# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma


Introduction
*By* MACKENZIE GORDON, JR.

Corals
*By* WILLIAM J. SANDO

Pelecypods
*By* JOHN POJETA, JR.

Gastropods
*By* ELLIS L. YOCHELSON

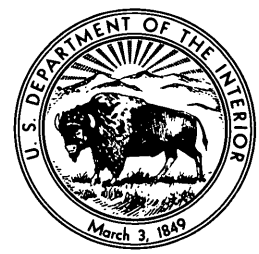
Trilobites
*By* MACKENZIE GORDON, JR.

Ostracodes
*By* I. G. SOHN



GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-A, B, C, D, E, F


*Papers illustrating and describing certain of G. H. Girty's invertebrate fossils from the Fayetteville Shale*





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# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Introduction

*By* MACKENZIE GORDON, JR.

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-A

*Collecting localities and biostratigraphic background for G. H. Girty's new species of invertebrates from the Fayetteville Shale*

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# ILLUSTRATION


PLATE 9. Map showing collecting localities for Girty's Fayetteville Shale fauna in northeastern Oklahoma and northwestern Arkansas ---------- In pocket.

# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—INTRODUCTION

By MACKENZIE GORDON, JR.


## ABSTRACT

In 1910, G. H. Girty published a paper on the fauna of the Fayetteville Shale of northern Arkansas and northeastern Oklahoma in which he described 110 new taxa of fossil invertebrates. He did not, however, designate any type specimens or divulge the localities at which the fossils were collected, nor did he illustrate the species. The present study is designed to fill the gaps in information on some of these species and to bring them as far as possible up to date and in line with the modern scheme of classification.

This report deals with the corals, pelecypods, gastropods, trilobites, and ostracodes. It does not include the brachiopods and bryozoans. The study has been performed by specialists of the U.S. Geological Survey who are contributing separate parts to the volume.

This introductory part outlines the problem and the solutions employed, lists Girty's collecting localities, and discusses the general stratigraphy of the Fayetteville Shale. Thirty-three of Girty's collections came from the basal part of the formation, known by its ammonoid fauna to be of late Viséan age. Two collections came from higher levels, one of them certainly from early Namurian equivalents. Three other collections that included important elements of Girty's type material are from the Batesville Sandstone.


## PREVIOUS INVESTIGATIONS

In 1910, G. H. Girty published the first of several papers on the Late Mississippian faunas of northern Arkansas. In his paper in the Annals of the New York Academy of Sciences he described 110 new taxa of fossils from the Fayetteville Shale. Unfortunately, he published no illustrations to accompany his descriptions, nor did he include any information as to the fossil localities from which his specimens were collected. Apparently, he intended to publish a more comprehensive treatment of the Fayetteville Shale fauna at a later date, as he did of the Wewoka fauna several years later (Girty, 1915b). Indeed, he prepared, with a few exceptions, figures and descriptions of the entire fauna of the Fayetteville Shale, including those species he did not regard as new. But for reasons not known, Girty never managed to complete the Fayetteville manuscript. He illustrated many of his Fayetteville Shale species in papers on the Moorefield Shale (Girty, 1911) and the Batesville Sandstone (Girty, 1915a), but not from the original specimens.

Girty's 1910 paper described a large number of bryozoans, including eight new genera and subgenera. Bassler (1941) published a short paper giving diagnoses of essential characters of all eight generic taxa, accompanied by drawings made from Girty's thin sections. He cited the provenance for all of them merely as "Fayetteville Shale. Vicinity of Fayetteville, Ark."

## PRESENT STUDY

The present study of Girty's material has been undertaken in order that illustrations of his types and locality information omitted by him in the 1910 paper be made available to the paleontologic profession and to the public in general. In addition, the selection of lectotypes by specialists in the several fossil groups serves to establish Girty's species on a firmer basis and document the type localities where topotypes may be secured.

A breakdown of the 110 new taxa described by Girty from the Fayetteville Shale is shown in the following table.

| | *New genera* | *New subgenera* | *New species* | *New varieties* | *Totals* |
|---|---|---|---|---|---|
| Corals | | | 2 | 1 | 3 |
| Bryozoans | 4 | 4 | 24 | 11 | 43 |
| Brachiopods | | 1 | 9 | 14 | 24 |
| Pelecypods | | | 19 | | 19 |
| Gastropods | | | 7 | | 7 |
| Ostracodes | 2 | | 7 | 4 | 13 |
| Trilobites | | | 1 | | 1 |
| Totals | 6 | 5 | 69 | 30 | 110 |

In this tabulation, what Girty regarded both as new genera and subgenera are considered genera by modern workers. The species, with the main exception of one that is synonymous with another of his species, are still regarded as valid. His varieties fall into several categories. Although varieties are not considered to be taxa that require formal names under the present International Code of Zoological Nomenclature, nevertheless, because Girty's names were published before 1961, they can be use if the taxa are now regarded as valid species or subspecies. Of Girty's "varieties," therefore, in the present report, part are regarded as species in their own

right, part as subspecies, and part as not sufficiently differentiated from earlier species to merit recognition.

