New Late Mississippian Ostracode Genera and Species From Northern Alaska

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By I. G. SOHN

A REVISION OF THE PARAPARCHITACEA

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Revision of the Paraparchitacea, and description and illustration of new genera and species from the Upper Mississippian of the Brooks Range, Alaska

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ABSTRACT

Collection from the marine Alapah Limestone, Brooks Range, Alaska, contain abundant and diversified ostracodes and include growth series of several taxa referable to *Paraparchites*. Study of these populations and a review of the world literature make it possible to discriminate several new genera in this group. I conclude that the ostracodes in these genera should be oriented so that the plenate end is posterior; that dimorphism is shown in the width of the posterior and (or) width below the midheight; that the presence or absence of dorsoposterior spines is constant within genera, and that these spines or tubercles, unlike those in the Leperditicopida, are not eye tubercles; that adults of some genera in the Paraparchitidae may be smaller than instars of other genera in this group; and that reversal of overlap and hingement is not a taxonomic criterion in this group. The presence of a well-developed inner lamella and a cyprid adductor muscle-scar pattern in some of the genera remove this group from the Palaeocopida as presently defined.

In order to document the above conclusions, several genera and species from areas other than Alaska are discussed and illustrated. The following are new: *Paraparchites kellettae, Shivaella* n. gen., *S. suppetia, S. mertiei, Chamishaella* n. gen., *C. aenigmatica, C. brosgei, Shishaella* n. gen., *S. williamsae, Shemonaella* n. gen., *S. dutroi,* and Coelonellidae, n. fam.

INTRODUCTION

Among the U.S. Geological Survey collections of Mississippian (Meramecian) ostracodes from northern Alaska is a sample of a coquina of ostracodes in the platy limestone member of the Alapah Limestone, 200 feet above the base of the limestone (USGS loc. 13288). This sample contains an abundant and diversified ostracode assemblage that includes growth stages of several taxa referable to the Paraparchitacea Scott, 1959 (Devonian–Permian), Bairdiacea Sars, 1887 (Late Ordovician–Holocene), and the Kloedenellacea Scott, 1961 (Late Ordovician (?)–Permian). Most of the specimens are carapaces; some are steinkerns or single valves. The size range of all the specimens is from less than 0.5 mm (millimeters) to more than 2 mm in greatest length. Examination of this collection, of types in the U.S. National Museum, and of specimens from various collections in the U.S. Geological Survey, coupled with information known about Ostracoda, makes it possible to propose several criteria pertaining to the classification of the Paraparchitacea. These criteria are discussed and are used as a basis for the revision of the superfamily Paraparchitacea, as well as for the description of new taxa. Figure 1 shows the stratigraphic ranges of the genera involved in this study.

Because all the genera in the Paraparchitacea are not represented in the collections from Alaska, this volume is divided into two parts: the first part (this report) deals with the Alaskan taxa; the second part deals with new species in other areas in the United States. In order to document this revision, a few

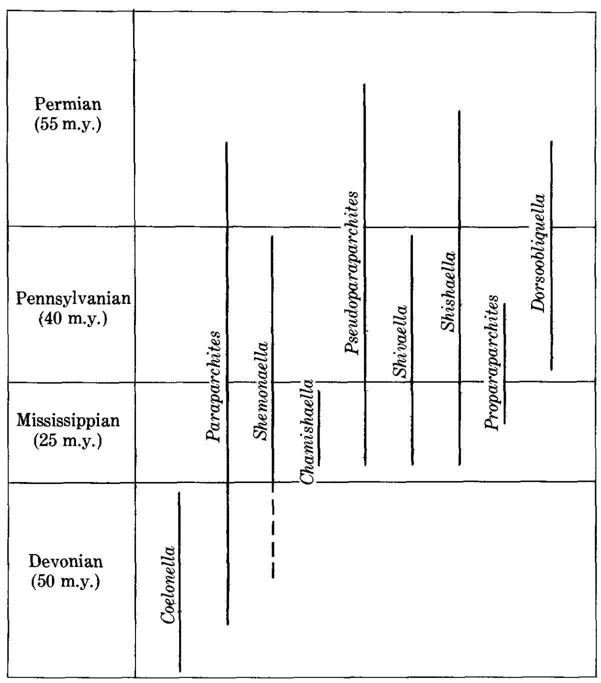

FIGURE 1.—Stratigraphic ranges of the genera discussed in this study.

species outside Alaska are illustrated and discussed in this report.

ECOLOGY

Paraparchites is essentially a marine genus. Species described in taxa of the Paraparchitacea are considered to be of marine origin. There are, however, certain records (Coryell and Rogatz, 1932; Mandelstam, 1956, p. 102, 104; Grachevskiy, 1958, p. 1322; Cordell, 1956, p. 42; Ferguson, 1962; and Sohn, unpub. data) that suggest a tolerance to brackish or hypersaline conditions. Living representatives of the superfamily Bairdiacea are restricted to normal marine waters; fossil representatives are associated with marine fossils. The Kloedenellacea are considered to represent marine environments, although some of the genera may have tolerated brackish-water environments. The collection (USGS loc. 13288) represents an assemblage of animals that lived together as an interrelated community. The presence of small specimens intermixed with large individuals indicates a minimum of sorting and transport. Closely related taxa (species or genera) occupied approximately the same ecologic niche at the same time. The presence of growth stages of five species in four genera in the same collection supports this conclusion. Paulsen (1962, p. 402, 409) described two living species of the benthonic myodocopid ostracode genus *Paraphilomedes* Paulsen, 1962, from the same locality. Although these represent a different ostracode suborder, they support the thesis that two or more closely related species of Ostracoda can coexist in apparently the same ecologic niche.

ORIENTATION

Paraparchites and related genera should be oriented so that the narrower end margin (antiplenate end) is posterior. Some species that were referred to *Paraparchites* have a dorsoposterior spine on one or both valves. These spines were incorrectly interpreted as ocular nodes or eye tubercles, and the valves were oriented with the spines or nodes at the anterior. These spines may be long and tapering as in *Leperditia armstrongiana* Jones and Kirkby, 1886 (=*Shivaella*, n. gen.), in which they extend laterodorsally (Jones and Kirby, 1886, pl. 7, fig. 1b). The broken bases of these spines are preserved on the surface of the shell as tubercles. Dorsoposterior spines are present in the living myodocopid species *Paraphilomedes unicornuta* Paulsen 1962, *P. tricornuta* Paulsen, 1962. The function of such spines is as yet unknown, although Henningsmoen (1965, p. 375–376) suggested that they may serve as buoyancy organs. The posterior position of the spines correlates with the orientation deduced from the position of the adductor muscle scar, which is generally in front of midlength (pl. 7, figs. 24, 26; pl. 8, fig. 43), and also correlates with the position of greatest width in dorsal outline due to dimorphism (pl. 3, figs. 31, 36).

ONTOGENETIC DEVELOPMENT

The presence or absence of dorsoposterior spines is not related to the growth stages in the ontogeny of an individual. Harris and Jobe (1956, p. 6) assumed that spines were present in immature stages and absent in the adult stages of *Paraparchites projectus* Harris and Jobe, 1956. A growth series of *Shivaella suppetia* n. sp., which ranges in greatest length from 0.54 mm to 1.35 mm in adult males and females, shows the dorsoposterior spines in all stages of growth, and a growth series of the associated *Chamishaella brosgei* n. sp., which ranges in greatest length from 0.67 mm to 2.42 mm, consistently does not have any spines; a similar series of the third associated species, *Shishaella williamsae* n. sp., which has a greatest length range of 0.49 mm to 2.18 mm, has a spine on the right valve only.

Adults in one taxon may be smaller than instars of other taxa. The size of eggs differs in ostracode species in the same family, and the first instar is approximately the same size as the egg. Egg sizes and greatest lengths of the adults of some living ostracodes are given in table 1. This table shows that the first instar of *Azygocypridina* sp. is larger than the adults of several other ostracode species. Ostracodes more than 2 mm in greatest length are known from the Paleozoic through the Holocene. Some taxa may reach the large size because of a large growth factor (Sohn, 1950; Anderson, 1964); others, because of a large first instar due to large eggs. I do not know of any study to determine which of the two factors is responsible for the large size (more than 2 mm) of any ostracode species, or whether the size is due to a combination of both factors, but the presence of large individuals does not necessarily mean that the youngest instars had to be very small (less than 0.5 mm).

The presence of small specimens that have spines associated with large specimens that do not have spines does not necessarily indicate that the spines were lost in the ontogeny of the species. It is equally as logical to assume that the small specimens having spines belong to a species that has spines in the adult stage, and that large specimens not having spines had young stages that also did not have spines.

TABLE 1.—*Greatest length of eggs and adults (in mm) in living ostracodes*

	Size of egg	Greatest length of adult
Xestoleberis aurantia (Baird, 1838)[1]	0.10	0.375–0.568
Cyprideis littoralis (Brady, 1869)[1]	.11	.78 – .81
Philomedes globosus (Liljeborg, 1853)[2]	0.49– .56	1.87 –2.32
Vargula hilgendorfi (Müller, 1890)[2]	.30	3.15
Azygocypridina sp.[3]	1.00	7.7

[1] Data from Elofson (1941, p. 361, 378).
[2] Original measurements.
[3] L. S. Kornicker (oral commun., 1967).

DIMORPHISM

Many of the genera assigned to the Paraparchitacea show dimorphism in the adult stage. Scott (1959, p. 673) stated that dimorphism is unknown in *Paraparchites,* but later he suggested (Scott, in Moore, 1961, p. Q180): "Dimorphism in the Paraparchitacea may be represented by a slight enlargement of the posterior half of the carapace." Jones and Kirkby (1886, p. 255) noted that *Leperditia scotoburdigalensis* (Hibbert, 1834) =*Paraparchites, Leperditia okeni* (Münster, 1830) = ?*Shishaella,* and "other species" are present in many localities as both thin and fat specimens. They regarded the thin specimens as males and the fat specimens as females. Chizhova (1960, p. 174, 177) suggested sexual dimorphism in the Lower Carboniferous *Paraparchites ventriosus* Chizhova, 1960=*Shishaella* in which the presumed females have a more convex ventral margin, a smaller greatest length, a shorter hinge margin, and a proportionally greater height and are wider in dorsal outline than the presumed males. *P. humerosus* Ulrich and Bassler, 1906, is dimorphic in being wider in end view near the venter in heteromorphs and narrower in tecnomorphs (pl. 1, figs. 25, 27, 30, 32).

REVERSAL OF OVERLAP

Although reversal of overlap has been used as a criterion to distinguish between ostracode genera, it is not a taxonomic criterion in the Paraparchitacea. *Persansabella* Coryell and Sohn, 1938 (Kloedenellacea), was described as differing from *Sansabella* Roundy, 1926, because of reversal of overlap and hingement. The type-series of *Sansabella amplectens* Roundy, the type-species of *Sansabella,* consists of 50-percent right over left and 50-percent left over right overlap; consequently, *Persansabella* was considered as a synonym of *Sansabella* in the "Treatise on Invertebrate Paleontology" (Sohn, in Moore, 1961, p. Q187). *Antiparaparchites reversus* Coryell and Rogatz, 1932, and *Paraparchites oviformis* Coryell and Rogatz, 1932, were described from the same collection, and I agree with Grachevskiy (1958, p. 1322) that the two taxa are conspecific.

PRESERVATION

Surface texture in Paraparchitacea may not be of taxonomic significance. Punctation, pits, and wrinkles on the surface of specimens in Paraparchitacea are probably due to the vagaries of preservation and subsequent extraction of the specimens. Species in genera in this superfamily have been described as having pits, punctae, or wrinkles, whereas the majority of species have smooth carapaces. The presence or absence of surface inequalities depends on the mode of preservation, and specimens in a single taxon from the same collection may be either smooth or punctate.

PUBLISHED HISTORY OF THE GROUP

Paraparchites was established by Ulrich and Bassler (1906, p. 149) to include the Carboniferous species that had been referred to *Leperditia* Rouault, 1851. Bassler and Kellett (1934, p. 423–431) referred 22 Carboniferous species to *Paraparchites,* not including subspecies; by now more than 100 species have been assigned to this genus. Scott (1959) redescribed the type-species, *P. humerosus* Ulrich and Bassler, 1906, and established the family Paraparchitidae in the superfamily Paraparchitacea. He later (Scott, in Moore, 1961, p. Q193) assigned the Paraparchitacea to the suborder Kloedenellocopina in the order Palaeocopida. During the interval 1906 through 1959, the following related genera were described:

Antiparaparchites Coryell and Rogatz, 1932
Pseudoparaparchites Kellett, 1933
Ardmorea Bradfield, 1935
Coelonella Stewart, 1936
Microcoelonella Coryell and Sohn, 1938
Microparaparchites Croneis and Gale, 1939
Proparaparchites Cooper, 1941
Paraparchitella Cooper, 1946
Samarella Polenova, 1952
Coeloenellina Polenova, 1952
Quasiparaparchites Grachevskiy, 1958
Dorsoobliquella Knüpfer, 1967

Scott (in Moore, 1961, p. Q194) referred all but the last three named genera to the Paraparchitidae. He correctly recognized some of the genera as junior synonyms and reduced the preceding list to the following five genera: *Paraparchites, Paraparchitella, Proparaparchites, Pseudoparaparchites,* and ?*Samarella.*

Scott (in Moore, 1961, p. Q194) did not illustrate *Paraparchitella* Cooper, 1946. His diagnosis "Like *Paraparchites* except that hinge channel is shallow and narrow; greatest width in posterior half; ventral overlap strong," did not agree with Cooper's (1946, p. 121) original conception of this genus. Cooper's description of *Paraparchitella* as having one valve overlapping along the venter and the other valve overlapping along the dorsum fits my diagnosis of the family Rishonidae (Sohn, 1960, p. 76). The type-species *P. ovata* Cooper, 1946, (p. 121, pl. 21, figs. 40–44, misspelled as *P. erata* Cooper n. sp., on p. 20) was recorded as having a length of only 0.65 mm and may represent a juvenile individual. This monotypic genus from the Lower Pennsylvanian of Illinois has not been recognized since its original description; consequently, I tentatively refer this taxon to the Rishonidae? Sohn, 1961. I have previously (Sohn, 1960, p. 80) discussed the Devonian genus *Samarella* Polenova, 1952, under the Rishonidae.

Becker (1964, p. 85) disagreed with my assignment of *Samarella* to the Rishonidae and followed Scott (in Moore, 1961) by referring *Samarella* to the Paraparchitidae?. He (Becker, 1964, p. 85) described two Middle Devonian (Eifelian) species: *S. jubata* Becker, 1964, and *S. laevinodosa* Becker, 1964. Averjanov (1968, p. 274) described and illustrated the Middle Devonian *S. binodosa* and *S. miropolskii*, and Groos (1969, p. 55) illustrated specimens of *S. crassa* Polenova, 1962, from Germany. Because *Samarella* is not present in the Mississippian of Alaska, it is not illustrated or further discussed in this study.

ACKNOWLEDGMENTS

I am grateful to the following for assistance: J. T. Dutro, Jr., and W. P. Brosgé, U.S. Geological Survey, for most of the collections from Alaska. The first collection was given to me by A. L. Bowsher, formerly with the U.S. National Museum. R. W. Harris, University of Oklahoma, loaned the types of *Paraparchites projectus* Harris and Jobe, 1956. Roberta C. Wigder drew the original of figure 2, and Elinor Stromberg drew figures 1 and 3 and composed the plates.

COLLECTION LOCALITIES

USGS Upper Paleozoic loc. No.	*Field No.*	*Description of locality, stratigraphic position, collector, and date*
3167	F–6	Brooks Range, Chandler Lake quadrangle, lat 68°22′30″ N., long 150°28′25″ W., on west slope of ridge east of Nanushuk River valley, 6,200 feet south of southeast corner of Nanushuk Lake. Alapah Limestone, lower part, basal 15 feet of brownish-gray bioclastic limestone, just above brown-weathering zone, 97–113 feet above base of formation; *Lithostrotion* aff. *L. asiaticum* Zone. Collected by A. L. Bowsher, J. T. Dutro, Jr., and C. J. Gudim, July 24, 1949.
11810	50ABe–41	Brooks Range, Chandler Lake quadrangle, lat 68°17′ N., long 152°37′ W., Chandler Lake valley, approximately 10,000 feet S. 85° E. of Astronomical Point on Little Chandler Lake. Composite measured section of Lisburne Group, Alapah Limestone, about 1,300 feet above base; *Goniatites crenistria* Zone. Collected by W. P. Brosgé, 1950.
13288	50ABe–47mf	Brooks Range, same area as USGS loc. 11810. Alapah Limestone, about 205 feet above base; *Lithostrotion* aff. *L. asiaticum* Zone. Collected by W. P. Brosgé, 1950.
5553	....	Fayetteville quadrangle, Sonora 7½-minute quadrangle, Washington County, Ark., Webber Mountain, NW¼NW¼ sec. 4, T. 17 N., R. 29 W., Fayetteville Shale. Collected by R. D. Messler, 1906.

AGE OF THE OSTRACODES

USGS collections 3167 and 13288 are from the foraminiferal assemblage zone 13 of Armstrong, Mamet, and Dutro (1970, p. 691), and USGS collection 11810 is from the next younger zone, 14, in the above classification. The stratigraphic correlation of the Alapah Limestone, the invertebrate fossils other than ostracodes, and the geologic framework of the area were discussed by Bowsher and Dutro (1957), Gordon (1957), and Yochelson and Dutro (1960). Sando, Mamet, and Dutro (1969) synthesized the inferred relationships of the Mississippian faunal zones.

Because the ostracodes are newly described, they cannot now be used to indicate the age of the rocks. Their description, however, makes them usable in future work because, according to the above-mentioned references, the age of the collections that contained the ostracodes is equivalent to middle Visean of the European stages and the middle Meramecian of the mid-continent. They are approximately equivalent to the St. Louis and Ste. Genevieve Limestones.

