section through a carapace (approximately $\times 105$). Paratype, USNM 118383.
 19. Dorsal section through a right valve (approximately $\times 75$). Paratype, USNM 118384. Knight's locality 38.
18. *Amphissites centronotus* (Ulrich and Bassler), 1906. (p. 13).
- Anterior section through a carapace (approximately $\times 90$); line of section anterior to central node. Figured specimen, USNM 118426. USGS locality 4030 blue.
23. *Roundyella nodomarginata* (Bradfield), 1935. (p. 19).
- Dorsal section through a carapace (approximately $\times 100$). Figures specimen, USNM 118382. Hoxbar formation. USGS locality 6599 blue.

PLATE 5

[Magnification approximately $\times 30$. All the specimens except figures 7, 8, and 19 are from P. B. King's (1930, p. 143) first limestone of section 24, USNM locality 703c]

FIGURES 1-6. *Coronakirkbya fimbriata* Sohn, n. gen., n. sp. (p. 11)

1. Left valve of younger growth stage. Paratype, USNM 118486.

2-4. Dorsal, lateral, and ventral views, respectively, of left valve. Outer frill broken; note row of frill tubule bases just above rabbeted margin on figure 4. Holotype USNM 118487.

5, 6. Outside and inside views of left valve. Note tubular character of frill and cardinal spines on figure 5, and part of outer frill on figure 6. Paratype, USNM 118488.

7, 8. *Semipetatus signatus* Sohn, n. gen., n. sp. (p. 16).

Lateral and dorsal views of left valve. Holotype, USNM 118411. Uppermost Leonard formation. USNM locality 703a. The grain just below the posterior shoulder of figure 7 is extraneous material; note reticulations near end margins. The two circular knobs on lobe of figure 8 are extraneous and are not present on any of the other specimens.

9-13. *Sanniolus sigmoides* Sohn, n. gen., n. sp. (p. 18).

9, 10. Lateral and interior views of left valve of young growth stage. Paratype, USNM 118375.

11-13. Dorsal, lateral, and interior views of right valve. Holotype, USNM 118374.

14-17. *Kindlella centrinoda* Sohn, n. sp. (p. 17).

14, 15. Dorsal and lateral views of left valve. Holotype, USNM 118489.

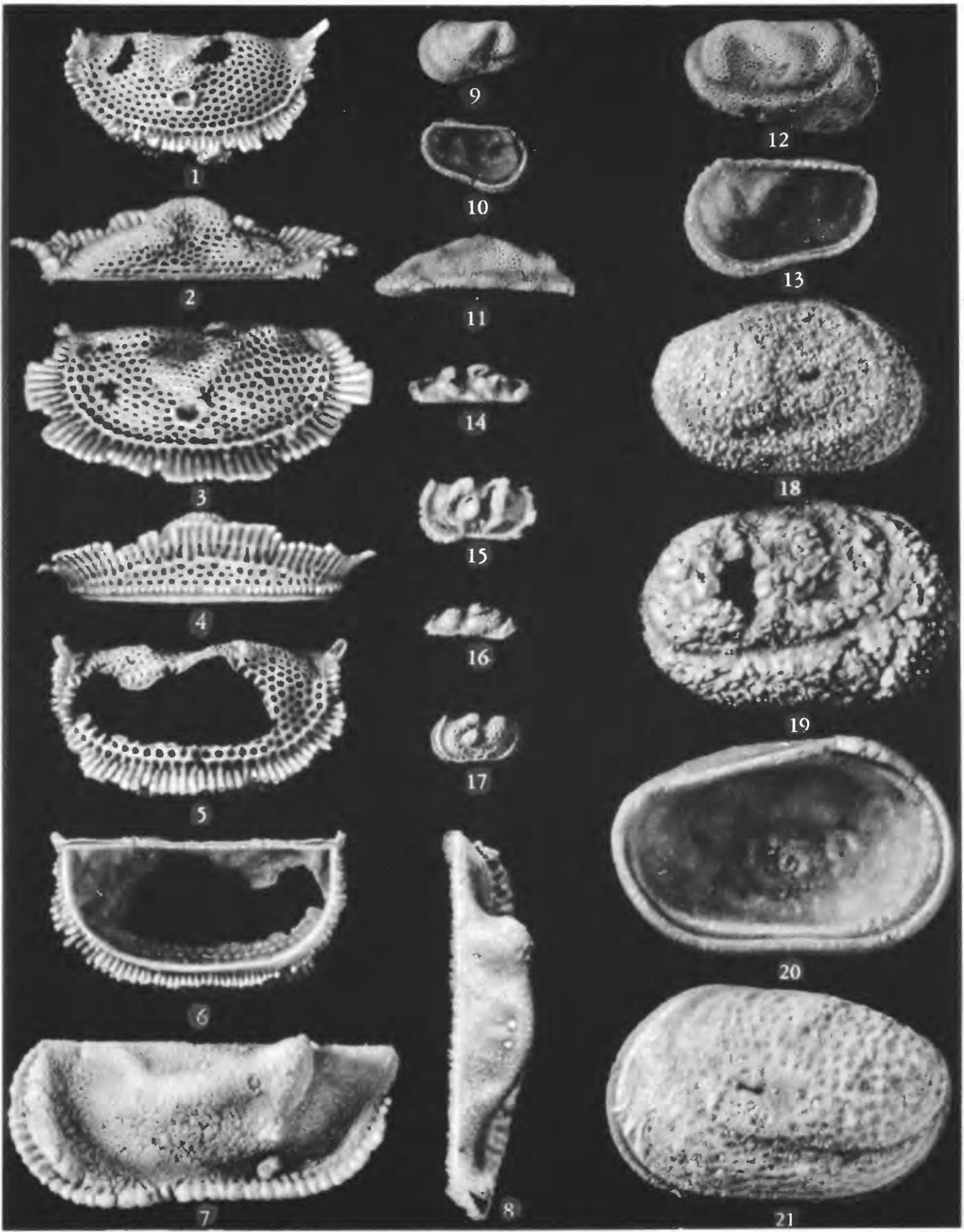
16, 17. Dorsal and lateral views of young growth stage. Paratype broken in handling.

18-21. *Miltonella shupeii* Sohn, 1950. (p. 17).

18. Lateral view of right valve. Topotype, USNM 118428.

19. Lateral view of right valve of the original of Girty's figure of *Argilloecia* sp., assumed by Girty to be from the Delaware Mountain formation. Figured specimen, USNM 118157. USGS locality 2969 green.

20, 21. Inside and lateral views of left valve. Note reticulated surface and muscle scar area. Topotype, USNM 118427.



PERMIAN OSTRACODES FROM THE GLASS MOUNTAINS, AND ONE SPECIMEN FROM THE DELAWARE MOUNTAINS, TEXAS