In this joint report, the corals were studied by William J. Sando, the pelecypods by John Pojetta, Jr., the gastropods by Ellis L. Yochelson, the trilobites by Mackenzie Gordon, Jr., and the ostracodes by I. G. Sohn.

Not included in the present report are the brachiopods and bryozoans, which constituted about three-fifths of Girty's new taxa from the Fayetteville Shale. A study of the brachiopods has been begun by Mackenzie Gordon Jr. and will be published separately. Little likelihood exists for publishing redescriptions and illustrations of the bryozoans in the near future. These present special difficulties. The thickness and relative poor condition of Girty's thin sections precludes their use for adequately illustrating Girty's genera and species. Nor is it possible to remount and regrind these sections. New sections must be cut, perhaps in part from new material collected from Girty's localities.

## ACKNOWLEDGMENTS

We are indebted to Prof. J. H. Quinn of the University of Arkansas whose convincing arguments as to the need for such a paper as this provided the initial motivation for this study.

## TYPES

As Girty designated no types and, in fact, divulged no collecting localities in his 1910 paper, the authors of this study have decided that all the material in Girty's collections actually from the Fayetteville Shale and labeled by him as belonging in his new taxa shall be considered primary types. A lectotype for each species is designated except where Girty's description is based on a single specimen, which is the holotype. The rest of the primary type material we regard as paralectotypes.

In almost every species the lectotype is a specimen that Girty himself selected for figuring. He had photographs made of these on matte paper so that they could be retouched by an artist. He marked each of these specimens with a special number to indicate illustrated material and kept it in a separate set. It is thus simple to recognize the material upon which the major part of his descriptions were based.

Some special problems have arisen in selecting types that show both internal and external characters adequately. This has called for supplementary material to be used for illustration by the present authors. In the corals: Girty ground down and thus partly destroyed his illustrated specimen to show cross sections only; Sando found it necessary to select a complete specimen to show external form and then make a series of cross sections using peel techniques. In the ostracodes: inadequate preservation of some of Girty's specimens has made it necessary for Sohn to seek new material by crushing the excess rock matrix of Girty's collections. Some of these topotypes are better preserved than the primary types.

Each author has worked out these problems one by one as they presented themselves, with the idea of fitting each species into the framework of present day classification. This is the intent and purpose of the present report.

## FAYETTEVILLE SHALE

The Fayetteville Shale, named by Simonds (1891, p. 42–48) for exposures at Fayetteville, Ark., is the most widely exposed of the formations of Late Mississippian (Chester) age in the Ozark Plateaus. From its easternmost exposure at the edge of the Mississippi River embayment near the settlement of Oil Trough, Independence County, Ark., it extends westward along the Boston Mountain escarpment and across northwest Arkansas almost continuously, with many outliers and inliers, into Oklahoma. In northeastern Oklahoma the Fayetteville Shale is exposed in a great C-shaped band of outcrop in the Wyandotte, Pryor, Vinita, Tahlequah, and Muskogee 30-minute quadrangles, somewhat augmented because of repetition by en echelon faulting in the Tahlequah and Muskogee quadrangles.

The formation is as much as 400 feet thick locally, but is normally between 200 and 300 feet thick. At its type locality (Adams and Ulrich, 1905, p. 4) and extending southwestward into the Tahlequah quadrangle, Oklahoma (Taff, 1905, p. 3), and eastward into the Marshall quadrangle, Arkansas, three members can be recognized in the Fayetteville Shale: a thick lower shale member; a fairly thick middle sandstone unit, the Wedington Sandstone Member, named by Adams (1904, p. 27); and a normally thin upper shale member. East and south of Pilot Mountain near St. Joe, Searcy County, Ark., the Wedington is absent. In Independence County, however, a limestone unit resembling the Pitkin Limestone occurs at approximately the same stratigraphic position that the Wedington Sandstone Member occupies farther to the west.

The typical shale is grayish black, rather silty, carbonaceous, normally fissile, locally papery, and weathers to a red or yellow clay. Concretions, fairly common in the lower part, consist of dense fine-grained dark-gray limestone and orange to reddish-brown clay ironstone, limonite, or siderite, some of them quite large and of the septarian type. At many localities a fossiliferous dark-gray limestone bed, commonly 2–3 feet thick but

as much as 10 feet thick locally, is present at the base of the formation, and it is from this limestone that most of the Fayetteville fossils described by Girty were collected.

The Wedington Sandstone Member consists normally of tan to gray-brown dense hard fine-grained flaggy sandstone, locally calcareous. In the thicker parts the beds commonly are massive. This member typically occupies a stratigraphic position from about the middle to near the top of the formation. It reaches a thickness of 150 feet at its type locality on Wedington Mountain, Washington County, Ark., but is thinner both to the east and to the west.