SYSTEMATIC DESCRIPTIONS

KEY TO THE GENERA

[Those marked with an asterisk are newly described]

1.	No posterodorsal spines	2
1a.	Posterodorsal spines	8

2(1).	Overreach above hingeline	7
2a.	No overreach above hingeline	3
3(2a).	Hinge margin channeled	4
3a.	Hinge margin not channeled	6
4(3).	Ventral overlap broad	*Coelonella*
4a.	Ventral overlap narrow	5
5(4a).	Large, usually more than 1 mm in greatest length	*Paraparchites*
5a.	Small, usually less than 1 mm in greatest length	*Proparaparchites*
6(3a).	Bend along ventral margin	*Quasiparaparchites*
6a.	No bend along ventral margin	*Shemonaella**
7(2).	Dorsal margin strongly convex	*Dorsoobliquella*
7a.	Dorsal margin straight or gently curved	*Chamishaella**
8(1a).	Posterodorsal spine on one valve	*Shishaella**
8a.	Posterodorsal spine on both valves	9
9(8a).	Spines close to dorsal margin, at or near posterior margin	*Pseudoparaparchites*
9a.	Spines below dorsal margin, in front of posterior margin	*Shivaella**

Class OSTRACODA Latreille, 1802

Order PODOCOPIDA Sars, 1866

The conception of this order is as used by me (Sohn, 1961) and not by other paleontologists.

Suborder unknown

Schallreuter (1968, p. 128) assigned the Paraparchitacea to the Platycopina, but the lateral outline, hingement, calcified inner lamella, and adductor muscle-scar pattern negates this assignment.

Superfamily PARAPARCHITACEA Scott, 1959

Emended diagnosis.—Smooth, subovoid, straight-backed, nonsulcate; ventral margin convex; overlap narrow to wide; has ridge and groove hinge, the hinge margin either channeled or with overreach of smaller valve; dorsoposterior spine on one or both valves, or no spines; usually dimorphic in width of posterior or of venter.

Discussion.—Scott's diagnosis (1959, p. 673), "Nonsulcate, nonlobate, nonvelate paleocopes with unequal valves, the larger overlapping the smaller around all or most of the free margin," was based on external morphology. The presence of a calcified inner lamella indicates podocopid affinities. The adductor muscle-scar pattern (fig. 2; pl. 5, figs. 18, 33, 35, 37, 39; pl. 7, figs. 21, 24–27, 33) suggests affinities in the Podocopida with the Cypridacea rather than the Cytheracea.

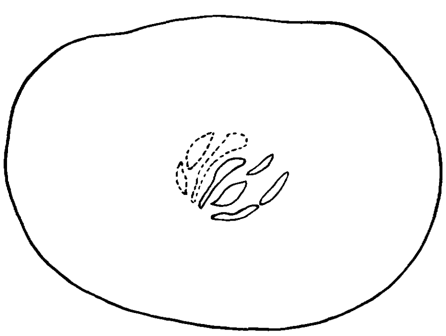

FIGURE 2.—Muscle-scar pattern of the inside left valve of *Shishaella marathonensis* (Hamilton, 1942). Permian, Glass Mountains, Tex. Figured specimen, USNM 168099. × 27.

Robinson (1969, pl. 3, figs. 3, 4) illustrated similar muscle scars in a left valve of *Paraparchites* sp. from the Lower Limestone Shales (Tournaisian) in the Forest of Dean, and in a right valve of *Paraparchites* cf. *P. inornatus* (McCoy, 1844) from the Scremerston Coal Group (Visean) in Warksburn, Northumberland, both in Great Britain. Because the complete specimens of both were neither described nor illustrated by Robinson, I do not know to which genera they belong in the present study. Bless (1967, p. 121–123, figs. 34, 35) described and illustrated a rounded compound adductor muscle scar of *Paraparchites cantelii* Bless, 1967, from the Westphalian D (Middle Pennsylvanian) of Spain; it consists of about 50 individual flecks roughly resembling those of *Chamishaella* illustrated on plate 5, figures 33, 35, 39, except that Bless neither mentioned nor illustrated the dorsoanterior knob and the accessory scars found in the Mississippian specimens. Although Bless stated that *P. cantelii* has a channeled hinge, he did not indicate whether or not the species has a dorsal overreach; consequently, the species cannot be assigned to *Chamishaella*.

Family PARAPARCHITIDAE Scott, 1959

Scott's original definition (1959, p. 673):

> Nonsulcate, nonlobate, nonvelate, smooth to punctate ostracodes with posterodorsal spine sometimes present; the dorsum is straight to gently convex; the valves are unequal with the larger valve overlapping the smaller one along the free margin, the valves are subovate to elongate-ovate with the ends broadly rounded; the hinge commissure is straight or interrupted at ends by faint to moderately strong posterior and anterior cardinal indentations where the overlap begins; one valve may slightly overreach the other dorsally, but dorsal shoulders are of equal height; Dev.–Permian.

This diagnosis was based on the external morphology. In this paper the family diagnosis is considered to be the same as the diagnosis of the superfamily. The group is probably polyphyletic, and future study may disclose that the genera assigned to the Paraparchitidae belong to more than one family.

Genus PARAPARCHITES Ulrich and Bassler, 1906, emend. Scott, 1959

Paraparchites Ulrich and Bassler, 1906, U.S. Natl. Mus. Proc., v. 30, p. 149; Scott, 1959, Jour. Paleontology, v. 33, no. 4, p. 673.

Antiparaparchites Coryell and Rogatz, 1932, Am. Midland Naturalist, v. 13, no. 6, p. 387. Based on reversal of overlap.

Ardmorea Bradfield, 1935, Bull. Am. Paleontology, v. 22, no. 73, p. 138. Based on steinkern.

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Microcoelonella Coryell and Sohn, 1938, Jour. Paleontology, v. 12, no. 6, p. 597. Based on a juvenile.

?*Cyathus* Roth and Skinner, 1930. Cooper, 1941, Illinois State Geol. Survey Rept. Inv. 77, p. 61.

Type-species (original designation).—*P. humerosus* Ulrich and Bassler, 1906, U.S. Natl. Mus. Proc., v. 30, p. 151, pl. 11, figs. 1–4. Scott, 1959, Jour. Paleontology, v. 33, p. 673, pl. 87, figs. 1–7. Scott, in Moore, 1961, p. Q193, fig. 135, text-figs. la–f. Lower Permian, Manhattan, Kans.

Diagnosis.—Lateral outline ovate to elongated-ovate; ends broadly rounded; dorsal margin usually straight, occasionally gently convex; dorsum incised without significant overreach; overlap along free margins narrow, there being no significant overlap; hinge simple; dimorphic in width; reversal of overlap known; surface smooth, without dorsal spines.

Discussion.—The above diagnosis is modified from Scott (1959; in Moore, 1961). All species previously assigned to *Paraparchites* that have spines and (or) a pronounced overreach along the dorsal or overlap along the ventral margins are excluded from this genus. The muscle-scar pattern in this genus is cyprid.

Antiparaparchites reversus Coryell and Rogatz, 1932, from the Arroyo Formation (Permian) of Texas, the type-species of *Antiparaparchites,* was described as having the overlap reversed from *Paraparchites. Paraparchites oviformis* Coryell and Rogatz, 1932, was described from the same collections. Coryell and Rogatz (1932, p. 387) referred *P. oviformis* to their plate 35, figures 1 and 2, and *A. reversus* to their plate 35, figures 3 and 4. Because of a typographical error, the plate on which the specimens are illustrated is numbered 34. The numbering of the illustrations is also reversed; figures 1 and 2 are given as the right and left valve of *Paraparchites oviformis* (p. 394); they are actually the left and right valves (the left overlaps the right along the free margins) of *Antiparaparchites.* Figures 3 and 4, which are described as left and right valves of *Antiparaparchites reversus,* represent the right and left valves of *Paraparchites.* The sizes of the two types confirm this: the length of *P. oviformis* is given as 0.95 mm (p. 387) and the length of *A. reversus* as 1.17 mm (p. 388). All the illustrations on plate 34 are stated to be $\times$ 45, and figures 1 and 2 are larger than figures 3 and 4; figure 1 measures 47 mm, and figure 3 measures 39 mm. The topotypes illustrated here (pl. 2, figs. 7–10, 13–15) have the same relative sizes; *A. reversus* is larger than *P. oviformis.*

The topotypes are slightly abraded carapaces; however, it is not possible to determine from the drawings of the types whether they also are slightly abraded. Scott (in Moore, 1961, p. Q193) illustrated two views of *P. reversus* (Coryell and Rogatz) as figures 135, text figures 1g and 1h, and labeled them as left and right valves, respectively. The illustrations are of *P. oviformis* and are right and left views, respectively. Kellett (1937) correctly stated that reversal of overlap in this group is not generically or specifically significant. The two species described from the Arroyo Formation of Texas by Coryell and Rogatz (1932) are synonyms and are referred to *P. texanus* Delo, 1930.

Only two additional species were described in *Antiparaparchites*: *A.*? *oblongus* Coryell and Rozanski, 1942, and *A. wabashensis* Payne, 1937. *A.*? *oblongus* is based on a steinkern of an indeterminable genus, and *A. wabashensis* belongs to *Sansabella* Roundy, 1926.

Ardmorea Bradfield, 1935, is monotypic and based on *A. symmetrica* Bradfield, 1935 (p. 138, pl. 13, figs. 6a, b), from the Devils Kitchen Member of Tomlinson (1928) of the Deese Formation (Pennsylvanian) of Oklahoma. I have examined the holotype and determined it to be a steinkern of *Paraparchites.*

Scott (1959, p. 673) referred *Coelonella* Stewart, 1936, to *Paraparchites* as a junior synonym. Stewart (1936, p. 742, 743) referred two species to *Coelonella*: the type-species, *Isochilina*? *scapha* Stewart, 1930, and the newly described *Coelonella plana* Stewart, 1936, both from the Silica Shale (Middle Devonian), Lucas County, Ohio. I am grateful to Mr. J. J. Burke, curator of the museum at the Ohio State University, for lending me the types and illustrated specimens of *Coelonella.* Additional specimens from the Silica Shale at the U.S. National Museum and topotypes collected by Mrs. Ruth E. Chilman, Detroit, Mich., were examined, and some were sectioned. On the basis of all the material available to me, I conclude that the type-species, *Isochilina*? *scapha* Stewart, 1930, is not congeneric with *Paraparchites* and does not belong to the same family as *Paraparchites.*

Přibyl (1955, p. 280) considered *Coelonella* as a subgenus of *Sansabella* Roundy, 1926. On the basis of the hinge structures of *Sansabella* and *Coelonella,* the two genera are not related, and each belongs to a different family.

The Devonian genus *Coeloenellina* Polenova, 1952, described from the U.S.S.R., is not considered in this study because specimens are not available. A discussion of this genus is in Polenova (1968, p. 10).

The type-species of *Microcoelonella* is *M. scanta* Coryell and Sohn, 1938, from the Reynolds Limestone of the Bluefield Group in the Mauch Chunk Series of Price, Heck, Tilton, and Wells (1939) (Upper Mississippian) of West Virginia. The holotype is probably a juvenile, and both the species and genus are considered nomina dubia until additional material is studied. Species not considered in this study because of the unavailability of original specimens are: The Devonian *Microcoelonella optata* Polenova, 1955, and *M. orthocornis* Rozhdestvenskaja, 1959 (misspelled *Microcoeloenella*); the Mississippian *M. symmetrica* Scott, 1942, *M. scantiformis* Buschmina, 1968, and *M. podiakovoensis* Buschmina, 1968; and the Permian *M. longula* Chen, 1958.

Cyathus Roth and Skinner, 1930, was based on a single carapace of *C. ulrichi* Roth and Skinner, 1930 (p. 347, pl. 28, figs. 5–8), from the McCoy Formation (Pennsylvanian) of Colorado. The holotype (USNM 103027) is a steinkern probably of an indeterminable kirkbyid. *C. vetustus* Cooper, 1941 (p. 61, pl. 13, figs. 9, 10), from the Paint Creek Formation (Mississippian) is probably a *Paraparchites*.

Dimorphism in *Paraparchites* is a vexing problem. Briefly, the following opinions have been recorded. In their discussion of *Leperditia scotoburdigalensis* (Hibbert, 1836), originally described as *Cypris*=*Paraparchites*, Jones and Kirkby (1886, p. 255) stated:

> In many localities where this species occurs there are both thin and fat specimens, as in the case of *Leperditia Okeni* and other species; the former we regard as probably males, the latter as females, similar differences of carapace being well known to mark the sexes in many cases among recent Ostracoda.

They illustrated on their plate 7, figures 4a, b, a specimen from the Calciferous Sandstones in left and dorsal views, but it is not certain from the illustrations whether the greatest width is at the midheight or near the ventral margin. The dorsal outline (fig. 4b) is of a carapace whose greatest width is at the approximate midlength and which tapers about equally toward both ends. Scott (1959, p. 673), in his revised generic description of *Paraparchites*, stated that dimorphism is unknown.

The type-series of *P. humerosus* illustrated by Scott consists of: the lectotype, which has a wider cross section near the ventral margin and represents a female (see this report, pl. 1, figs. 26–28); two right valves of adults that are also females, one of which is reillustrated (pl. 1, figs. 24, 25); and three preadult specimens whose narrow ventral margin in cross section is similar to the cross section of a carapace (pl. 2, fig. 17) having a greatest length of 1.7 mm. Among the unillustrated paratypes is a broken right valve that was probably 2 mm in greatest length and therefore an adult. This specimen, illustrated on plate 1, figures 29 and 30, is narrow near the venter and probably represents a male. I do not know whether all the species in the genus show a similar dimorphism, because most of the described species were not illustrated in end view. For this reason the statement in the diagnosis, "dimorphic in width," does not specify whether it is width of posterior or near venter.

Although the Devonian genus *Coelonella* Stewart, 1936, is not considered to be a synonym of *Paraparchites*, plate 2, figure 16, shows a typically paraparchitid cross section of *Paraparchites* sp. from the Manlius Limestone of New York.

Stratigraphic range.—Devonian–Permian.

Paraparchites humerosus Ulrich and Bassler, 1906, emend. Scott, 1959

Plate 1, figures 24–32; plate 2, figure 17

Paraparchites humerosus Ulrich and Bassler, 1906 [part], U.S. Natl. Mus. Proc., v. 30, p. 151, pl. 11, figs. 1–4. "Elendale" Formation, Manhattan, Kans.

Scott, 1959, Jour. Paleontology, v. 33, no. 4, p. 671–673, pl. 87, figs. 1–7. Restudy of the types.

[not] *Paraparchites humerosus* Ulrich and Bassler. Delo, 1931, Washington Univ. (St. Louis) Studies, new ser., Sci. and Technology, no. 5, p. 42, pl. 4, fig. 1. Pennsylvanian, well in Hamilton County, Kans. Misidentification.

[not] *Paraparchites humerosus* Ulrich and Bassler. Kellett, 1933, Jour. Paleontology, v. 7, no. 1, p. 64, pl. 13, figs. 1–12. Upper Pennsylvanian and Permian of Kansas. =*P. kellettae*, n. sp.

[not] *Paraparchites humerosus kansasensis* Harris and Lalicker, 1932, Am. Midland Naturalist, v. 13, no. 6, p. 396, pl. 36, figs. 1a, b. Wreford Limestone, Cowley County, Kans. =*P. kansasensis* Harris and Lalicker, 1932.

[not] *Paraparchites humerosus spinosus* Upson, 1933, Nebraska Geol. Survey Bull. 8, 2d ser., p. 12, pl. 1, figs. 2a, b. Shale 1 foot above base of Funston Limestone, Hooser, Kans. =?*P. kansasensis* Harris and Lalicker, 1932.

[not] *Paraparchites humerosus texana* Delo, 1930, Jour. Paleontology, v. 4, no. 2, p. 153, pl. 12, fig. 1. Probably Permian, well in Menard County, Tex. =*Paraparchites texanus* Delo, 1930.

Discussion.—See Scott (1959) for description and illustrations of this species and designation of the lectotype. This species was discussed herein under the genus. Delo's specimen of this species (see preceding synonymy) is, as indicated by Kellett (1933,

p. 65), not conspecific with the type. Because the specimen is not available for examination, its affinities are not discussed.

Ulrich and Bassler (1906, p. 151) stated that this species is "abundant in the Elendale Formation, Manhattan, Kansas, and in yellow shales of the Wreford limestone, 6 miles west of Reece, Kansas." The cotypes (USNM 35627) are labeled "Elendale," a name not listed in the literature and undoubtedly an error for the Elmdale Shale. "Elmdale" is an abandoned name for a shale overlying the Americus Limestone, the basal member of the Foraker Limestone of the Council Grove Group. A single specimen, a crushed valve on yellow shale (USNM 35657), is from the Wreford Limestone, 6 miles west of Reece, Kans. This specimen has the same lateral outline as *P. humerosus* var. *spinosus* Upson, 1933, which I questionably refer to *P. kansasensis* Harris and Lalicker, 1932.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Paralectotype (pl. 1, figs. 24, 25)	2.04	1.33	0.64
Lectotype (pl. 1, figs. 26–28)	1.90	1.30	1.08
Paralectotype (pl. 1, figs. 29, 30)	Broken	1.17	0.58
Paralectotype (pl. 1, figs. 31, 32)	1.75	1.15	0.91

Stratigraphic range.—Lower Permian, "Elmdale Shale" (=Foraker Limestone).

Geographic distribution.—Manhattan, Kans.

Paraparchites kellettae Sohn, n. sp.

Plate 2, figures 11, 12

Paraparchites humerosus Ulrich and Bassler. Kellett, 1933, Jour. Paleontology, v. 7, no. 1, p. 64, pl. 13, figs. 1–12.