The upper shale member is somewhat like the lower member, but the shale is generally more platy and less fissile. It is more thickly bedded than the lower shale member and commonly is nodular (Purdue, 1907, p. 3). Intercalated blocky beds, 3 inches to 1 foot thick, of dark-gray fine-grained hard limestone are common in the upper part of the Fayetteville Shale, particularly in the region east of St. Joe. The upper member, locally absent, is commonly about 15–30 feet thick, but is as much as 70 feet thick in the area east of Elkins, in the southwest corner of the Eureka Springs quadrangle (Purdue and Miser, 1916, p. 13).

Throughout most of the region of its outcrop in Arkansas the Fayetteville Shale conformably overlies the Batesville Sandstone and is in turn overlain conformably by the Pitkin Limestone. In some parts of Washington and Madison Counties the Pitkin was entirely removed by erosion just prior to the deposition of the Cane Hill Member of the Hale Formation and locally, as in the town of Fayetteville, the Cane Hill Member rests directly upon the Fayetteville Shale.

In the southern part of its outcrop belt in Oklahoma the same relationship exists. In parts of the Muskogee, Pryor, Vinita, and Wyandotte quadrangles the Pitkin Limestone is absent and the Fayetteville is directly overlain by rocks of the Morrow Series (Snider, 1915, p. 40, 41, 44–47). In other parts of the Pryor, Vinita, and Wyandotte quadrangles, the Middle Pennsylvanian rocks overlap the Lower Pennsylvanian (Morrow) rocks northward and rest directly upon the Fayetteville Shale, which eventually is truncated northward and westward by erosion.

## COLLECTING LOCALITIES

In the introduction to his Fayetteville paper, Girty (1910, p. 189) stated that a "rather persistent calcareous bed at the very base of the formation has furnished the new species described below, except for a very few which came from a locality in the Batesville sandstone near the town of Fayetteville." Actually, the material that Girty set aside and arranged systematically by taxa as constituting the basis for his Fayetteville Shale paper includes Batesville Sandstone collections from the vicinities of Fayetteville, Pea Ridge, and St. Joe, Ark., some 13 collections in all.

It has been the decision of the authors of the present study that inasmuch as the title of Girty's paper makes no mention of the Batesville Sandstone and as nearly all the specimens selected by Girty for figuring are from the basal part of the Fayetteville Shale, pre-Fayetteville collections should be as far as possible eliminated from consideration. Girty apparently had come to the same decision, as is indicated by his having removed some Batesville Sandstone fossils to another location and drawer, accompanied by a note that they were not to be included in the report. We are, therefore, including for consideration in this report only three collections from the Batesville Sandstone. These are USGS localities 2839, which provided the primary types of the coral *Palaeacis carinata* Girty; 2840, which contained the lectotype of the snail *Platyceras subelegans* Girty; and 5556, from which was taken the largest pygidium (paralectotype) of the trilobite *Paladin mucronatus* (Girty).

Girty's collections from the Fayetteville Shale total 35, all but two of which came apparently from the basal few feet of the formation. One of the exceptions (USGS loc. 1412A) is from limestone intercalated with shale at an undisclosed distance above the top of the Batesville Sandstone and the other (USGS loc. 5551) is from near the top of the Fayetteville Shale. The collections studied by Girty were not made solely by him, but by a number of the early paleontologists and stratigraphers who worked with the U.S. Geological Survey before and just after the turn of the century. Included in this group, besides Girty, were G. D. Harris, W. P. Jenney, R. D. Mesler, H. D. Miser, A. H. Purdue, F. W. Simonds, J. A. Taff, E. O. Ulrich, H. S. Williams, and others. That so many collectors would have restricted their collecting to the basal part of the formation may seem surprising until it is remembered that the highly fossiliferous layers, except for some concretionary ones where cephalopods predominate, are virtualy restricted to the base of the Fayetteville, except locally in Oklahoma.

The collecting localities extend westward from Boone County, Ark., to near Adair, Mayes County, Okla. The localities, their descriptions, and the collectors and dates of collecting are given below. All of the locality numbers are from an early catalog started by H. S. Williams and predate the present register of late Paleozoic localities of the U.S. Geological Survey. The localities,

with one exception, are shown on plate 1. Uncertainty as to the precise location of USGS locality 3637 "near Fayettevile, Ark.," precludes showing it on the map.