?*Paraparchites oviformis* Coryell and Rogatz. Upson, 1933, Nebraska Geol. Survey Bull. 8, 2d ser., p. 13, pl. 1, figs. 3a, b. Shale in Kinney Limestone Member, Matfield Shale, Gage County, Nebr.

Name.—In honor of Betty Kellett (Mrs. E. H. Nadeau).

Holotype.—USNM 85423.

Paratypes.—A growth series of seven additional specimens on the same slide.

Type-locality.—Kellett's (1933, p. 106) locality 45, U.S. Highway 40 opposite cemetery, Fort Riley, Geary County, Kans.

Type-level.—Fort Riley Limestone, Chase Group, Permian.

Diagnosis.—End margins unequal, posterior narrower; ventral margin curved.

Discussion.—Kellett adequately described and illustrated an ontogenetic series of this species. Scott (1959, p. 672) correctly noted that the orientation of Kellett's specimens should be reversed 180°. The original of Kellett's illustration (1933, pl. 13, figs. 1, 8) is reillustrated (pl. 2, figs. 11, 12) as the holotype; her remaining seven specimens (USNM 85423) are here designated as paratypes. Upson (1933) illustrated a specimen as *P. oviformis* Coryell and Rogatz that appears to be more closely related to this species than to *P. texanus* Delo, 1930.

Stratigraphic range.—Upper Pennsylvanian(?) and Lower Permian.

Geographic distribution.—Chase, Geary, Lyon,and Wabaunsee Counties, Kans., and Gage County, Nebr.

Paraparchites texanus Delo, 1930

Plate 2, figures 1, 2, 7–10, 13–15

Paraparchites humerosus var. *texana* Delo, 1930, Jour. Paleontology, v. 4, no. 2, p. 153, pl. 12, fig. 1. Probably Permian, well in Menard County, Tex.

Paraparchites oviformis Coryell and Rogatz, 1932, Am. Midland Naturalist, v. 13, p. 387, pl. 35, figs. 1, 2=pl. 34, figs. 3, 4. Arroyo Formation, Tom Green County, Tex.

Antiparaparchites reversus Coryell and Rogatz, 1932, Am. Midland Naturalist, v. 13, p. 388, pl. 35, figs. 3, 4=pl. 34, figs. 1, 2. Same collection as above.

[not] *Paraparchites oviformis* Coryell and Rogatz. Upson, 1933, Nebraska Geol. Survey Bull. 8, 2d ser., p. 13, pl. 1, figs. 3a, b. =?*Paraparchites kellettae* Sohn, n. sp.

Diagnosis.—Greatest height at anterior cardinal angle; ventral margin truncated upwards from that point.

Discussion.—Topotypes of *Paraparchites oviformis* and *Antiparaparchites reversus* cannot be distinguished from the holotype of *P. texanus*. These two species are discussed under the genus.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Holotype (pl. 2, figs. 1, 2)	0.96	0.70	.049
Topotype (pl. 2, figs. 7–10)	1.07	.78	.48
Topotype (pl. 2, figs. 13–15)	.85	.65	.42

Stratigraphic range.—Permian(?), C. Cromwell, Winslow 1 well, 600–620 feet; Permian, Arroyo Formation.

Geographic distribution.—Menard and Tom Green Counties, Tex.

Genus SHIVAELLA Sohn, n. gen.

Name.—The name *Shivaella* is feminine.

Type-species.—*Shivaella suppetia* Sohn, n. sp.

Diagnosis.—Dorsoposterior spines on both valves; lacks a flattened dorsoposterior area that extends laterally from the slightly incised hingeline.

Description.—The carapace is approximately 1 mm or larger in greatest length; the dorsal margin is straight. The hingeline is slightly incised but lacks any significant overreach of either valve, and the free margins are curved. The dorsoposterior spines are symmetrical in position on both valves. Both valves are equally curved from the dorsal margin to the ventral margin; consequently, the bases of the spines are removed from the hingeline. The hinge of the right valve consists of a groove into which the left valve fits, and the left valve overlaps the right along the free margins. The amount of overlap varies with species; some have an incised contact margin, while others have a normal overlap of the left valve over the right. A narrow calcified inner lamella can be seen in silicified valves and on steinkerns. Details of the muscle-scar pattern were not discerned.

Discussion.—The first species to be described that belongs to *Shivaella* was *Leperditia armstrongiana* Jones and Kirkby, 1886, from the Carboniferous Limestone Series of Great Britain. They illustrated two specimens (1886, p. 253, pl. 7, figs. 1a, b): a left (right) valve from Storr Moss, Lancashire, England (fig. 1a), and the dorsal view of a cast from Law Quarry, Ayrshire, Scotland (fig. 1b). The steinkern clearly shows on both ends the grooves made by the calcified part of the inner lamella. Jones and Kirkby stated (1886, p. 254): "The spines * * * are stout at the base, of considerable length, and tapering to a fine point; they are directed outward, upward and rather forward [backward]. In casts * * * the spines are about one third of the valve length." Most of the specimens on hand have rather stubby spines, but I have seen one carapace that has long curved tapering spines that practically touched each other behind the carapace. I have no basis for interpreting the function of the spines in this genus or in the other genera discussed in this paper.

That this genus is dimorphic in width of posterior is shown by a growth series of the type-species.

In addition to the species discussed or illustrated in this study, the following described species should be referred to *Shivaella*:

Paraparchites armstrongianus (Jones and Kirkby). Pozner, 1951, p. 23, pl. 1, fig. 7=*Shivaella* sp. because of more subcircular lateral outline.
- *bucerus* Kummerow, 1953, p. 11, pl. 1, fig. 2.
- *carbonarius* (Hall). Gorak, 1967, p. 46, pl. 25, figs. 4a–c =*S.* sp.
- *longa* Chizhova, 1960, p. 175, pl. 3, figs. 2–4.
- *magnus* Kellett, 1933, v. 7, no. 1, p. 65, pl. 13, figs. 13, 23, 38, 39.

Leperditia microphthalma Eichwald, 1860, p. 1336, pl. 53, fig. 7.

Paraparchites oblongus Coryell and Sample, 1932, p. 250, pl. 24, fig. 3=*Shivaella*? *brazoensis* (Coryell and Sample, 1932).
- *palopintoensis* Coryell and Sample, 1932, p. 248, pl. 24, fig. 4=*Shivaella*? *brazoensis* (Coryell and Sample, 1932).
- *papillatus* Ershova, 1968, p. 88, pl. 1, figs. 1a, b.
- *pinguis* Green, 1963, p. 126, pl. 8, figs. 1–7.
- *quasiporrectus* Buschmina, 1968, p. 30, pl. 3, figs. 1, 2.

Quasiparaparchites redaevkensis Grachevskiy, 1958, p. 1324, text figs. 2a–d.

Cythere spinigera McCoy, 1844, p. 168, pl. 23, fig. 23.

?*Micrococlonella*? *tuberculata* Robinson, 1959, p. 443, text fig. 2, figs. 3a–c. The reasons for questioning this assignment are the reversed overlap, rounded cardinal angles, and elongated lateral outline.

Stratigraphic range.—Mississippian–Pennsylvanian.

Shivaella suppetia Sohn, n. sp.

Plate 3, figures 1–38

Name.—*Suppetia*, Latin for help.

Holotype.—USNM 168004.

Paratypes.—USNM 167995–168003.

Material.—More than 75 carapaces in various stages of growth.

Type-locality.—Top of ridge east of Little Chandler Lake, Brooks Range, Alaska.

Type-level.—Platy limestone member of the Alapah Limestone, 200 feet above the base of the limestone (USGS loc. 13288).

Diagnosis.—Posterodorsal spines more than one-quarter the greatest length in from posterior margin and about one-eighth the greatest length down from dorsal contact; dorsal outline subelliptical; greatest width slightly behind midlength.

Description.—The lateral outline is subovate; the dorsal margin is straight; the anterior margin is curved, and it extends farther forward than the narrower curved posterior margin extends backward. The cardinal angles are approximately equal. The ventral margin is convex; the greatest height is slightly behind a line drawn perpendicular to the dorsal margin at the anterior cardinal angle. The venter is incised, the result being a narrow overlap of the left valve over the right. The hingeline is incised, the grooved hinge of the right valve overlapping the dorsal edge of the left. The spines are about twice as far in from the posterior margins as down from the dorsal margin. Dimorphism is shown in width of posterior in dorsal view. Presumed heteromorphs have a wider posterior and also are slightly wider near the venter in end view.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Paratype (pl. 3, figs. 1–5)	0.54	0.40	0.37
Paratype (pl. 3, figs. 6–10)	.65	.48	.40
Paratype (pl. 3, figs. 11–15)	.85	.61	.53

	Greatest length	Greatest height	Greatest width
Paratype (pl. 3, figs. 16–20)	1.04	0.75	0.67
Paratype (pl. 3, figs. 21–25)	1.03	.76	.63
Paratype (pl. 3, figs. 26–28)	1.03	.76	.65
Holotype (pl. 3, figs. 29–33)	1.35	.99	.76
Paratype (pl. 3, figs. 34–38)	1.31	1.04	.82

Discussion.—The presence of spines in all stages of growth indicates that in this species spines are not associated with sex or maturation. Finding of this growth series helped clarify the relationship of the genera in the Paraparchitacea, hence the specific name. *S. suppetia* has spines closer to the dorsal margin and has a narrower anterior in dorsal outline than *S. pingue* (Green, 1963). *S. pingue* (Green, 1963) (Lower Mississippian), and the new species *S. mertiei* (Upper Mississippian) have an incised venter in common with *S. suppetia;* this feature may prove to be diagnostic of the Mississippian. I am not segregating this group into a separate supraspecific category because this feature was not discussed or illustrated in the descriptions of many of the other species that I refer to *Shivaella.*

Age.—Upper Mississippian (Meramecian).

Distribution.—In addition to the type-locality a few representatives of this species were found at USGS locality 11810.

Shivaella mertiei Sohn, n. sp.

Plate 4, figures 17–27

Name.—In honor of J. B. Mertie, Jr., U.S. Geological Survey.

Holotype.—USNM 168032.

Paratypes.—USNM 168025–168031.

Material.—Four silicified carapaces and 26 silicified valves in various stages of growth.

Type-locality.—West slope of ridge, east of Nanushuk Valley, 6,200 feet south of southeast corner of Nanushuk Lake, Brooks Range, Alaska, USNM locality 3167.

Type-level.—Alapah Limestone, 312 feet above base, from basal 15 feet of brown-gray bioclastic limestone, just above brown-weathering zone.

Diagnosis.—Differs from *S. suppetia* n. sp. in having a straighter ventral margin, a more obtuse anterior cardinal angle, in being narrower near the venter, and in having the spines slightly closer to the dorsal margin.

Description.—The lateral outline is subovate; the dorsal margin is straight; and the anterior margin is gently curved in the upper part and more convex in the lower part so that the bend in curvature is at or slightly below midheight. The posterior margin is curved, about half as broad as the anterior margin, and joins the ventral margin at about midheight. The ventral margin is gently curved; the greatest height is slightly in front of a line drawn perpendicular to the dorsal margin at the anterior cardinal angle. The venter is incised, but the valves are not so wide near the venter as those of *S. suppetia.* The spines are about three times as far in from the posterior margin as down from the dorsal margin.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Paratype (pl. 4, figs. 19, 20)	0.60	0.45	0.20
Paratype (pl. 4, fig. 18)	.96	.77	.37
Paratype (pl. 4, fig. 17)	1.20	.91	.41
Paratype (pl. 4, figs. 21–24)	1.58	1.20	.89
Paratype (pl. 4, fig. 25)	1.61	1.20	.45
Paratype (pl. 4, fig. 27)	1.78	1.29	.89
Holotype (pl. 4, fig. 26)	1.99	1.45	.55

Discussion.—Single valves have a narrow calcified inner lamella and show the tongue and groove hingement typical of the group. Dimorphism could not be determined in this species, possibly because of insufficient material.

Stratigraphic range.—Visean, lower Meramecian.

Geographic distribution.—Brooks Range, Alaska.

Shivaella nicklesi (Ulrich, 1891)

Plate 4, figures 1–16

Leperditia nicklesi Ulrich, 1891, Jour. Cincinnati Soc. Nat. History, v. 13, p. 200, pl. 18, figs. 1a–e. See "Discussion" for locality and age.

Paraparchites nicklesi (Ulrich). Harlton, 1929, Am. Jour. Sci., 5th ser., v. 18, p. 255, pl. 1, fig. 1. Fayetteville Shale, Girty's type-locality, railroad cut at Fayetteville, Ark.

[not] *P. nicklesi* (Ulrich). Girty, 1911, U.S. Geol. Survey Bull. 439, p. 105, pl. 9, figs. 2–5=*Shishaella* sp.

[not] *P. nicklesi* (Ulrich). Croneis, 1930, Arkansas Geol. Survey Bull. 3, p. 61, pl. 15, fig. 11=*Shishaella cyclopea* (Girty, 1910).

[not] *P. nicklesi* (Ulrich). Morey, 1935, Jour. Paleontology, v. 9, no. 4, p. 317, pl. 28, fig. 26=genus and species indet.

[not] *P. nicklesi* (Ulrich). Morey, 1936, Jour. Paleontology, v. 10, no. 2, p. 115, pl. 17, fig. 26=*Shishaella* sp.

[not] *P. nicklesi* (Ulrich). McLaughlin and Simons, 1951, Jour. Paleontology, v. 25, p. 517, pl. 76, figs. 9, 10=*Pseudoparaparchites dornickhillicus* (Bradfield, 1935).

[not] *P. nicklesi* (Ulrich). Green, 1963, Research Council Alberta Bull. 11, p. 127, pl. 8, figs. 10, 11=*Shishaella* sp.

Paraparchites projectus Harris and Jobe, 1956 [part], Oklahoma Geol. Survey Circ. 39, p. 6, pl. 1, figs. 7a–d (not fig. 6, holotype=*Shishaella cyclopea* (Girty, 1910)). "Manning" horizon (Chester equivalent), Major County, Okla.

Diagnosis.—Differs from all other species here assigned to *Shivaella* in that the greatest height is at or slightly in front of midlength, and that the spine is somewhat more removed from the posterior than from the dorsal margins.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Topotype (pl. 4, figs. 1–5)	0.81	0.62	0.41
Lectotype (pl. 4, figs. 10–12)	1.61	1.16	.54
Hypotype (pl. 4, figs. 13–16)	1.77	1.18	.75

Discussion.—A slide (USNM 41844) is labeled "Cotypes, *Leperditia nicklesi* Ulrich, Chester, Grayson Springs Station, Ky." The entry for that number in the U.S. National Museum catalogue is dated August 25, 1902, and lists five specimens, cotypes figured by Ulrich (1891, pl. 18, figs. 1a–e). In the original publication (Ulrich, 1891, p. 200), however, the locality was cited as "Warsaw beds of St. Louis group, Columbia, Monroe Co., Ill." Because the slide labeled "Cotypes" contains five specimens, including a right valve that was the original of Ulrich's figure 1a, the conception of the species has to be based on these specimens. I therefore designate that specimen—USNM 41844A (pl. 4, figs. 10–12)—as the lectotype and the remaining four specimens—three right valves, one of which is broken, and a smaller left valve—as paralectotypes. Some 2 ounces labeled "Washings, Chester gr. 1/4 mil. E. Grayson Springs, Ky." in the U.S. National Museum was searched, and a complete carapace of a young growth stage having the two spines was recovered. This specimen, probably a topotype, is illustrated (pl. 4, figs. 1–5).

Girty (1911, p. 105) commented that the specimens from the Moorefield Shale, Arkansas, which he identified as *Paraparchites nicklesi*, had the spine on the left [right] valve, but the spine was not seen on the numerous right [left] valves that he examined. Girty's specimens probably belong to *Shishaella*.

Morey (1935, p. 317) reported three specimens from the basal Mississippian of Missouri. Two of these did not have a spine; the third, a right valve, had a spine. The illustrated specimen does not have the same lateral outline as Ulrich's specimens, and the spine is not discernible on the illustration. I do not know to which genus Morey's specimens belong. The following year he (Morey, 1936, p. 115) illustrated the only specimen, a right valve, from the lower part of the Chouteau Limestone, Missouri, as *P. nicklesi*. He noted that the position of the spine was farther from the anterior [posterior] than most individuals of this species. This specimen is not conspecific with Ulrich's specimens, and its generic affinities are undeterminable. As can be seen on the probable topotype and Harlton's hypotype (pl. 4, figs. 13–16), the venter is not incised in this species.

Stratigraphic range.—Chester Series (Upper Mississippian).

Genus CHAMISHAELLA Sohn, n. gen.

Name.—The name *Chamishaella* is feminine.

Type-species.—*Chamishaella brosgei* Sohn, n. sp.

Diagnosis.—Paraparchitidae lacking dorsoposterior spines and having an overreach of smaller valve along hingeline.

Description.—The carapace is large, smooth, and subovate in lateral outline. One valve overlaps slightly along the free margins; the other overreaches along the dorsal margin. The subcentral adductor muscle scar apparently consists of a circular rosette of small individual scars. The calcified inner lamella is of approximately the same width around the free margins. Dimorphism is shown in width near the venter in end view.

Discussion.—The shell of this genus is relatively thick, and the carapace may be more than 2 mm in greatest length. In addition to the type species, the following species probably belong to *Chamishaella*:

Paraparchites auriculatus Pozner, 1951, p. 24, pl. 1, fig. 6.
carbonarius (Hall), emend. Whitfield, 1882, p. 94, pl. 9, figs. 24–27.
disjunctus Morey, 1935, p. 317, pl. 28, figs. 9, 13.
?*P. emaciatus* Scott, 1942, p. 153, pl. 25, fig. 1. This species may belong to *Sansabella* Roundy, 1926.
P. inornatus (McCoy). Gorak, 1964, p. 188, pl. 4, figs. 1a, b, 2a, b=*C.* n. sp. aff. *C. disjuncta* (Morey, 1935).
suborbiculatus (Münster). Pozner. 1951, p. 22, pl. 1, figs. 2–5=*C.* n. sp.
tumidus Kummerow, 1939, p. 12, figs. 4a–d.