*Register of Fayetteville Shale collecting localities*

| *USGS loc.* | *Description and collectors* |
|---|---|
| 1292A | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Sec. 15, T. 17 N., R. 29 W. G. D. Harris, circa 1888. [USGS Folio 119 (Adams and Ulrich, 1905) shows Fayetteville Shale cropping out in NW¼ and SW cor. sec. 15.] |
| 1292B3 | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Lemons coal bank, sec. 22, T. 17 N., R. 29 W. G. D. Harris, circa 1888. [USGS Folio 119 (Adams and Ulrich, 1905) shows Fayetteville Shale cropping out in SW¼ sec. 22.] |
| 1339A | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Sam Eidson's stillhouse, 9 miles northeast of Fayetteville (see 1339E). From black limestone near base of Fayetteville Shale, 20 ft above top of Boone limestone. W. P. Jenney, Aug. 28, 1891. |
| 1339B | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Near Sam Eidson's stillhouse. From a thin local layer of dark limestone in Fayetteville Shale (Williams, 1900, p. 361) |
| 1339E | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. About 5½ miles southeast of Springdale; a short distance downslope from remains of Sam Horn's stillhouse (formerly Sam Eidson's and since burned down); in faulted area, south of fault, south of center SE¼ sec. 16, T. 17 N., R. 29 W. G. H. Girty, Oct. 5, 1908. |
| 1339G | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Vicinity of Sam Eidson's stillhouse. Fossils from limestone in Fayetteville Shale, incorrectly included with collection 1339D, which is from the Boone Formation. |
| 1412A | Harrison quadrangle, Carroll County, Ark. Beyond Carrolton in S½NE¼ sec. 19, T. 19 N., R. 22 W. Marshall Shale (Fayetteville of present usage) and limestone. H. S. Williams, Sept. 20, 1890. [Girty believed, from slabs of *Archimedes*-bearing limestone included in this collection, that it came from Pitkin Limestone, but Williams's field notes show limestone as lenses interbedded with shale a short distance above Batesville Sandstone.] |
| 2845 | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Road at base of Price Mountain, west side, in sec. 4, T. 17 N., R. 29 W., E. F. Burchard, Sept. 18, 1902. |
| 3636 | Muskogee quadrangle (Hulbert 15-min quad.), Cherokee County, Okla. Tahlequah-Menard road, near center sec. 6, T. 16 N., R. 22 E. Fayetteville Shale, limestone in lower part. E. O. Ulrich, T. Shaler, and W. S. T. Smith, July 22, 1904. |
| 3637 | Fayetteville quadrangle(?), Washington County(?), Ark. Near Fayetteville, Ark. R. D. Mesler, 1904(?) [Fauna and matrix appear to be typical of limestone of basal Fayetteville Shale.] |
| 3638 | Muskogee quadrangle (Hulbert 15-min quad.), Cherokee County, Okla. Tahlequah-Menard road, near line between secs. 5 and 6, T. 16 N., R. 22 E. E. O. Ulrich and J. A. Taff, July 22, 1904. |
| 3638A | Muskogee quadrangle (Hulbert 15-min quad.), Cherokee County, Okla. Same as 3638. |
| 3640 | Winslow quadrangle, Washington County, Ark. Just south of the town of Morrow. Fayetteville Shale, limestone in basal part above wavy layer. E. O. Ulrich and W. S. T. Smith, July 1904. |
| 3641 | Winslow quadrangle, Washington County, Ark. ½ mile south of Morrow. Fayetteville Shale, limestone in basal part above wavy layer. J. A. Taff, E. O. Ulrich, W. S. T. Smith, and A. H. Purdue, July 18, 1904. |
| 3641A | Winslow quadrangle, Washington County, Ark. ½ mile south of Morrow in bed of creek. Fayetteville Shale, basal limestone, 5–10 feet thick. G. H. Girty, Sept. 30, 1908. |
| 3651 | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. Vicinity of Fayetteville, SW. cor. sec. 9, T. 16 N., R 29 W. R. D. Mesler. [This locality is approximately ½ mile south of Wyman, near north end of dam constructed in early 1960's.] |
| 3651A | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. Along south bluff of hill, south half sec. 9, T. 16 N., R. 29 W. Fayetteville Shale, lower part. R. D. Mesler. [Girty notes that this seems to be same locality as 3651 and 3652. Most of bluff mentioned by Mesler lies in NW¼ sec. 16.] |
| 3651B | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. Same locality as 3651 and 3652 Mesler's personal collection from his locality A3, acquired by purchase. |
| 3651C | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. Same locality as 3651 and 3652, near Round Mountain. Base of Fayetteville Shale R. D. Mesler and G. H. Girty, Sept. 26, 1907. |
| 3652 | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. Vicinity of Fayetteville, south side of hill, southern half sec. 9, T. 16 N., R. 29 W. Fayetteville Shale, R. D. Mesler. |
| 5550 | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. NW¼NW¼ sec. 27, T. 17 N., R. 29 W. Black limestone with fossils at base of Fayetteville Shale. G. D. Harris, circa 1888. [See Simonds, 1891, p. 135, sec. 5 for nearby measured section.] |
| 5550A | Fayetteville quadrangle (Elkins 7½-min quad.), Washington County, Ark. NW¼NW¼ sec. 27, T. 17 N., R. 29 W. Limestone at bottom of Fayetteville Shale. F. W. Simonds, circa 1888. [Approximately same locality as 5550.] |
| 5551 | Fayetteville quadrangle (Fayetteville 7½-min quad.), Washington County, Ark. Cut on St. Louis-San Francisco Railroad just north of Fayetteville. Near top of Fayetteville Shale. G. H. Girty, Aug. 23 and 26, 1902. [Girty's locality map shows this to be west of present Fayetteville City Park.] |
| 5553 | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. Webber Mountain, NW¼NW¼ sec. 4, T. 17 N., R. 29 W. Fayetteville Shale, R. D. Mesler, 1906. |