Stratigraphic range.—Mississippian (Tournaisian through Visean, Lower Namurian(?)).

Chamishaella aenigmatica Sohn, n. sp.

Plate 5, figures 1–21, 23–26

Name.—*Aenigma*, puzzling.

Holotype.—USNM 168052.

Paratypes.—USNM 168045–168051.

Material.—Fifteen carapaces, well to poorly preserved.

Type-locality.—USGS locality 13288.

Type-level.—Platy limestone member of the Alapah Limestone, 200 feet above the base.

Diagnosis.—Has distinct cardinal angles; overlapping valve invaginated at dorsum; distinct rim along free margins of overlapped valve, and shallow grooves subparallel to dorsal part of end margins.

Description.—The valves are subovate and have straight dorsal and convex ventral margins. The ends are rounded and truncated near the cardinal angles. The greatest convexity of anterior margin is at or below midheight; of posterior margin, above midheight. Shallow grooves, which vary in depth with individuals, extend downward from the dorsal margin subparallel to the truncated parts of the end margins. The overlapping valve abuts against a thin ridge on the smaller valve along the free margins and has a downward bend along the dorsum so that the hinge line is invaginated. The smaller valve overreaches along the dorsum.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Paratype (pl. 5, figs. 1, 2)	0.91	0.64	0.45
Paratype (pl. 5, figs. 3–7)	1.20	.85	.60
Paratype (pl. 5, figs. 8–12)	1.42	1.07	.76
Paratype (pl. 5, figs. 13–17)	1.76	1.22	.79
Paratype (pl. 5, figs. 18, 19)	1.76	1.42	.75+
Holotype (pl. 5, figs. 20, 21)	1.80	1.31+	.99
Paratype (pl. 5, figs. 23–26)	2.15	1.40+	1.06

Discussion.—Because of the apparent channeled dorsum, I had difficulty in the generic assignment of this species. The difference between the invaginated dorsum of this species and of species here assigned to *Paraparchites* is: the invagination in *C. aenigmatica* is caused by a bend in the overlapping valve, and the dorsal margin overreaches and then joins the groove at the hingeline, whereas both valves in species of *Paraparchites* are of equal height along the dorsal margin and contribute equally in the formation of the channeled dorsum. The grooves subparallel to the end margins at the cardinal angles vary in expression with individuals; on one paratype (pl. 5, figs. 23–26) they extend downward and join subparallel to the ventral margin so that the groove known in *Conchoprimitia* Öpik, 1935, is duplicated. I do not consider this groove to be of morphological significance in *Chamishaella*. It is either a preservation phenomenon or the result of temporary retention of the valve of the previous instar after molting, as illustrated by Cooper (1945, pl. 57, figs. 7–12, 31–36). Figure 3 demonstrates the plausibility of the retention of instar interpretation.

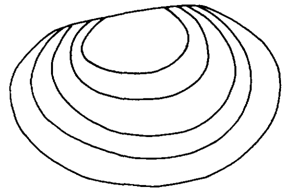

FIGURE 3.—Outline of grooves of *Chamishaella aenigmatica* n. sp. (× 20). This drawing is a composite of the groove on the specimen shown on plate 5, figure 1, superposed on the grooves of the specimens shown in figures 3, 10, and 20, and on the lateral outline of the right valve of the specimen shown in figure 20.

One specimen of *C. brosgei* has a vaguely outlined similar groove on the right valve (pl. 6, fig. 13), but that species is readily distinguished from *C. aenigmatica* by more elongated lateral outline and absence of the incised dorsum. Buschmina (1968, p. 37, pl. 4, figs. 1, 2) illustrated the late Tournaisian new species *Paraschmidtella*? *belsuensis* that also has a groove subparallel to the free margins. Buschmina differentiated her species from *P. dorsopunctata* Swartz, 1936, the type-species of the Ordovician-Devonian genus, on the lateral outline, lack of surface pores, and presence of the subconcentric groove. *P. belsuensis* Buschmina, 1968, does not have a channeled hinge and probably belongs to *Chamishaella*.

Stratigraphic range.—Upper Mississippian (upper Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Chamishaella brosgei Sohn, n. sp.

Plate 6, figures 1–32

Name.—In honor of W. P. Brosgé, U.S. Geological Survey.

Holotype.—USNM 168068.

Paratypes.—USNM 168061–168067.

Material.—Twenty-five carapaces including various stages of growth.

Type-locality.—Top of ridge east of Little Chandler Lake, Brooks Range, Alaska.

Type-level.—Platy limestone member of the Alapah Limestone, 200 feet above the base of the limestone (USGS loc. 13288).

Diagnosis.—Differs from all other species referred to this genus in that the greatest height is at midlength and the ventral margin is evenly rounded.

Description.—The carapace is smooth, large, more than 2 mm in greatest length, and subcircular in lateral outline. The dorsal margin is gently arched and overreaches the larger valve in later instars and adults. The larger valve overlaps slightly or not at all along the free margins where it abuts against a narrow selvage. The posterior margin is somewhat narrower than the round anterior margin. A subcentral adductor muscle-scar pattern may be discerned in many specimens, particularly the larger ones; it apparently consists of a circular rosette of minute individual scars. Partially exfoliated specimens indicate that a narrow calcified inner lamella is present; it is evidently the same width along all the free margins. Dimorphism is shown by greater width near the ventral margin in heteromorphs (pl. 6, figs. 28, 32). These presumed females do not have any perceptible overlap along the ventral margin.

The tecnomorphs and instars are widest in end view at or above midheight.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Paratype (pl. 6, figs. 1–5)	0.67	0.54	0.37
Paratype (pl. 6, figs. 6–10)	1.00	.71	.55
Paratype (pl. 6, figs. 11–15)	1.05	.72	.59
Paratype (pl. 6, figs. 16–19)	1.54	.98	.80
Paratype (pl. 6, figs. 20–24)	2.00	1.52	1.08
Holotype (pl. 6, figs. 25–28)	2.39	1.71	1.25
Paratype (pl. 6, figs. 29–32)	2.42	1.90	1.21

Discussion.—A growth series ranging in greatest length from 0.7 mm to 2.42 mm was recovered. Those specimens smaller than 1 mm do not have a well-defined overreach above the hingeline; the larger specimens have a flattened area above the hingeline. This species differs from the Visean *Chamishaella tumida* (Kummerow, 1939) in that the overreaching dorsal margin is not umbonate and the greatest height of the Visean species is in front of the midlength. *C. brosgei* is closest to *C. carbonaria* (Hall, 1858), from which it differs in having a narrower posterior margin, a longer hingeline, and a narrower overlap along the ventral margin.

Stratigraphic range.—Upper Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Chamishaella sp. aff. Cythere inflata Münster, 1830

Plate 5, figures 32, 33, 36, 37

Cythere inflata Münster, 1830, [Neues] Jahrb. Mineralogie, Geognosie, Geologie, u. Petrefaktenkunde, Jahrg. 1, p. 65. Carboniferous limestone, Regnitzlosau near Hof, northeastern Bavaria.

Cytherella(?) *inflata* (Münster). Jones and Kirkby, 1865, Annals Mag. Nat. History, 3d ser., v. 15, p. 408, pl. 20, figs. 8a–c. Carboniferous limestone, at Tragenau near Hof, Bavaria.

Jones, Kirkby, and Brady, 1884, London, Palaeontogr. Soc., p. 74, pl. 7, figs. 2a, b. Carboniferous shales, Craigenglen, Stirlingshire.

Paraparchites inflatus (Münster). Bassler and Kellett, 1934, Geol. Soc. America Spec. Paper 1, p. 426. See for additional references and occurrences.

[not] *Cythere inflata* McCoy, 1844, p. 167, pl. 23, fig. 17. Homonym.

[not] *Cythere inflata* Terquem, 1878, Soc. Géol. France Mém., 3d ser., v. 1, p. 108, pl. 12, figs. 13a–d. Homonym.

[not] *Cythere inflata* Brady, 1890, Royal Soc. Edinburgh Trans., v. 35, pt. 2, no. 14, p. 498, pl. 2, figs. 8, 9. Homonym.

Discussion.—One carapace missing parts of its shells, a second carapace missing one shell, and steinkerns of carapaces are available from USGS collection 13288. In size and posterior outline these specimens resemble the steinkern illustrated by Jones and Kirkby (1865) but differ in lateral outline and dorsal aspect. They are easily differentiated from *Chamishaella*? sp. in lacking the furrow along the hingeline that can be seen on a partially exfoliated carapace of *Chamishaella*? sp. (pl. 5, figs. 27–31).

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Figured specimen (pl. 5, figs. 32, 33)	2.24	1.46	1.09
Figured specimen (pl. 5, figs. 36, 37)	2.06	1.58	1.5+

Stratigraphic range.—Upper Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Chamishaella? sp.

Plate 5, figures 22, 27–31, 34, 35, 38, 39

Specimens that have an inverted heart-shaped outline in end view are present in USGS collection 13288 mostly as steinkerns; some are partially exfoliated carapaces, and there are two complete carapaces. These specimens and similarly shaped steinkerns or exfoliated carapaces such as *Leperditia bosquetina* Jones and Kirkby, 1886, *Paraparchites galbus* Pozner, 1951, *Cytherella*? *inflata* (Münster). Jones and Kirkby, 1895, and *Paraparchites inflatus* (Münster). Kummerow, 1939, may represent an undescribed genus. Because the inflated venter would indicate heteromorphs and because similar specimens not having an inflated venter, representing tecnomorphs, are either not present in the collection or were not recognized, the species is not formally named and is tentatively referred to *Chamishaella*.

The specimens illustrated here show the following features: (1) Overreach of the right valve (pl. 5, figs. 27, 28), (2) a rounded compound muscle-scar impression which forms a small node in the dorsoanterior part of the scar (pl. 5, figs. 35, 39) and on steinkerns (pl. 5, figs. 22, 23), and (3) a channeled venter, as illustrated for *Aparchites whiteavesi* Jones, 1889, by Swartz (1969, pl. 145, figs. 3, 5, 6). *Chamishaella* sp. aff. *Cythere inflata* Münster, 1830, has a similar adductor muscle-scar impression (pl. 5, figs. 33, 37). The horizontal pleat along the dorsal margin of the left valve (pl. 5, figs. 27, 28), where the right valve overreaches and overlaps, may prove to be diagnostic of the genus to which these specimens belong.

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Measurements (in mm).—

	Minimum or greatest length	Minimum or greatest height	Minimum or greatest width
Figured carapace (pl. 5, figs. 27–31)	1.61	1.26	1.08
Unfigured carapace (USNM 168057)	1.57	1.18	1.01
Figured steinkern (pl. 5, figs. 22, 34, 35)	1.94	1.47	1.20
Figured steinkern (pl. 5, fig. 38)	2.07	1.52	1.23
Figured specimen (pl. 5, fig. 39)	1.71	1.48	1.13

Stratigraphic range.—Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Genus SHISHAELLA Sohn, n. gen.

Name.—The name *Shishaella* is feminine.

Type-species.—*Paraparchites nickelsi* var. *cyclopea* Girty, 1910, p. 232; Sohn, 1969, p. 50, pl. 8, figs. 15–24.

Diagnosis.—A single spine on the posterodorsal area of overlapped valve.

Description.—Large, subovate smooth ostracodes; one valve overlaps along the free margins; the other may or may not overreach above the hingeline. Ridge and groove hinge. The adductor muscle-scar pattern is circular, consists of a number of individual scars, and has two elongated mandibular scars (fig. 2). Narrow calcified inner lamella present. Dimorphic in some species in that the heteromorphs are somewhat wider near the venter than the tecnomorphs; in other species greater width is near the posterior.

Discussion.—Species on hand and also some of those previously described belong to two groups, one having a definite overreach above the hingeline on the overlapped valve and one having no overreach. These two groups can be easily differentiated by specimens that are approximately 0.7 mm or larger in greatest length. Because the overreach is either poorly defined or missing in younger instars (compare pl. 8, figs. 4, 5, to figs. 24, 25), it is not practical to segregate the two groups into distinct genera. The known stratigraphic range of the overreaching group is from the Lower Mississippian to the Lower Permian, whereas the range of the group having no overreach in larger individuals is from the Lower Mississippian to the lower Upper Pennsylvanian. This suggests that future study may disclose two distinct genera that are lumped in this study in *Shishaella*.

Stratigraphic range.—Lower Mississippian–Lower Permian.

In addition to the species described or illustrated in this paper, the following described forms should be transferred to this group:

Paraparchites armstrongianus (Jones and Kirkby). Buschmina, 1968, p. 26, pl. 1, fig. 4, right, dorsal=*Shishaella* sp.

Paraparchites discoides Kummerow, 1939, p. 12, pl. 1, figs. 5a, b.

donica Tschernyshev. Buschmina, 1968, p. 28, pl. 1, figs. 1, 3.

gibbus Buschmina, 1968, p. 29, pl. 2, figs. 2, 4.

harltoni Bradfield, 1935, p. 33, pl. 1, figs. 9a, b.

inornatus (McCoy). Delo, 1931, p. 42, pl. 4, fig. 2=*Shishaella* sp.

inornatus (McCoy). Croneis and Gale, 1939, p. 256, pl. 6, fig. 33=*Shishaella juvensis* (Croneis and Gale, 1939).

inornatus (McCoy). Cooper, 1941, p. 62, pl. 13, figs. 13, 14=*Shishaella kinkaidensis* (Croneis and Thurman, 1939).

Leperditia juvensis Croneis and Gale, 1939, p. 255, pl. 5, fig. 20.

Paraparchites kinkaidensis Croneis and Thurman, 1939, p. 301, pl. 7, fig. 22; Cooper, 1941, pl. 13, figs. 20, 21.

Cypridina laevigata Eichwald, 1857, p. 310. See *Rishona*? *laevigata* (Eichwald). Sohn (1960, p. 79)=*Shishaella*?.

Paraparchites laduensis Knight, 1928, p. 234, pl. 31, fig. 7= ?*S. claytonensis* (Knight, 1928).

magnus var. *uralensis* Glebovskaya, 1939, p. 168, 174, pl. 1, figs. 7, 7a.

nickelsi (Ulrich). Morey, 1936, p. 115, pl. 17, fig. 26= *Shishaella* sp.

nickelsi (Ulrich). Green, 1963, p. 127, pl. 8, figs. 10, 11= *Shishaella* sp.

?*Leperditia okeni* (Münster). Jones and Kirkby, 1896 [part], p. 178, pl. 11, figs. 8–11.

Paraparchites okeni (Münster). Gorak, 1966, p. 100, pl. 46, fig. 3=*Shishaella* sp.

okeni (Münster). Kummerow, 1939, p. 10, pl. 1, figs. 1a, b=*Shishaella* sp.

okeni obliquus (Jones and Kirkby). Kummerow, 1939, p. 11, pl. 1, figs. 2a, b=*Shishaella* sp.

ovatus Cooper, 1941, p. 62, pl. 14, figs. 1, 2.

porrectus Zanina, 1956, p. 192, pl. 1, figs. 1a, b.

porrectus Zanina n. var. Buschmina, 1968, p. 31, pl. 3, figs. 3, 4=*Shishaella* sp.

productus Green, 1963, p. 125, pl. 8, figs. 14–21.

rhombicus (Jones and Kirkby). Gorak, 1964, p. 189, pl. 3, figs. 8a, b=*Shishaella*? sp.

samuela Coryell and Rozanski, 1942, p. 139, pl. 23, fig. 2.

unicornis Zanina, 1968, p. 171, pl. 1, figs. 4, 5.

unoculus Buschmina, 1968, p. 26, pl. 1, fig. 5, right, dorsal.

schweyeri Glebovskaya, 1939, p. 169, 174, pl. 1, figs. 8, 8a–c (?overlap and spine reversed).

ventriosus Chizhova, 1960, p. 177, pl. 4, figs. 1, 2.

P.? sp. Buschmina, 1965, p. 66, pl. 4, figs. 1–3.

Shishaella cyclopea (Girty, 1910)

Plate 7, figures 1–35.

Paraparchites nickelsi var. *cyclopea* Girty, 1910, New York Acad. Sci. Annals, v. 20, no. 3, pt. 2, p. 232.

Paraparchites? cyclopeus Girty. Sohn, 1969, U.S. Geol. Survey Prof. Paper 606, p. 50, pl. 8, figs. 15–24 (see for synonymy).

Diagnosis.—Strong overreach; spine at approximately one-quarter of greatest length in from posterior margin; subovate lateral outline; swelling near dorsal margin of right valve and near ventral margin of left valve.

Description.—See Sohn (1969, p. 50).

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Figured specimen (pl. 7, figs. 1–4)	0.47	0.32	0.20
Figured specimen (pl. 7, figs. 5–8)	.48	.34	.23
Figured specimen (pl. 7, figs. 9, 10)	.72	.52	.38
Figured specimen (pl. 7, figs. 19, 20)	.85	.63	.42
Figured specimen (pl. 7, figs. 11, 12)	.92	.70	.49
Figured specimen (pl. 7, figs. 13, 14)	1.22	.94	.62
Figured specimen (pl. 7, figs. 15–18)	1.40	1.0	.72
Figured specimen (pl. 7, figs. 22–25)	1.71	.95+	.84
Figured specimen (pl. 7, figs. 29–32)	1.85	1.35	.93
Figured specimen (pl. 7, figs. 26–28)	1.95	1.42	......
Paralectotype (pl. 7, fig. 35)	3.15	2.27	1.69
Lectotype	3.30	2.23	1.69

Discussion.—The ontogenetic series illustrated on plate 7 shows the spine developed on specimens as small as 0.47 mm in greatest length (pl. 7, fig. 2). Two topotype carapaces (pl. 7, figs. 26–28, 29–32) do not show the diagnostic spine because both are partially corroded specimens. Although one carapace (USNM 168106; pl. 7, figs. 29–32) appears to be perfect, the shell surface in the area of the spine is rough, and this roughening suggests that the spine was present. The diagnostic swelling near the dorsal margin of the right valve (pl. 7, fig. 30) and near the venter on the left valve (pl. 7, fig. 29) attest to the specific identity. The other carapace (USNM 168107; pl. 7, figs. 26–28) had parts of the shell surface removed on the right valve as evidenced by the darker outline in the lower right area of figure 28.

Green (1963, p. 125, pl. 8, figs. 14–21) illustrated a growth series of the Early Mississippian *Shishaella producta* (Green, 1963) in which the position of the spine is constant in those specimens that range in greatest length from 0.53 mm to 2.01 mm. The position of the spine in *Shishaella* was probably constant during the ontogeny of the individual.

The fragment of a large topotype left valve from USGS collection 5553 was converted to fluorite in order to examine the muscle-scar pattern, but the pattern did not show up so clearly as those illustrated on plate 7, figures 21, 24, 25, 27, and 33. Note the accessory scars on figure 25 that suggest cyprid affinities, similar to the pattern illustrated in text figure 2.

Geologic range.—Upper Mississippian (lower Namurian), Chester Series.

Geographic distribution.—Fayetteville Shale and Batesville Sandstone, Arkansas; Golconda and Renault Formations, Illinois; and subsurface "Manning Zone," Oklahoma.

Shishaella williamsae Sohn, n. sp.

Plate 8, figures 1–5, 11–25, 31–44

Name.—In honor of Mrs. Evelyn G. Williams, U.S. Geological Survey.

Holotype.—USNM 168076.

Paratypes.–USNM 168069–168075.

Material.—More than 20 carapaces representing various stages of growth.

Type-locality.—Top of ridge east of Little Chandler Lake, Brooks Range, Alaska.

Type-level.—Platy limestone member of the Alapah Limestone, 200 feet above the base of the limestone (USGS loc. 13288).

Diagnosis.—Anterior cardinal angle more obtuse than posterior angle; ventral margin convex; spine close to dorsal margin.

Description.—The lateral outline is subcircular, the greatest height being at approximate midlength and greatest width posterior to midlength. The dorsal margin is straight, and the anterior cardinal angle is more obtuse than the posterior angle. Large specimens have a slight but definite overreach of the right valve along the hinge margin. The overlap of the left valve is relatively narrow and slightly wider along the ventral than along the end margins. The dorsoposterior spine is a distance of one to two times the diameter of its base down from the dorsal margin, and about twice that distance in from the posterior margin. Partially exfoliated specimens do not have a list on the free margin of the right valve.

Measurements (in mm).—

	Greatest length	Greatest height	Greatest width
Paratype (pl. 8, figs. 1–5)	0.49	0.35	0.26
Paratype (pl. 8, figs. 11–15)	.91	.67	.45
Paratype (pl. 8, figs. 16–20)	1.25	.93	.66
Paratype (pl. 8, figs. 21–25)	1.40	1.05	.68
Paratype (pl. 8, figs. 31–35)	1.73	1.19	.85
Holotype (pl. 8, figs. 36–40)	1.81	1.38	1.01
Paratype (pl. 8, figs. 41–44)	2.18	1.62	1.04

Discussion.—The new species resembles *Shishaella harltoni* (Bradfield, 1935) from the Lower Pennsylvanian of Oklahoma, in the position of the spine but differs in having a more rounded ventral margin. Some individuals have the spine closer to the dorsal margin than others (pl. 8, figs. 24, 34, 39), and this difference is probably due to individual variation. Dimorphism is possibly indicated by greater width near the posterior in dorsal outline as shown on plate 8, figures 37, 39, 32, 34, 42. Chizhova (1960, p. 177, pl. 4, figs. 1a–c) illustrated the male of *S. ventriosa* (Chizhova, 1960) which is more elongated and which has a straighter ventral margin than the female. *S.* cf. *S. williamsae* (pl. 8, figs. 6, 26) bears a similar relation to *S. williamsae* but is not considered to be the male of *S. williamsae* because specimens considered to be males of this new species are present in the collection (pl. 8, figs. 31, 41).

Stratigraphic range.—Upper Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Shishaella cf. S. williamsae Sohn, n. sp.

Plate 8, figures 6–10, 26–30

Rare specimens that differ from *S. williamsae* in lateral outline because the ventral margin is less convex were found in the same collection. The reason for not considering these as the male dimorphs was previously discussed.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Figured specimen (pl. 8, figs. 6–10)	0.79	0.55	0.40
Figured specimen (pl. 8, figs. 26–30)	1.35	.99	.67

Stratigraphic range.—Upper Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Genus SHEMONAELLA Sohn, n. gen.

Name.—The name *Shemonaella* is feminine.

Type-species.—*Shemonaella dutroi* Sohn, n. sp.

Diagnosis.—Unspined Paraparchitidae not having an incised dorsum.

Description.—The carapace is smooth, and it is subovate to elongate-ovate in lateral outline; the cardinal angles are obtuse. One valve overlaps slightly along the free margins where it may abut against a narrow flange; the overlapped valve may be slightly higher along the hinge margin and may not have any pronounced overreach. The hinge of the overlapping valve consists of a ridge that fits into a groove of the opposing valve. There is a calcified inner lamella along the free margins. Dimorphism in greater width of posterior or near the venter is shown by some of the species including the type-species.

Discussion.—The genus is established for those species assigned to *Paraparchites* that do not have an incised hinge margin, pronounced overreach, or posterodorsal spines. Because most of the previously described species that lack the above structures were inadequately described or illustrated, they cannot be assigned with any degree of certainty to *Shemonaella.*

Grachevskiy (1958, p. 1323) described the Visean genus *Quasiparaparchites* in the Leperditellidae for two new species: *Q. malinovskensis,* the type-species, and *Q. radaevkensis.* Both were described from the Malinovka Formation in the Kuibyshev Trans-Volga region. *Q. radaevkensis* Grachevskiy, 1958, has dorsoposterior spines on both valves; consequently, it is here referred to the new genus *Shivaella. Q. malinovkensis* appears to differ from *Shemonaella* in having a pronounced ventral bend on the overlap valve and a transversely striate or denticulate structure on the corresponding area of the smaller valve. Because this species was illustrated by only left and dorsal views, it is not possible to determine whether it is congeneric with *Shemonaella.* Future study may demonstrate that *Shemonaella* is a junior synonym of an emended conception of *Quasiparaparchites* Grachevskiy, 1958.

In addition to the new species, the following species either belong to or may belong to *Shemonaella*:

Lepeditia okeni var. *acuta* Jones and Kirkby, 1865, p. 406, pl. 20, figs. 4a, b.

Cythere amygdalina McCoy, 1844, p. 165, pl. 23, fig. 8.

?*Paraparchites*? *ardmorensis* Bradfield, 1935, p. 34, pl. 1, figs. 7a, b. Based on an internal mold.

Paraparchites bigsnowyensis Scott, 1942, p. 154, pl. 25, figs. 6, 7.

?*Leperditia bosquetiana* Jones and Kirkby, 1886, p. 254, pl. 7, figs. 2a–c.

Leperditia compressa Jones and Kirkby, 1886, p. 256, pl. 7, figs. 7a, b.

?*Paraparchites galbus* Pozner, 1951, p. 25, pl. 2, figs. 1–3.

?*Cytherella*(?) *inflata* (Münster). Jones and Kirkby, 1865, p. 408, pl. 20, figs. 8a–c. See Schmidt, 1939, p. 383.

Cythere inornata McCoy, 1844, p. 167, pl. 23, fig. 18.

[not] *Paraparchites inornatus* (McCoy). Pozner, 1951, p. 23, pl. 1, figs. 1a–c.

Paraparchites karagandensis Buschmina, 1959, p. 190, pl. 1, figs. 4a–c.

maccoyanus Schmidt, 1939, p. 383, new name for *Cythere inflata* McCoy, 1844 not Münster, 1830.

nicklesi (Ulrich). Green, 1963, p. 127, pl. 8, figs. 10, 11.

Leperditia oblonga Jones and Kirkby, 1865, p. 407, pl. 20, fig. 5.

Paraparchites oskolensis Samoilova and Smirnova, 1962, p. 83, pl. 13, figs. 2a, b. Middle Devonian.

Leperditia parallela Jones and Kirkby, 1865, p. 407, pl. 20, figs. 6a, b.
rhombica Jones and Kirkby, 1896, p. 185, pl. 12, fig. 6.
Proparaparchites sibiricus Buschmina, 1968, p. 33, pl. 4, fig. 7. Left, dorsal.
?*Leperditia subaequalis* Reed, 1927, p. 72, pl. 10, figs. 18, 18a, b.
Paraparchites symmetricus Kummerow, 1953, p. 11, pl. 1, figs. 3a, b.
ukrainica (Tschernichev). Buschmina, 1959, p. 191, pl. 1, figs. 1a, b.

Stratigraphic range.—Middle Devonian(?), Mississippian–Pennsylvanian.

Shemonaella dutroi Sohn, n. sp.

Plate 9, figures 1–44

Name.—In honor of J. T. Dutro, Jr., U.S. Geological Survey.

Holotype.—USNM 168090.

Paratypes.—USNM 168080–168089.

Material.—More than 50 carapaces and steinkerns, some broken.

Type-locality.—USGS locality 13288.

Type-level.—Platy limestone member of the Alapah Limestone, 200 feet above the base.

Diagnosis.—Elongated-subovate; posterior margin only slightly shorter than anterior margin; greatest height approximately in anterior third of greatest length; hinge long, more than two-thirds of greatest length; ventral margin evenly convex.

Description.—The carapace is elongated-subovate in lateral view and has an evenly curved ventral margin; the end margins are of approximately equal convexity, the posterior margin only slightly shorter. The hinge is slightly more than two-thirds the greatest length, which is approximately at midheight. Dorsal outline lanceolate; heteromorphs wider in posterior. End view of heteromorphs wider below midheight; tecnomorphs and juveniles wider above midheight. The left valve overlaps the right along the venter where it abuts against a ridge formed by the sharp bending of the right valve along the free margin.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Paratype (pl. 9, figs. 1–5)	0.71	0.54	0.43
Paratype (pl. 9, figs. 6–10)	.82	.58	.47
Paratype (pl. 9, figs. 11–15)	.88	.59	.41
Paratype (pl. 9, figs. 16–20)	1.31	.81	.61
Paratype (pl. 9, figs. 21–25)	1.48	.97	.73
Paratype (pl. 9, figs. 26–30)	1.85	1.23	.92
Paratype (pl. 9, figs. 31–35)	1.94+	1.24	.93
Paratype (pl. 9, figs. 36–38)	1.87+	1.22	.96
Paratype (pl. 9, fig. 39)	2.0+	1.28+	1.05+
Holotype (pl. 9, figs. 40–44)	2.29+	1.48	1.19

Discussion.—This species differs from *Leperditia okeni* (Münster). Jones and Kirkby, 1865, in that the ventral margin is not truncated posteriorly. Most of the specimens referred to *Leperditia okeni,* and later to *Paraparchites okeni* (Münster, 1830) are misidentified as to species, and some as to genus. The unraveling of that taxon is beyond the scope of this paper. The new species differs from all the other species referred to this genus in elongate-subovate lateral outline.

The shell of this species must have been relatively thin because most of the specimens look like either steinkerns or subinternal molds. Only one broken specimen (pl. 9, fig. 39), a carapace missing most of its ventroanterior, has undoubted shell material.

Stratigraphic range.—Upper Mississippian (lower Meramecian).

Geographic distribution.—Brooks Range, Alaska.

Order ?PALAEOCOPIDA Henningsmoen, 1953

Because there is no evidence to remove *Coelonella* Stewart, 1936, from the Palaeocopida, it is tentatively retained in that order.

Superfamily unknown

Family COELONELLIDAE Sohn, n. fam.

Diagnosis.—Smooth, asymmetrical, elongated, has channeled dorsum, broad ventral overlap, and nonarticulated hingement consisting of the inbending and internal curving for a short distance laterally towards the valve walls of the shell on both valves below the dorsum.

Description.—The carapace is small, about 1 mm or less in greatest length, subovate; it has unequally rounded end margins, a straight dorsal margin, and convex to gently curved ventral margin. The dorsum is channeled, usually long, formed by the downward bend of both valves at the dorsal margin, and bounded on each end by the overlapping end margins of the larger valve. The hinge is neither denticulated nor ridged and grooved. The valves continue curving laterally for a short distance below the channeled dorsum internally toward the inside surface of each valve, so that the continuation of the convex outside surfaces of the valves barely touch to form the floor of the dorsal channel (pl. 1, fig. 23; pl. 2, figs. 3–6).

Discussion.—The edentulous, nonarticulated hingement of the nominate genus has, so far as I know, not yet been recorded in the Ostracoda. It is sufficiently distinct to warrant the establishment of the new family. Dissociated valves are rare and suggest a strong ligament in conjunction with the overlap to prevent disarticulation. I do not know how the ligament functioned or where it was attached. The muscle-scar pattern is as yet unknown, nor have I been able to recognize dimorphism in *Coelonella,* the only known genus in this family.

Genus COELONELLA Stewart, 1936

Coelonella Stewart, 1936, Jour. Paleontology, v. 10, no. 8, p. 742.

Sansabella (*Coelonella*) Přibyl, 1955, Czechoslovakia, Ustrední ústavu geologichý, Sbornik, v. 21, p. 280.

Type-species (original designation).—*Isochilina*? *scapha* Stewart, 1930, Ohio Jour. Sci., v. 30, no. 1, p. 57, pl. 1, figs. 11, 12. Silica Shale (Middle Devonian), Ohio.

Diagnosis.—Small, asymmetrical, elongated; has channeled dorsum and broad ventral overlap; hingement coelonellid.

Discussion.—A cross section of a topotype carapace of *Coelonella scapha* (Stewart, 1936) disclosed a hingement unlike any previously described in Ostracoda. The dorsal margins bend down to form the invaginated dorsum and then continue to bend into the body of the carapace, touching each other without any apparent ridge and groove contact (pl. 2, figs. 3–6). The ventral overlap is broad, and the contact is straight, an additional feature that distinguishes this genus from *Microcheilinella* Geis, 1933, in which the contact is sigmoid. There are indications that the contact area between the overlapping valves may be fluted subparallel to the free margins.

The Devonian genus *Coeloenellina* Polenova, 1952 (type-species *C. parva* Polenova, 1952) was described in the Leperditellidae (Polenova, 1952, p. 66) as having a groove along the hinge of the right valve for the reception of the dorsal margin of the left valve. According to the original description, this genus is smaller than *Coelonella;* its greatest length is 0.37 mm as compared with 0.8 mm and longer for *Coelonella*. Polenova (1968, p. 10–15) reassigned *Coeloenellina* to the Aparchitidae and described species having a greatest length of 0.73–0.82 mm. In addition, she transferred species previously referred to *Coelonella*, including some of those listed below, to *Coeloenellina*. Because the hingement of the species Polenova (1968) referred to *Coeloenellina* and the hingement of those described by her in *Coelonella* are as yet unknown, it is impossible to determine the correct generic assignment. The following species were described in *Coelonella*:

Coelonella bergica Krommelbein, 1954, p. 256, pl. 2, figs. 11a–d. Givetian, northwestern Germany.
bijensis Rozhdestvenskaja, 1959, p. 131, pl. 2, figs. a–d. Eifelian, western Bashkir, U.S.S.R.
Sansabella (C.) devonica Přibyl, 1955, p. 281, pl. 1, figs. 3–10, pl. 3, figs. 13–15. Lower Devonian, Bohemia.
Coelonella gabdjukovensis Rozhdestvenskaja, in Abushik and others, 1960, p. 287, pl. 58, figs. 5a, b. Eifelian, southern Urals, U.S.S.R.
granulifera Stewart and Hendrix, 1945, p. 100, pl. 11, figs. 3–5. Olentangy Shale (Upper Devonian), Delaware County, Ohio.
punctulifera Stewart and Hendrix, 1945, p. 101, pl. 11, figs. 6–8. Olentangy Shale (Upper Devonian), Delaware County, Ohio.
reversa Egorova, 1966, VNII, p. 168, pl. 1, figs. 1–3. Givetian, Russian platform.
testata Polenova, 1955, p. 202, pl. 3, figs. 5a–c. Middle Devonian, Volga-Ural region.

Stratigraphic range.—Lower through Upper Devonian.

Coelonella plana Stewart, 1936

Plate 1, figures 1–8

Coelonella plana Stewart, 1936, Jour. Paleontology, v. 10, no. 8, p. 743, pl. 100, figs. 3, 4. Silica Shale, Lucas County, Ohio.

Leperditia(?) *subrotunda*(?) Ulrich. Stewart, 1930, Ohio Jour. Sci., v. 30, no. 1, p. 57, pl. 1, fig. 10. Silica Shale, Lucas County, Ohio.

Discussion.—The holotype, here illustrated on plate 1, figures 1–3, is a squashed carapace missing the ventroanterior part of the margin. Stewart (1936, pl. 100, fig. 3) indicated the missing part by a dashed line on her drawing. I have two collections of carapaces from the type-locality; one by C. L. Cooper, the other donated by Mrs. Ruth E. Chilman. The holotype is recorded as 0.88 mm long and 0.70 mm high.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Figured specimen (pl. 1, figs. 4–6)	0.84	0.57	0.34
Figured specimen (pl. 1, figs. 8 and 9)	.76	.55	.33

Stratigraphic range.—Middle Devonian.

Geographic distribution.—Known from Lucas County, Ohio.

Coelonella scapha (Stewart, 1930)

Plate 1, figures 9–23; plate 2, figures 3–6

Isochilina? *scapha* Stewart, 1930, Ohio Jour. Sci., v. 30, no. 1, p. 57, pl. 1, figs. 11, 12. Silica Shale, Lucas County, Ohio.