| USGS loc. | Description and collectors |
|---|---|
| 5553A | Fayetteville quadrangle (Sonora 7½-min quad.), Washington County, Ark. South side of Webber Mountain, 3 miles east of Springdale, ½ mile east of fork of road, about on line between secs. 4 and 5, where crossed by road. Along road and loose in field. Basal limestone of Fayetteville Shale. G. H. Girty, Oct. 5, 1908. |
| 7081 | Pryor quadrangle, Mayes County, Okla. At road crossing 5 miles due east of Adair, G. H. Girty, Sept. 14, 1908. [Girty thought this to be the same as one of the localities of Drake (1897).] |
| 7082 | Winslow quadrangle, Washington County, Ark. Along road, 3 miles southwest of Clyde. Southeast of center of sec. 24, T. 14 N., R. 33 W. Fayetteville Shale, basal limestone. G. H. Girty, Oct. 2, 1908. |
| 7084 | Harrison quadrangle, Boone County, Ark. Along road at house at road forks, SE¼SE¼ sec. 4, T. 18 N., R. 21 W. Top of Batesville Sandstone. G. H. Girty, Oct. 8, 1908. [Should be considered base of Fayetteville Shale.] |
| 7085 | Harrison quadrangle, Carroll County, Ark. Center of SW¼ sec. 6, T. 18 N., R. 22 W. Fayetteville Shale, 2½-ft limestone at base. R. D. Mesler and H. D. Miser, Oct. 30, 1908. |
| 7086 | Harrison quadrangle, Carroll County, Ark. NW¼ sec. 20, T. 18 N., R. 22 W. Fayetteville Shale, limestone at base. R. D. Mesler and H. D. Miser, Oct. 30, 1908. |
| 7087 | Winslow quadrangle, Washington County, Ark. Bed of Illinois River, 100 yds upstream from bridge, 2 miles northeast of Prairie Grove, in north part of SW¼ sec. 8, T. 15 N., R. 31 W. Fayetteville Shale, 1-ft limestone at base. G. H. Girty, Sept. 29, 1908. |
| 7088 | Tahlequah quadrangle, Adair County, Okla. Along dim road at foot of mountain, 1¼ miles south and ¼ mile east of Westville. Fayetteville Shale, lower horizon in basal limestone. G. H. Girty, Oct. 3, 1908. |
| 7088A | Tahlequah quadrangle, Adair County, Okla. Same locality as 7088. Middle horizon of basal limestone of Fayetteville Shale. G. H. Girty, Oct. 3, 1908. |
| 7088B | Tahlequah quadrangle, Adair County, Okla. Same locality as 7088. Upper horizon of basal limestone of Fayetteville Shale. G. H. Girty, Oct. 3, 1908. |
| 7088C | Tahlequah quadrangle, Adair County, Okla. Same locality as 7088. Very top of limestone, a few feet above 7088B. G. H. Girty, Oct. 3, 1908. |

*Supplementary register of Batesville Sandstone collecting localities that provided Fayetteville fauna type specimens*

| USGS loc. | Description and collectors |
|---|---|
| 2839 | Fayetteville quadrangle (Pea Ridge 7½-min quad.), Benton County, Ark. Small knob near center of sec. 23, T. 21 N., R. 29 W. Fossils from 100 ft of interbedded sandstone and limestone. R. D. Mesler, Mar. 14, 1901. [Matrix shows this to be a limestone in the Batesville Sandstone.] |
| 2840 | Fayetteville quadrangle (Pea Ridge 7½-min quad.), Benton County, Ark. Along ravine between secs. 27 and 22, T. 21 N., R. 29 W. Fossils from 100 ft of interbedded sandstone and limestone. R. D. Mesler, Mar. 15, 1901. [Matrix shows that this is from Batesville Sandstone.] |
| 5556 | Yellville quadrangle, Searcy County, Ark. Sandstone in creek bed, old town of St. Joe, Ark. "Batesville Sandstone." G. H. Girty, Sept. 21, 1907. [Despite Girty's quotation marks, this locality falls within area mapped by McKnight (1935, pl. 3) as Batesville Sandstone.] |

## NEW SPECIES OF INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE OTHER THAN THOSE OF GIRTY (1910)

It is difficult to ascertain the exact number of new species with a Fayetteville Shale provenance because for some of them the type locality and formation was not identified and some appear to be synonyms of earlier species. Nevertheless, in addition to the species described by Girty in his 1910 paper, more than 55 new species have been described from this formation by various authors.