Coelonella scapha (Stewart). Stewart, 1936, Jour. Paleontology, v. 10, no. 8, p. 742, pl. 100, figs. 1, 2.
Kesling and Weiss, 1953, Michigan Univ., Mus. Paleontology Contr., v. 11, no. 3, p. 67, pl. 5, figs. 13–16. Norway Point Formation, Michigan.

Discussion.—The holotype and subsequently illustrated specimen are abraded carapaces. A topotype carapace collected by C. L. Cooper was sectioned, and the section is illustrated (pl. 2, fig. 6). This specimen illustrates the diagnostic hinge of the genus. In addition, specimens donated by Mrs. Ruth E. Chilman to the U.S. National Museum were examined. This suite contains some younger growth stages, and some of the specimens are illustrated (pl. 1, figs. 9–18, 23; pl. 2, figs. 3–5). Because most of the specimens are either squashed or somewhat abraded, definite dimorphism cannot be determined. There is, however, a suggestion of dimorphism in that some individuals are more slender in dorsal outline.

Measurements (in mm).—

	Greatest length	*Greatest height*	*Greatest width*
Figured specimen (pl. 1, figs. 9, 10)	0.69	0.34	0.36
Figured specimen (pl. 1, figs. 11, 12)	.72	.42	.39
Figured specimen (pl. 1, figs. 13–15)	1.08	.63	.50
Figured specimen (pl. 1, fig. 23)	.91	.54	.28
Peel specimen (pl. 2, figs. 3–5)	......	.63	.50
Thin section (pl. 2, fig. 6)	......	.63	.53

Stratigraphic range.—Middle Devonian.

Geographic distribution.—Described from Lucas County, Ohio, identified from Alpena County, Mich.

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PLATES 1-9

Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225.

PLATE 1

[Magnification × 30; photographs by R. H. McKinney]

FIGURES 1–8. *Coelonella plana* Stewart, 1936 (p. A18).

1–3. Right, dorsal, and left views of carapace. Holotype, Ohio State Univ. No. 18171. Silica Shale, Zone 3, Middle Devonian, quarry at Silica, Lucas County, Ohio.

4–6. Right, dorsal, and left views of carapace. Figured specimen, USNM 168091. Silica Shale, Zone 1, same quarry as above. C. L. Cooper collection 675–1, collected by G. A. Stewart, October 1941.

7, 8. Right and dorsal views of carapace. Figured specimen, USNM 168092. Silica Shale, units 9 and 11, North Quarry, Medusa Portland Cement Company, Lucas County, Ohio. Collected by Mrs. Ruth E. Chilman.

9–23. *Coelonella scapha* (Stewart, 1930) (p. A18).

9, 10. Dorsal and left views of carapace of a young instar. Figured specimen, USNM 168093. Same collection and locality as figures 7 and 8.

11, 12. Left and right views of a slightly larger carapace. Figured specimen, USNM 168094. Same collection and locality as figures 7 and 8.

13–15. Left, ventral and dorsal views of adult carapace. Figured specimen, USNM 168095. Same collection and locality as figures 7 and 8.

16–18. Ventral, right lateral, and dorsal views of adult carapace. Figured specimen lost. Same collection and locality as figures 7 and 8.

19–22. Left, dorsal, right, and ventral views of abraded carapace. Holotype, Ohio State University No. 16538. Silica Shale, Zone 3, quarry at Silica, Lucas County, Ohio.

23. Inside view of left valve that shows deep invagination of hinge margin. Figured specimen, USNM 168096. Silica Shale, unit 9, quarry at Silica, Lucas County, Ohio. Collected by Mrs. Ruth E. Chilman.

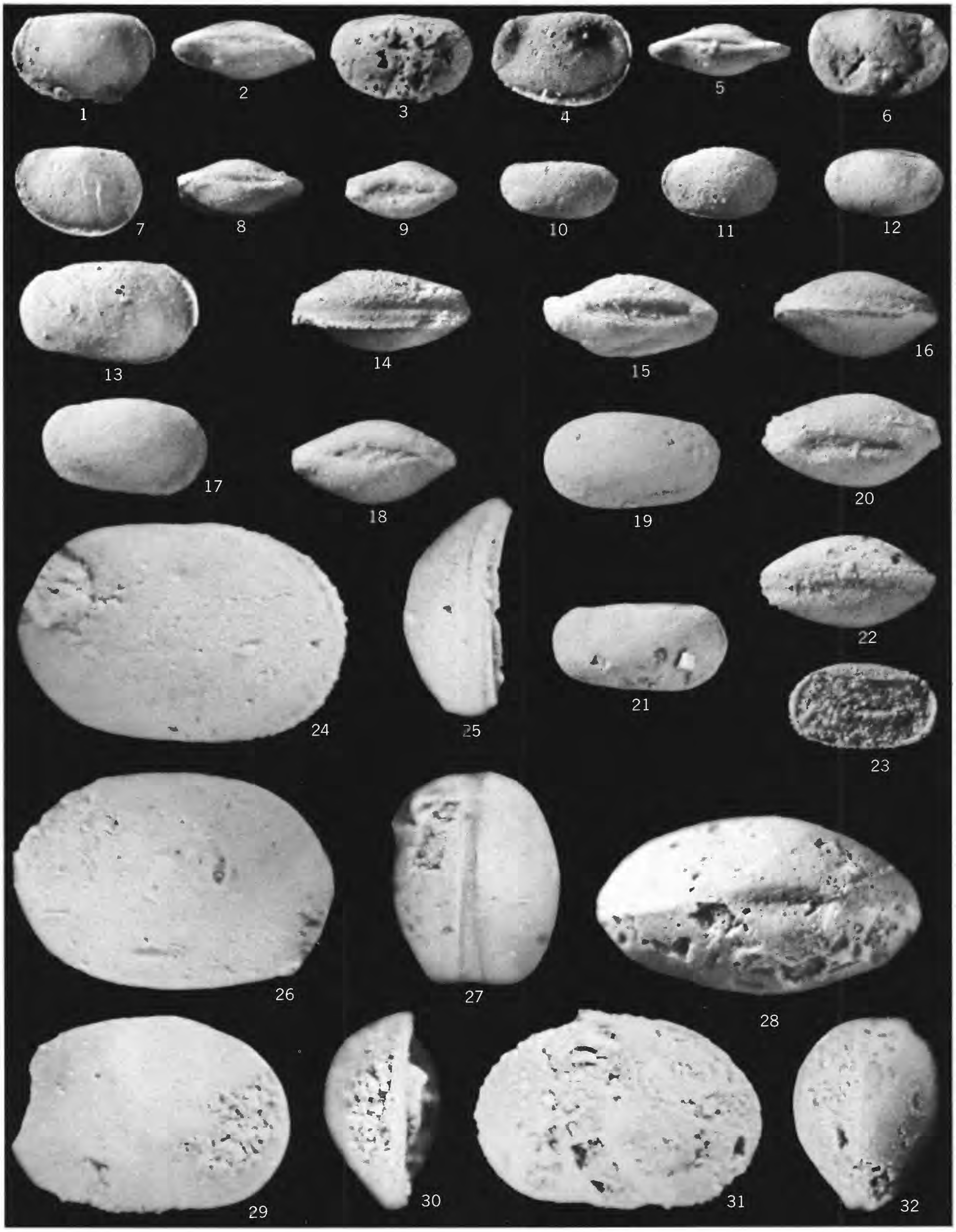
24–32. *Paraparchites humerosus* Ulrich and Bassler, 1906 (p. A7).

24, 25. Lateral and anterior views of right valve of a female. Paralectotype, USNM 137564. The edge of the smaller specimen nested inside can be seen in figure 25. This specimen is the original of Scott (1959, pl. 87, fig. 1). Elmdale Shale of former usage (Permian) near Manhattan, Kans.

26–28. Left, anterior, and dorsal views of a female carapace. Lectotype, USNM 35627. Illustrated by Scott (1959, pl. 87, figs. 3, 4). Same collection and locality as figures 24 and 25.

29, 30. Right and anterior views of a broken valve of tecnomorph. Paralectotype, USNM 167975. Same collection and locality as figures 24 and 25.

31, 32. Left and posterior views of carapace of a tecnomorph. Paralectotype, USNM 137564b. This specimen was illustrated in dorsal view by Scott (1959, pl. 87, fig. 7). Same collection and locality as figures 24 and 25.



COELONELLA, PARAPARCHITES

PLATE 2

[Except where noted, magnification × 30; photographs of specimens by R. H. McKinney; photographs of sections by D. H. Massie]

FIGURES 1, 2, 7–10, 13–15. *Paraparchites texanus* Delo, 1930 (p. A8).

1, 2. Left and dorsal views of carapace. Holotype, USNM 81799. Probably Permian, well in Menard County, Tex.

7–10. Dorsal, right, left, and ventral views of carapace. Topotype of *Antiparaparchites reversus* Coryell and Rogatz, 1932, USNM 167983. Arroyo Formation, Tom Green County, Tex.

13–15. Right, dorsal, and left views of carapace. Topotype of *P. oviformis* Coryell and Rogatz, 1932, USNM 167984. Same collection as figures 7–10.

3–6. *Coelonella scapha* (Stewart, 1930) (p. A18).

3–5. Two acetate peels and a polished surface of a carapace × 150. Figured specimen, USNM 168097. Silica Shale, units 9 and 11, north quarry, Medusa Portland Cement Company, Lucas County, Ohio. Collected by Mrs. Ruth E. Chilman.

6. Thin section of a carapace, × 150. Topotype, USNM 168098. Silica Shale, Zone 1, quarry at Silica, Lucas County, Ohio. C. L. Cooper colln. 675–1, collected by G. A. Stewart, October 1941.

11, 12. *Paraparchites kellettae* Sohn, n. sp. (p. A8).

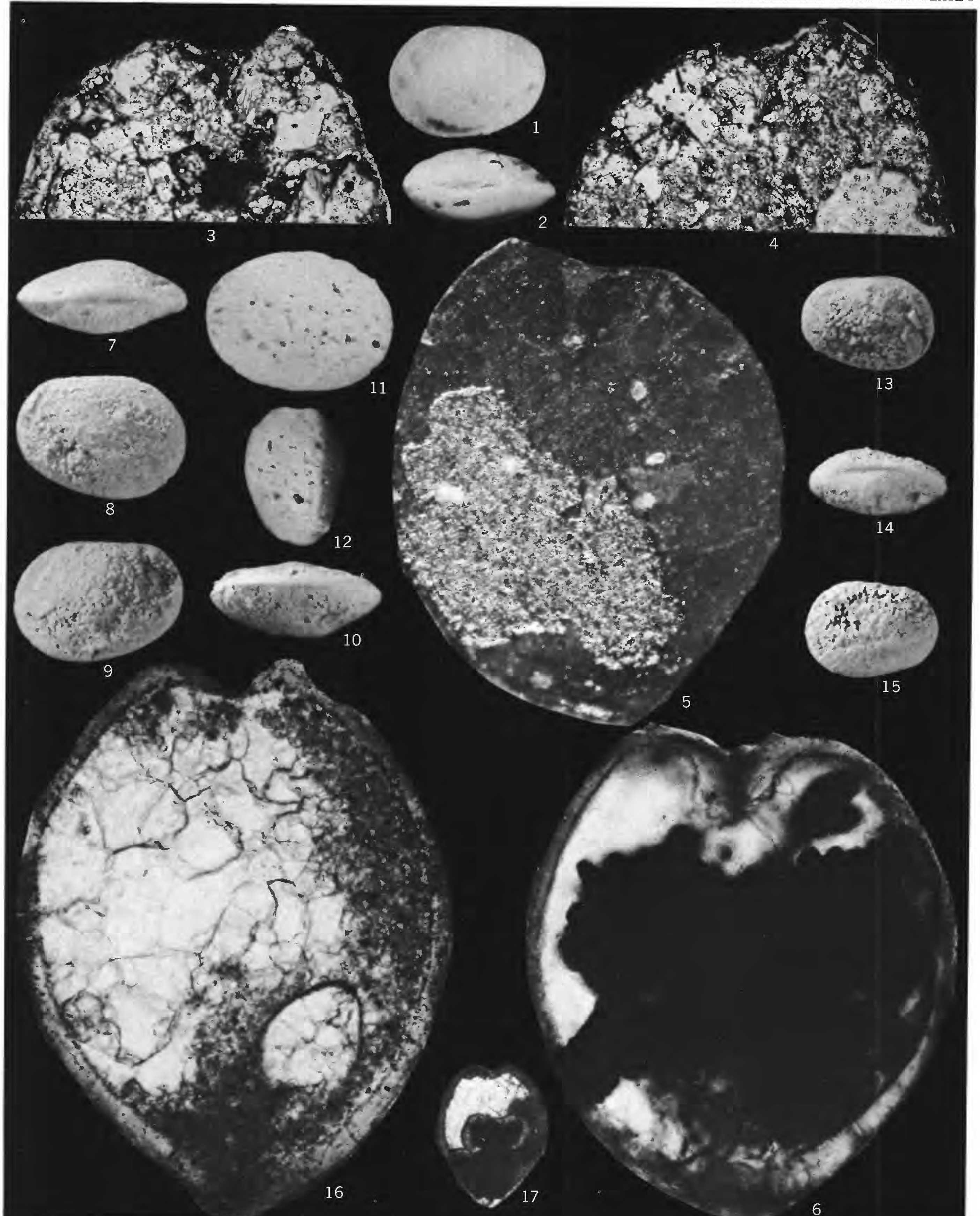
Right view and anterior of carapace illustrated by Kellett (1933, pl. 13, figs. 1, 8) as *P. humerosus* (Ulrich and Bassler). Holotype, USNM 85423. Fort Riley Limestone, Geary County, Kans.

16. *Paraparchites* sp. (p. A7).

Thin section of a carapace × 150. Figured specimen, USNM 167985. Manlius Limestone, large quarry near railroad, 1.0 mile southeast of Munnsville, Munnsville quadrangle, New York. Collected by J. M. Berdan, USGS locality 5209–SD.

17. *Paraparchites humerosus* Ulrich and Bassler, 1906 (p. A7).

Thin section of a paratype × 25. Paratype, USNM 167986. "Elmdale Shale" (Lower Permian), Manhattan, Kans.



PARAPARCHITES, COELONELLA

PLATE 3

[Magnification approximately × 30; photographs by R. H. McKinney]

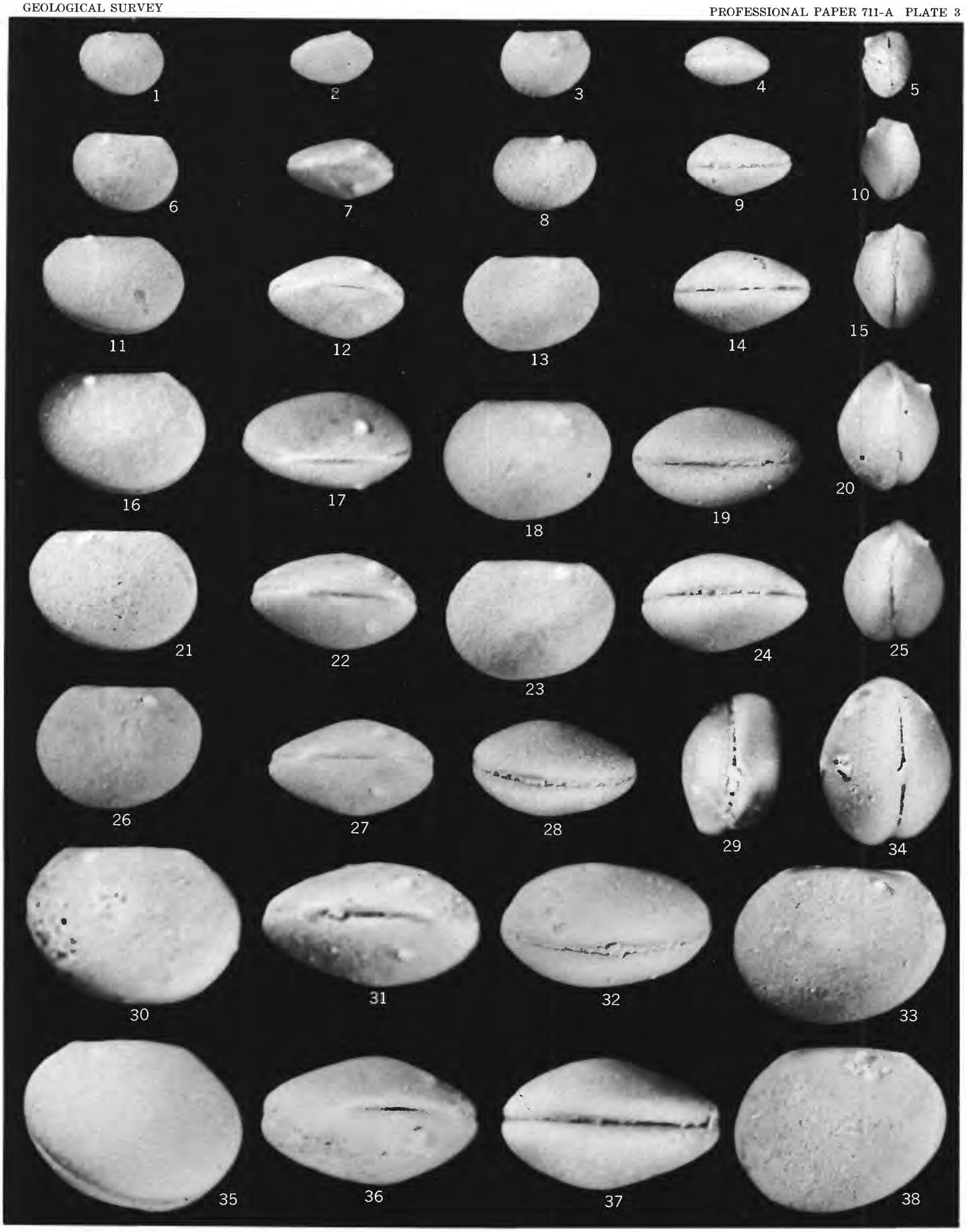
FIGURES 1–38. *Shivaella suppetia* Sohn, n. sp. (p. A9).