Drake (1897) appears to have been the first to describe a Fayetteville brachiopod when he erected two new productoid species from Oklahoma and also figured a third. Snider (1915) described 12 new Fayetteville species from Oklahoma: a coral, seven brachiopods, two pelecypods, a gastropod, and a cephalopod, of which, he said, four are restricted to that formation. As Snider did not cite type specimens or identify the localities or formations and as the other eight species occur also in adjacent formations, it is not possible to tell from the published record how many valid species were based upon primary types from the Fayetteville Shale. The lectotype of one of them, the cephalopod, has since been shown to have come from the Fayetteville and at least two of them are synonyms of previously described species.

Girty (1929) described two pelecypods and a gastropod from the Fayetteville Shale in Arkansas. The same year, Harlton (1929) described 11 species of ostracodes from this formation both from Oklahoma and from Arkansas which appear to belong in eight genera. One of these has since been placed in synonymy.

Croneis (1930, pl. 18) established five new species of Fayetteville Shale invertebrates: a crinoid, a brachiopod, and three pelecypods, by illustrating them on a plate of characteristic fossils from this formation in his compendium on the geology of the Arkansas Paleozoic area. According to the International Code of Zoological Nomenclature, 1930 was the last year that a new species could be established by the indication merely of a photograph coupled with a name. These species have never been described or the whereabouts of their type localities and type specimens divulged. In the same paper, Croneis (1930, p. 69–72) also introduced a number of new names

for Fayetteville Shale species in his comprehensive faunal lists for the three main subdivisions of the formation. These listed names are nomina nuda and have no taxonomic standing.

Strimple (1962) has listed 13 species of crinoids from the Fayetteville Shale in Oklahoma. Ten of them, represening nine genera, were originally described and figured from the formation in several short papers by Strimple (1948, 1949, 1951a, b, c). Most of the crinoids came from thin limestone lentils in the shale in Craig County, Okla.

The cephalopods of the Fayetteville Shale have received considerable study in recent years. The following papers have described a total of 27 new species from the formation, all of them from Arkansas.

Croneis (1926) described and figured a new genus and three new species of actinoceroids from the lower member of the formation. Flower and Gordon (1959) described and figured three new genera and four new species of coleoid cephalopods. The holotype of one of them, however, came from the Chainman Shale of Utah. Gordon (1960) described and illustrated a new nautiloid genus and species and two new ammonoid genera and species from the Fayetteville Shale.

McCaleb, Quinn, and Furnish (1964, p. 28–31), in a review of some members of the family Girtyoceratidae, established another new genus and species of ammonoids. Saunders (1964) described and figured another ammonoid.

Gordon (1964), in a monographic study on the Carboniferous cephalopods of Arkansas, described 50 species identifiable as to genus from the Fayetteville Shale including eight new species of nautiloids and seven of ammonoids.

Conodonts are locally common in the Fayetteville Shale, but have not yet been described. It appears likely that the invertebrate fauna of the Fayetteville Shale, when adequately studied, will number well in excess of 300 species.

## BIOSTRATIGRAPHIC CONSIDERATIONS

More than one fauna is present in the Fayetteville Shale. Studies of the ammonoids (Gordon, 1964, p. 72–74) have shown that two distinct assemblage zones can be recognized in the formation and these can be correlated with stages and ammonoid zones of northwest Europe. The lower part of the Fayetteville Shale in which are found ammonoids of the *Goniatites granosus* Zone is equivalent to the uppermost part of the Viséan Stage of northwest Europe; the upper and by far the greater part of the formation is occupied by the *Tumulites varians* Zone of Gordon, 1969 [=*Eumorphoceras milleri* Zone of Gordon, 1964, p. 73] and is equivalent to the lowermost part of the Namurian Stage of northwest Europe. In some places, for example in the vicinity of the town of Marshall, Searcy County, Ark., the *Tumulites varians* Zone occupies the entire thickness of the Fayetteville (Gordon, 1964, p. 73–74).

Almost without exception, the Fayetteville Shale collections studied by Girty (1910) are from the basal limestone of the formation and belong in the *Goniatites granosus* Zone, Cephalopods characteristic of this zone were, in fact, identified in some of Girty's Fayetteville collections and these collections can be recognized by their numbers in the report on the Arkansas Carboniferous cephalopods (Gordon, 1964, table 2).

Only one of Girty's Fayetteville collections can be said to have come undoubtedly from the lower Namurian part of the formation. This is the collection (USGS loc. 5551) from near the top of the shale at Fayetteville that provided the holotype of *Camarotoechia purduei laxa* Girty. Another collection (USGS loc. 1412A) is possibly from the Namurian part of the formation, but as the distance above the base of the Fayetteville Shale was not recorded for this collection and no ammonoids were found in it, the containing bed cannot be assigned definitely to either zone.

The two collections from the Batesville Sandstone (USGS locs. 2839 and 2840), included here because they provided the primary types of *Palaeacis carinata* Girty and the lectotype of *Platyceras subelegans* Girty, respectively, belong in the *Goniatites granosus* Zone, which is Late Viséan in age.

It is important to bear in mind, therefore, that the Fayetteville fossils described by Girty in his 1910 paper, with the exception of one brachiopod subspecies, come from uppermost Viséan equivalents. Although many of the brachiopods and some of the mollusks and other invertebrates range much higher in the Chester rocks of the American midcontinent, it is mainly by careful comparison of their stratigraphic ranges with those of the ammonoids that the major faunal subdivisions in the Upper Mississippian succession can be determined. Some restriction in the ranges of the ostracodes appears to be evident, and particularly of the crinoids.

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# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Corals

*By* WILLIAM J. SANDO

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-B

*Illustration and redescription of G. H. Girty's type specimens of coral species from the Fayetteville Shale*


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# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—CORALS

By WILLIAM J. SANDO

ABSTRACT

Three coral species described by G. H. Girty in 1910 are illustrated for the first time. Lectotypes chosen from Girty's syntypes are redescribed. The taxonomy of *Michelinia meekana* Girty and *Palaeacis carinata* Girty remain unchanged, whereas *Menophyllum excavatum* var. *arkansanum* Girty is changed to *Zaphrentites arkansanus* (Girty).

## INTRODUCTION

Corals are a relatively minor constituent of the Fayetteville fauna described by Girty (1910), both in numbers of individuals and taxonomic diversity. Only three coral species, based on a total of 22 specimens from 11 localities, were described from this fauna.

The purpose of this paper is to designate and illustrate lectotypes from Girty's syntype lots and to supplement Girty's descriptions of the species. The taxonomy of two of the species, *Michelinia meekana* Girty and *Palaeacis carinata* Girty, is not changed, but *Menophyllum excavatum* var. *arkansanum* Girty is elevated to species rank and allocated to the genus *Zaphrentites* Hudson.

Historical details of the Fayetteville faunal studies have been given by Gordon on page 1 in chapter A of this report. Gordon's paper also includes a register of the collecting localities referred to in this study. Supraspecific classification follows Hill (1956) and Hill and Stumm (1956). Morphologic terminology is generally that of Hill (1956) and Hill and Stumm (1956), with exception of the terms "calicular angle," "alar diameter," and "cardinal-counter diameter," which are defined in a paper by Sando (1961).

## SYSTEMATIC PALEONTOLOGY

**Phylum COELENTERATA**
**Class ANTHOZOA**
**Order RUGOSA**
**Suborder STREPTELASMATINA**
**Superfamily CYATHAXONIICAE**
**Family HAPSIPHYLLIDAE**
**Genus ZAPHRENTITES Hudson, 1941**

**Zaphrentites arkansanus (Girty), 1910**

Plate 1, figures 1–17

1910. *Menophyllum excavatum* var. *arkansanum* Girty, p. 190.

*Original description.*—"Corallum rather small, conical, showing much variation in the rapidity of enlargement and in the amount of curvature. Exterior marked by the usual longitudinal striation, the striae being rather numerous and closely arranged but not very strong. Calice deep. Septa at maturity about 28, fewer, of course, in the earlier stages. Secondary septa present only toward the upper limit of the theca where they appear merely as slightly elevated ridges. Septa and walls much thickened by steroplasma, so that the interseptal loculi are nearly closed. The three fossulae are often clearly distinguishable, especially in the more mature part of the corallum. Interseptal tissue practically absent, rarely developed about the margins of the calicinal portion."

*Type material.*—The type lot consists of 17 syntypes. A specimen (USNM 158785) from USGS locality 3651C, herein illustrated on plate 1, figures 1–9, is chosen as lectotype. Paralectotypes are as follows: three specimens (USNM 158791, 158792) from USGS locality 3651B, one specimen (USNM 158795) from USGS locality 1339B, three specimens (USNM 158789, 158790) from USGS locality 1339A, three specimens (USNM 158786–158788) from USGS locality 7088C, one specimen (USNM 158794) from USGS locality 7087, one specimen (USNM 158797) from USGS locality 3637, two specimens (USNM 158793) from USGS locality 1292B3, and two specimens (USNM 158796) from USGS locality 3652.

Girty's unpublished notes suggest that he intended to choose one of the specimens (USNM 158791) from USGS locality 3651B as the type of the species. This specimen was sawed or ground down on both ends so that a complete ontogenetic sequence could not be obtained from it. The specimen (USNM 158785) from USGS locality 3651C is the most complete and best preserved specimen in the type lot. Moreover, it seems to have come from the same locality as the specimen favored by Girty. For these reasons this specimen has been chosen as lectotype.

Three specimens from USGS locality 5553, originally included by Girty in the syntype lot, are regarded as a different species. These specimens differ from the others in the syntype lot in showing periodic amplexoid retreat of the septa and in having the cardinal septum either on the convex side of the corallum or 90° from the plane of curvature.