1–25. Right, dorsal, left, ventral, and posterior views of five growth stages, showing the ontogenetic development. Paratypes, USNM 167995–167999. Platy limestone member of the Alapah Limestone, Little Chandler Lake, Brooks Range, Alaska. USGS locality 13288.

26–28. Left, dorsal, and ventral views of a preadult individual. Paratype, USNM 168000. Same collection and locality as figures 1–25.

29–33. Posterior, right, dorsal (anterior to the left), ventral (anterior to the right), and left views of presumed female. Holotype, USNM 168004. Same collection and locality as figures 1–25.

34–38. Posterior, right, dorsal, ventral, and left views of presumed adult male. Paratype, USNM 168001. Same collection and locality as figures 1–25.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SHIVAELLA

PLATE 4

[Magnification approximately × 30; except where noted, photographs by R. H. McKinney]

FIGURES 1–16. *Shivaella nicklesi* (Ulrich, 1891) (p. A10).

1–5. Left, ventral, dorsal, right, and posterior views of a young instar. Topotype, USNM 168033. Chester Series, ¼ mile east of Grayson Springs, Ky.

6–9. Left, dorsal, right, and posterior views of a carapace, paratype of *Paraparchites projectus* Harris and Jobe (1956, pl. 1, figs. 7a–c), University of Oklahoma collection MC 7A. "Manning" horizon (Upper Mississippian), well in Major County, Okla.

10–12. Dorsal, lateral, and posterior views of right valve. Lectotype, USNM 41844A. Chester Series, Grayson Springs Station, Ky.

13–16. Left, dorsal, right, and posterior views of a carapace illustrated by Harlton (1929, pl. 1, fig. 1) as *Paraparchites nicklesi* (Ulrich). Figured specimen, USNM 79357. Fayetteville Shale, Girty's type-locality, railroad cut at Fayetteville, Ark.

17–27. *Shivaella mertiei* Sohn, n. sp. (p. A10).

17. Lateral view of a silicified left valve representing an immature instar. Paratype, USNM 168026. Alapah Limestone, Nanushuk Valley, Brooks Range, Alaska.

18. Lateral view of right valve of an instar younger than illustrated in figure 17. Paratype, USNM 168027. Same collection and locality as figure 17.

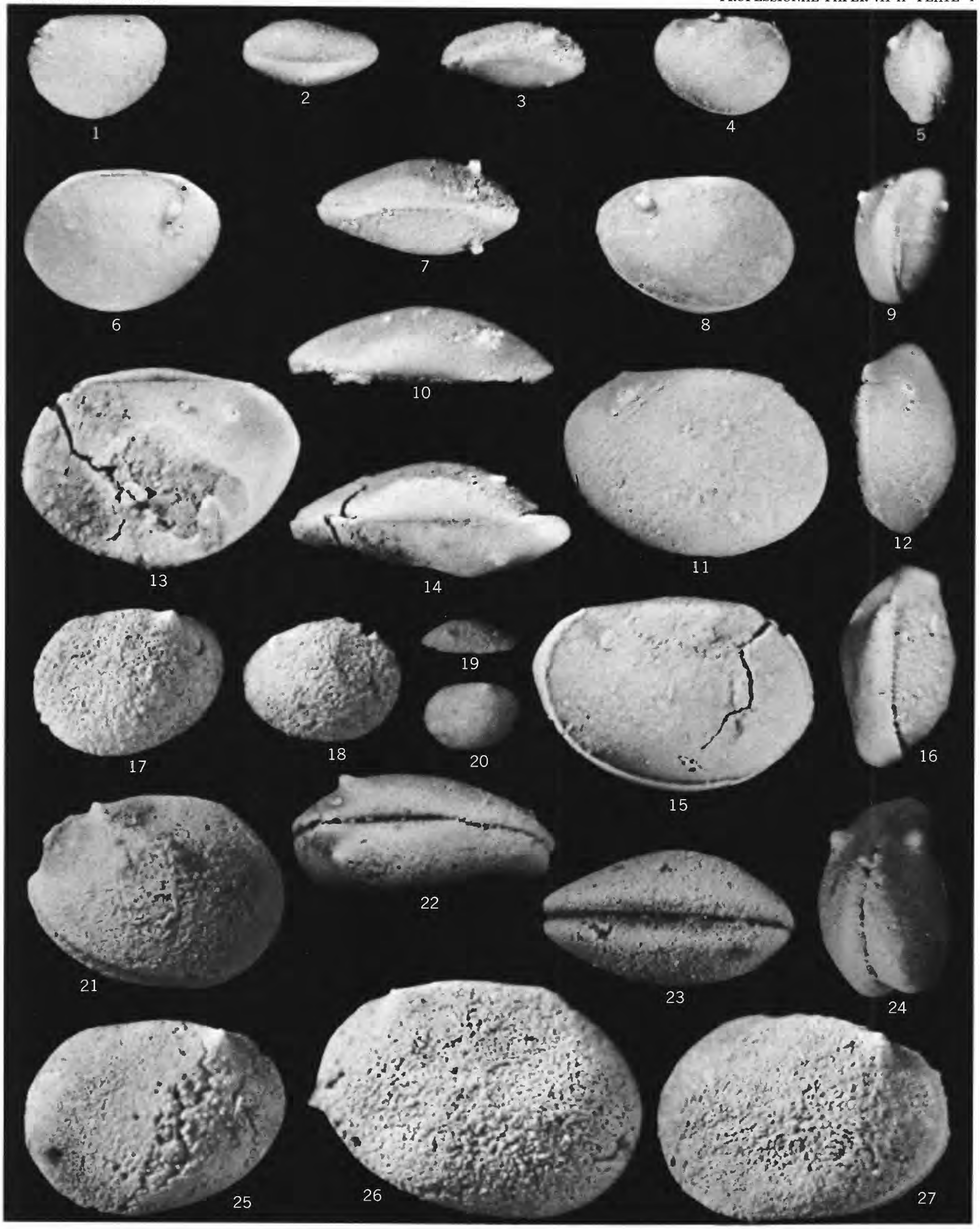
19, 20. Dorsal and lateral views of a left valve of a very young instar. Paratype, USNM 168025. Same collection and locality as figure 17. Photographs by N. W. Shupe.

21–24. Right, dorsal, ventral, and posterior views of a carapace. Paratype USNM 168028. Same collection, locality, and photographer as figures 19, 20.

25. Lateral view of a left valve. Paratype, USNM 168029. Same collection and locality as figure 17.

26. Lateral view of a right valve. Holotype, USNM 168032. Same collection and locality as figure 17.

27. Lateral view of left valve of carapace. Paratype, USNM 168030. Same collection and locality as figure 17.



SHIVAELLA

PLATE 5

[Magnification approximately × 20; photographs by R. H. McKinney]

FIGURES 1–21, 23–26. *Chamishaella aenigmatica* Sohn, n. sp. (p. A11).

1, 2. Right and dorsal views of a carapace, young instar. Paratype, USNM 168045. Alapah Limestone (lower Meramecian), Chandler Lake quadrangle, Alaska.

3–7. Right, dorsal, left, ventral, and posterior views of a carapace, larger instar. Paratype, USNM 168046. Same collection and locality as figures 1 and 2.

8–12. Left, dorsal, right, ventral, and posterior views of a carapace, larger instar than above. Paratype, USNM 168047. Same collection and locality as figures 1 and 2.

13–17. Right, dorsal, left, ventral, and posterior views of a carapace, larger instar than above. Paratype, USNM 168048. Same collection and locality as figures 1 and 2.

18, 19. Right and dorsal views of a partially exfoliated carapace that shows the location of the muscle-scar impression. Paratype, USNM 168049. Same collection and locality as figures 1 and 2.

20, 21. Right and posterior views of a carapace, heteromorph. Holotype, USNM 168052. Same collection and locality as figures 1 and 2.

23–26. Right, dorsal, left, and ventral views of a carapace, probably a tecnomorph larger than the holotype. Note partially exfoliated left valve exposing the amount of overlap along the venter and the rim along the venter of the right valve. Paratype, USNM 168050. Same collection and locality as figures 1 and 2.

22, 27–31, 34, 35, 38, 39. *Chamishaella*? sp. (p. A13).

27–31. Dorsal, left, ventral, right, and posterior views of carapace. Figured specimen, USNM 168053. Same collection and locality as figures 1 and 2.

22, 34, 35. Posterior, ventral, and right views of a steinkern of a larger carapace. Figured specimen, USNM 168054. Same collection and locality as figures 1 and 2.

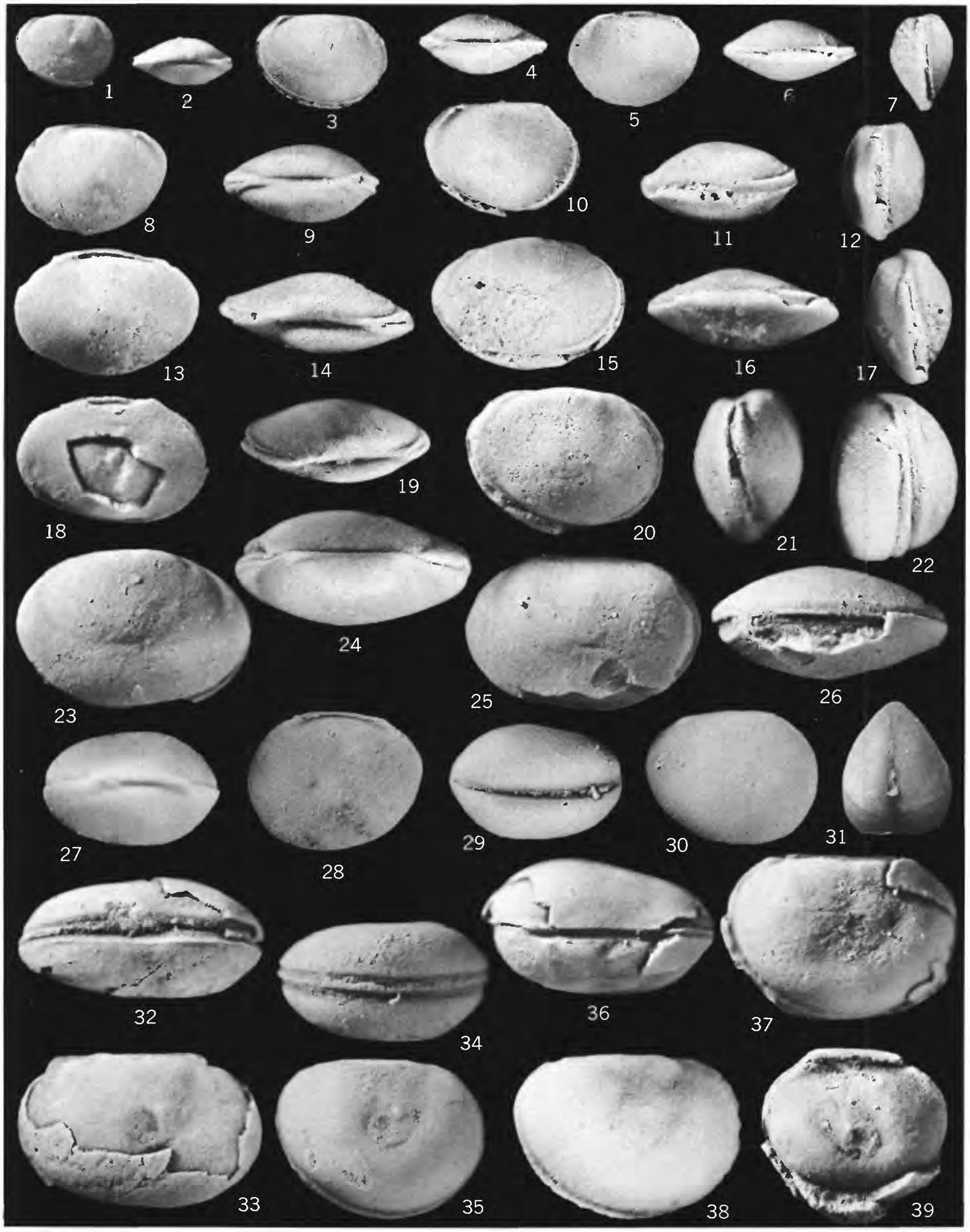
38. Right view of a steinkern. Figured specimen, USNM 168055. Same collection and locality as figures 1 and 2.

39. Left view of a carapace whose valve has been removed; limestone matrix adheres at the venter. Figured specimen, USNM 168056. Same collection and locality as figures 1 and 2.

32, 33, 36, 37. *Chamishaella* sp. aff. *Cythere inflata* Münster, 1830 (p. A13).

32, 33. Ventral and right views of a partially exfoliated carapace. Figured specimen, USNM 168058. Same collection and locality as figures 1 and 2.

36, 37. Dorsal and right views of a partially exfoliated carapace. Figured specimen, USNM 168059. Same collection and locality as figures 1 and 2.



CHAMISHAELLA AND *CHAMISHAELLA*?

PLATE 6

[Magnification approximately × 20; photographs by R. H. McKinney]

FIGURES 1–32. *Chamishaella brosgei* Sohn, n. sp. (p. A12).

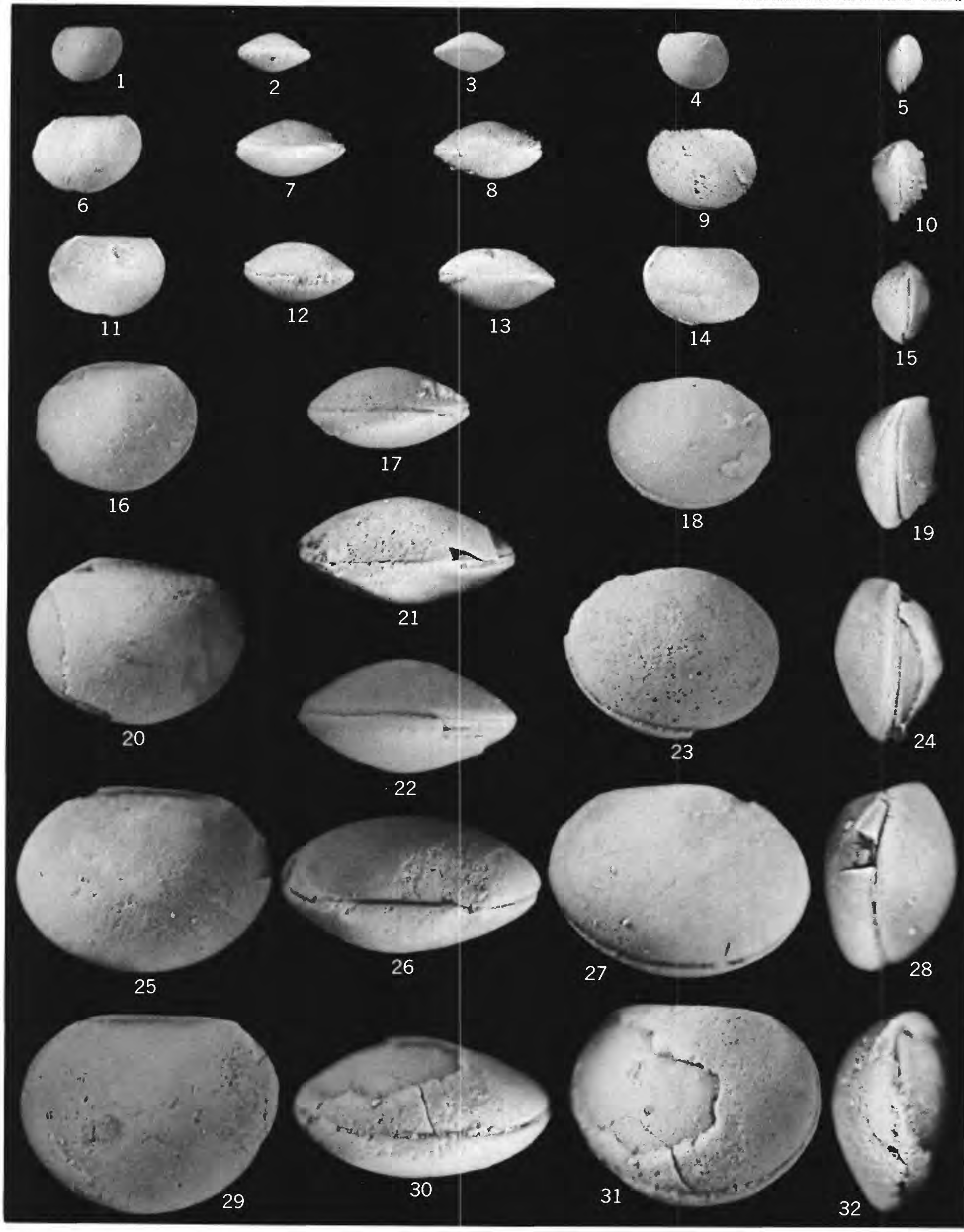
1–15. Left, ventral, dorsal, right, and posterior views of three carapaces, young stages of growth. Paratypes, USNM 168061–168063. Platy limestone member of the Alapah Limestone, Little Chandler Lake, Brooks Range, Alaska. USGS locality 13288.

16–19. Left, ventral, right, and posterior views of carapace, slightly larger growth stage, figure 17 partially exfoliated on anterior part of venter. Paratype, USNM 168064. Same collection and locality as figures 1–15.

20–24. Left, dorsal, ventral, right, and anterior views of carapace representing a still larger growth stage, partially exfoliated on anterior part of venter in figure 22. Paratype, USNM 168065. Same collection and locality as figures 1–15.

25–28. Left, dorsal, right, and posterior views of carapace, presumed adult female. Holotype, USNM 168068. Same collection and locality as figures 1–15.

29–32. Left, ventral, right, and posterior views of carapace, presumed adult male. Paratype, USNM 168066. Same collection and locality as figures 1–15.



CHAMISHAELLA

PLATE 7

[Magnification approximately × 20; photographs by R. H. McKinney]

FIGURES 1–35. *Shishaella cyclopea* (Girty, 1910) (p. A14).

1–4. Left, dorsal, right, and posterior views of a carapace, very young instar. Topotype, USNM 168100. Fayetteville Shale, Washington County, Ark. USGS locality 5553.

5–8. Left, dorsal, right, and posterior views of a carapace, approximately the same growth stage as above. Topotype, USNM 168101. Same collection and locality as figures 1–4.

9, 10. Right and dorsal views of carapace of a larger instar. Figured specimen, USNM 153785. The same illustrations as by Sohn (1969, pl. 8, figs. 15, 16). Black limestone near base of Fayetteville Shale, 20 feet above top of Boone Formation, Washington County, Ark.

11, 12. Right and dorsal views of a larger instar. Figured specimen, USNM 153786. The same illustrations as by Sohn (1969, pl. 8, figs. 17, 18). Same collection and locality as figures 9 and 10.

13, 14. Right and dorsal views of a carapace, larger instar. Topotype, USNM 168102. Same collection and locality as figures 1–4.

15–18. Posterior, right, dorsal, and left views of a carapace either the same or the next larger instar than figures 13 and 14. Topotype, USNM 168103. Same collection and locality as figures 1–4.

19, 20. Right and dorsal views of a carapace. Probably the same growth stage as figures 9 and 10. Topotype, USNM 168104. Same collection and locality as figures 1–4.

21. Interior of a fragment of a right valve; note hinge and muscle scars. Topotype, USNM 168108. Same collection and locality as figures 1–4.

22–25. Right, dorsal, left, and inside fragment of shell removed from left of a carapace; note muscle scar on mold and on shell. Still larger instar. Topotype, USNM 168105. Same collection and locality as figures 1–4.

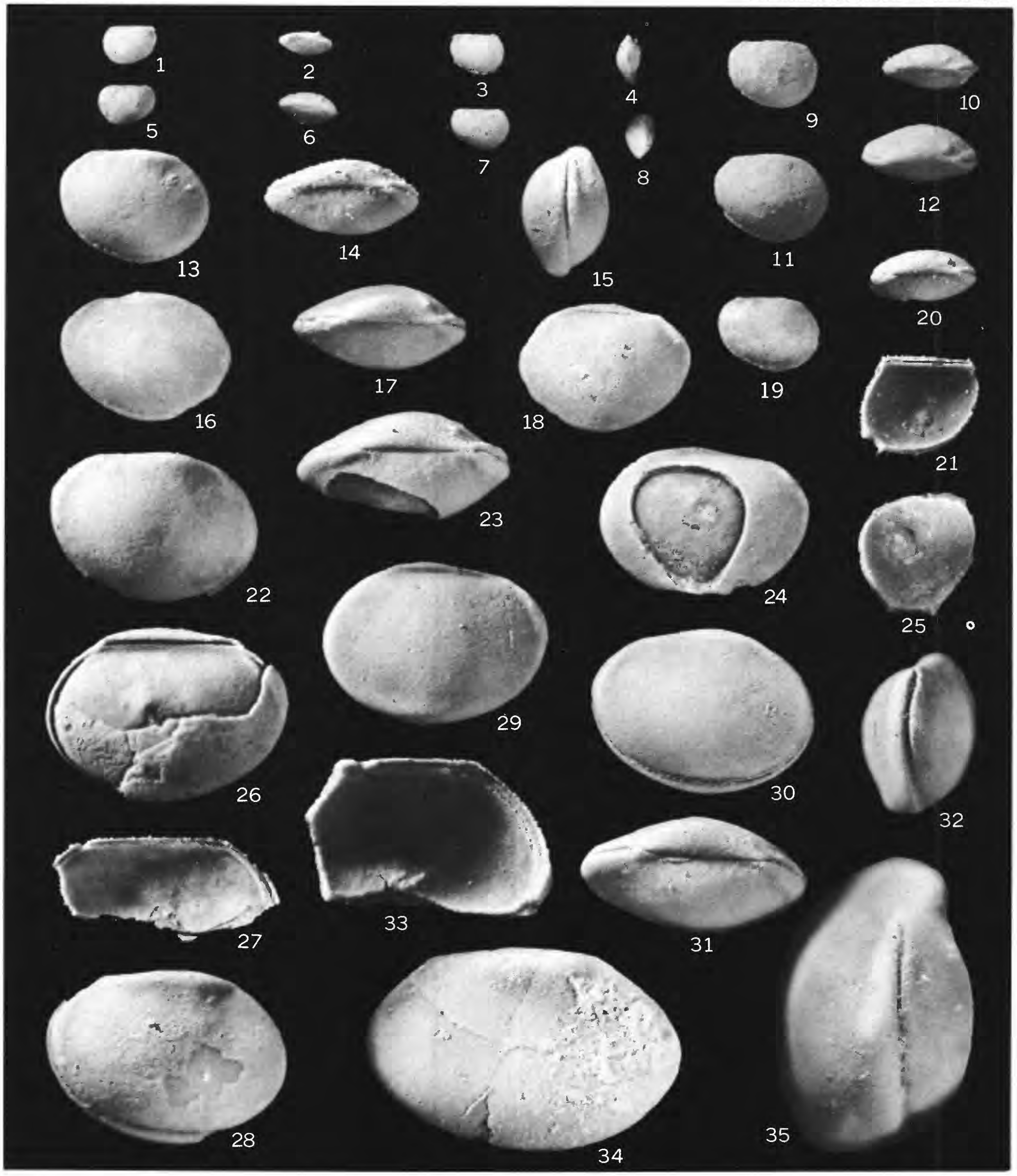
26–28. Left, inside of part of left valve, and right valve of a carapace. Note hinge impression and muscle scar in figure 26 and hinge and muscle scar in figure 27. Topotype, USNM 168107. Same collection and locality as figures 1–4.

29–32. Left, right, dorsal, and posterior views of a carapace. Note ventral bulge in figures 29 and 32. Topotype, USNM 168106. Same collection and locality as figures 1–4.

33. Inside of a fragment of a left valve that was converted to fluorite. Note hinge and dorsoanterior overlap. Topotype, USNM 168109. Same collection and locality as figures 1–4.

34. Right view of a valve in matrix. Holotype of *Paraparchites projectus* Harris and Jobe, 1956. "Manning" horizon (Chester), discovery well in Ringwood Oil Pool, core 6801–20 feet, Major County, Okla. University of Oklahoma collection MC 6A.

35. Posterior view of carapace. Paralectotype, USNM 153788. Other views were illustrated by Sohn (1969, pl. 8, figs. 22–24). Same collection and locality as figures 1–4.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SHISHAELLA

PLATE 8

[Magnification approximately × 20; photographs by R. H. McKinney]

FIGURES 1–5. *Shishaella williamsae* Sohn, n. sp. (p. A15).

Right, ventral, left, dorsal, and posterior views of a carapace of a very young individual. Paratype, USNM 168069. Alapah Limestone, Brooks Range, Alaska, USGS locality 13288.

6–10. *Shishaella* cf. *S. williamsae* Sohn (p. A16).

Right, ventral, left, dorsal, and posterior views of a young instar. Figured specimen, USNM 168077. Same collection and locality as figures 1–5.

11–25. *Shishaella williamsae* Sohn, n. sp.

Right, ventral, left, dorsal, and posterior views of three carapaces representing two growth stages. Paratypes, USNM 168070–168072. Same collection and locality as figures 1–5. Note the groove in figure 16 that corresponds in size to the specimen represented by figure 11.

26–30. *Shishaella* cf. *S. williamsae* Sohn (p. A16).

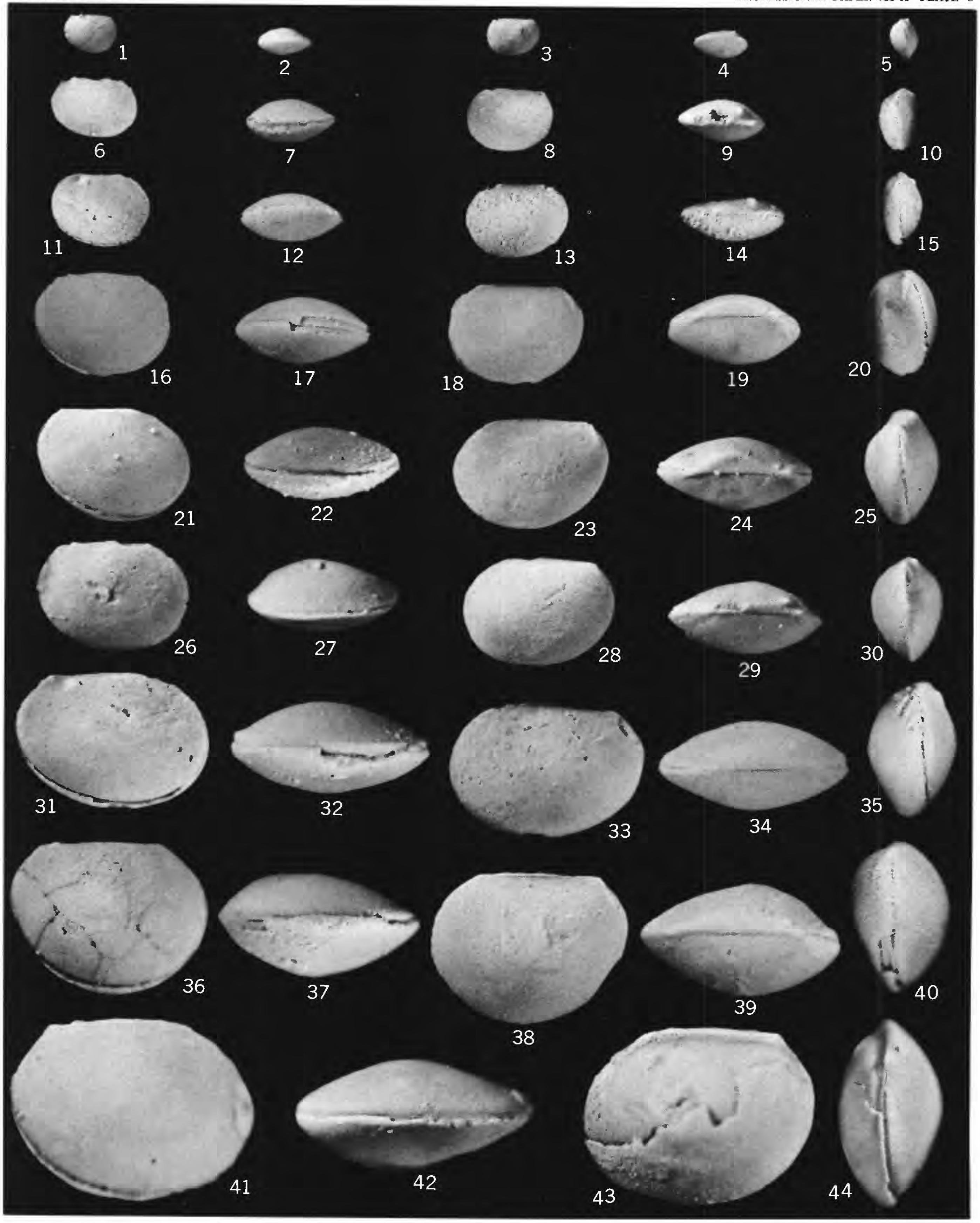
Right, ventral, left, dorsal, and posterior views of carapace. Figured specimen, USNM 168078. Same collection and locality as figures 1–5.

31–44. *Shishaella williamsae* Sohn, n. sp.

31–35. Right, ventral, left, dorsal, and posterior views of presumed adult male carapace. Paratype, USNM 168073. Same collection and locality as figures 1–5.

36–40. Right, ventral, left, dorsal, and posterior views of presumed adult female carapace. Holotype, USNM 168076. Same collection as figures 1–5.

41–44. Right, ventral, left, and posterior views of a partially exfoliated presumed male carapace. Paratype, USNM 168074. Same collection and locality as figures 1–5.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SHISHAELLA

PLATE 9

[Magnification approximately × 20; photographs by R. H. McKinney]

FIGURES 1–44. *Shemonaella dutroi* Sohn, n. sp. (p. A17).

1–5. Right, dorsal, left, ventral, and posterior views of a carapace from which some shell material appears to have been removed, very young instar. Paratype, USNM 168080. Alapah Limestone, Chandler Lake quadrangle, Alaska, USGS locality 13288.

6–10. Right, dorsal, left, ventral, and posterior views of a carapace having the same preservation as figures 1–5, slightly larger instar. Paratype, USNM 168081. Same collection and locality as figures 1–5.

11–15. Right, dorsal, left, ventral, and posterior views of a carapace of a slightly larger instar than figures 6–10; note crushed ventroanterior in figure 13. Paratype, USNM 168082. Same collection and locality as figures 1–5.

16–20. Right, dorsal, left, ventral, and posterior views of a carapace of a still larger instar. Paratype, USNM 168083. Same collection and locality as figures 1–5.

21–25. Right, dorsal, left, ventral, and posterior views of a carapace representing either the same or the next instar illustrated in figures 16–20. Paratype, USNM 168084. Same collection and locality as figures 1–5.

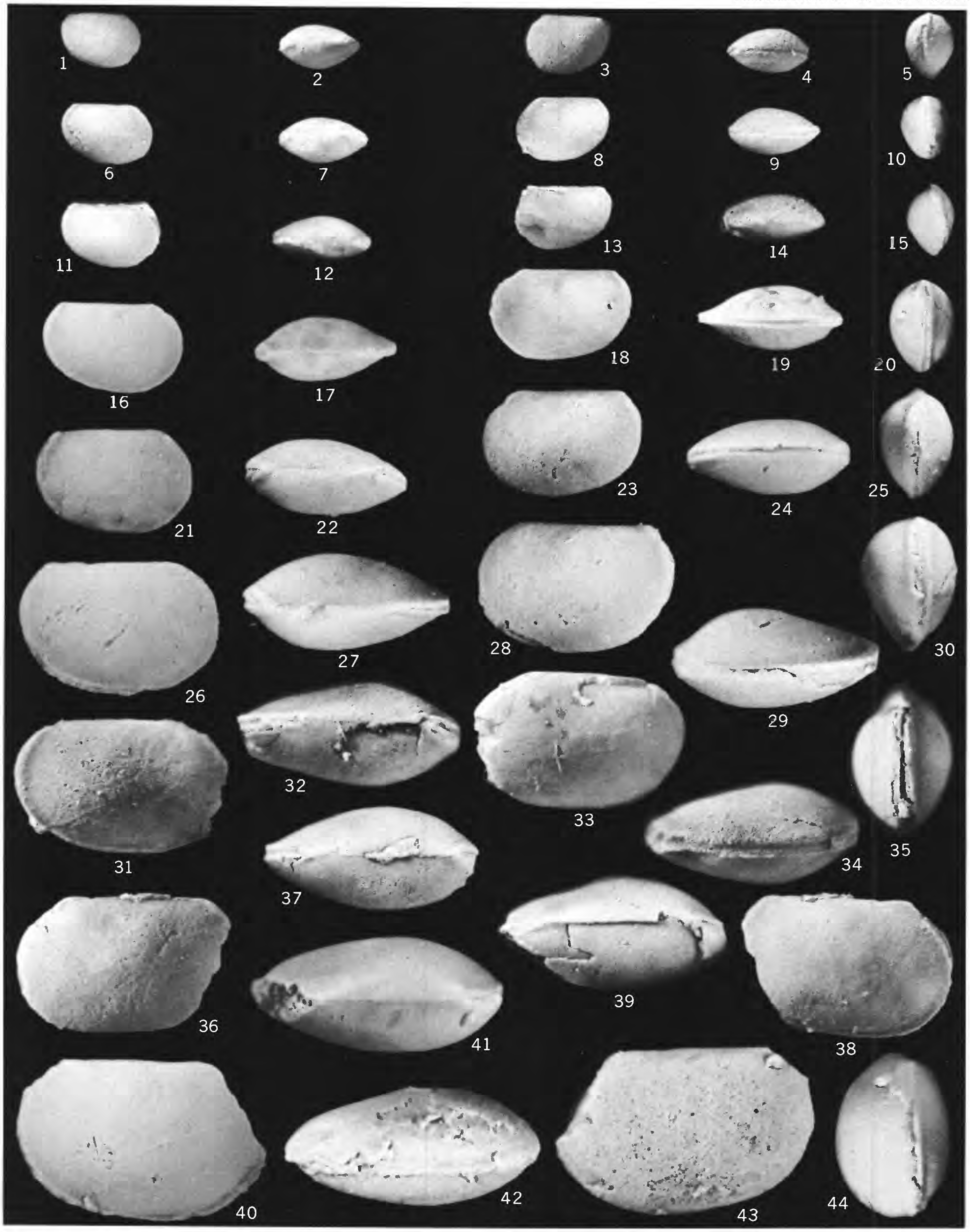
26–30. Right, dorsal, left, ventral, and posterior views of a carapace, possibly an adult tecnomorph. The shell appears to be missing along the venter of figure 29. Paratype, USNM 168085. Same collection and locality as figures 1–5.

31–35. Right, dorsal, left, ventral, and posterior views of a broken carapace, missing its shell, possibly a heteromorph. Paratype, USNM 168086. Same collection and locality as figures 1–5.

36–38. Left, dorsal, and right views of a carapace missing the posterior. Paratype, USNM 168087. Same collection and locality as figures 1–5.

39. Dorsal view of a broken carapace of an adult heteromorph having the shell preserved. Paratype, USNM 168088. Same collection and locality as figures 1–5.

40–44. Right, dorsal, ventral, left, and posterior views of a broken carapace of a heteromorph. Holotype, USNM 168090. Same collection and locality as figures 1–5.



SHEMONAELLA