*Description of lectotype.*—The lectotype (pl. 1, figs. 1–9) is a nearly perfect specimen, lacking only the tip of the corallum. The corallum is 29.5 mm long and attains a maximum diameter of 17.2 mm. The corallum is trochoid, moderately curved, and has a calicular angle of approximately 35°. The plane of curvature coincides with the cardinal-counter plane, and the cardinal septum is on the concave side of the corallum. The shape of transverse sections through the corallum changes from circular in the earliest preserved stage (14 major septa) to oval, that is, compressed perpendicular to the cardinal-counter plane, in the intermediate stages, to circular again in the calice. The calice is 14 mm deep. Longitudinal ornamentation consists of broad (0.5–0.7-mm wide) rounded interseptal ridges. Transverse ornamentation consists of growth wrinkles 1–2 mm wide and finer growth lines spaced 0.1–0.2 mm apart.

Internal details were determined by study of five transverse thin sections. The earliest section studied (pl. 1, fig. 1) shows 14 major septa at an alar diameter of 3.0 mm and a cardinal-counter diameter of 3.1 mm. The septal complement (clockwise) is: cardinal, two cardinal laterals, alar, three counter laterals, counter, three counter laterals, alar, two cardinal laterals. All the septa are dilated and wedge shaped; they occupy most of the space in the interior of the corallum. The cardinal septum is long and somewhat thicker than the other major septa. A peripheral stereozone 0.5 mm thick, composed entirely of epitheca, is present at this level.

A thin section (pl. 1, fig. 2) cut at an alar diameter of 4.4 mm and a cardinal-counter diameter of 4.6 mm shows 16 major septa. The septal complement (clockwise) is: cardinal, two cardinal laterals, alar, four counter laterals, counter, four counter laterals, alar, two cardinal laterals. Internal details are very similar to those of the earlier growth stage.

A thin section (pl. 1, fig. 3) cut at an alar diameter of 5.9 mm and a cardinal-counter diameter of 6.8 mm shows 20 major septa. The septal complement (clockwise) is: cardinal, three cardinal laterals, alar, five counter laterals, counter, five counter laterals, alar, three cardinal laterals. As in the earlier growth stages the interior of the corallum is almost entirely occupied by dilated, wedge-shaped major septa. The peripheral stereozone has approximately the same width as before. The cardinal septum is again long and extends to the axis of the corallum.

A thin section (pl. 1, fig. 4) cut at an alar diameter of 7.7 mm and a cardinal-counter diameter of 10.4 mm shows 24 major septa. The septal complement (clockwise) is: cardinal, four cardinal laterals, alar, six counter laterals, counter, six counter laterals, alar, four cardinal laterals. Internal details are similar to the preceding stage except for the cardinal septum which is now slightly withdrawn from the axis of the corallum and partly attenuated near the middle of its length, where the beginnings of a fossula are evident. The peripheral stereozone is now approximately 1 mm thick.

A thin section (pl. 1, fig. 5) cut at an alar diameter of 10 mm and a cardinal-counter diameter of 12.0 mm represents a growth stage just below the base of the calice. This section shows 26 major septa arranged as follows (clockwise): cardinal, four cardinal laterals, alar, seven counter laterals, counter, seven counter laterals, alar, four cardinal laterals. The major septa are thinner than in preceding stages, which produces a more open internal structure. Alar pseudofossulae are present, and the septa of the cardinal quadrants are withdrawn from the axial region; they now abut on the sides of a conspicuous parallel-sided cardinal fossula which contains a very short cardinal septum. Traces of the tabulae are visible for the first time. The peripheral stereozone is from 1.0 to 1.5 mm thick.

A thin section (pl. 1, fig. 6) cut in the calice at an alar diameter of 12.9 mm and a cardinal-counter diameter of 13.5 mm shows 28 major septa. The septal complement (clockwise) is: cardinal, four cardinal laterals, alar, eight counter laterals, counter, eight counter laterals, alar, four cardinal laterals. Although all the major septa are reduced considerably in length, the cardinal septum is even shorter and consists of a low ridge on the interior of the corallum. The minor septa are evident for the first time as inconspicuous ridges. The peripheral stereozone is now about 1 mm thick.

Septal microstructure is of the zigzag type described by Kato (1963).

*Description of paralectotypes.*—The paralectotype coralla show considerable individual variation in shape. They range from rapidly expanding, moderately curved cones like the lectotype (pl. 1, figs. 7–9) to slowly expanding, nearly straight cones (pl. 1, figs. 15–17). The calicular angle ranges from 20° to 35° in these specimens. The relation between the diameter of the corallum and the number of major septa is shown in figure 1. In all but one paralectotype, the plane of curvature coincides with the cardinal-counter plane, and the cardinal septum is on the concave side of the corallum. As in the lectotype, the corallum is commonly compressed perpendicular to the cardinal-counter plane in some growth stages, but this variation in shape does not seem to follow any orderly pattern in the specimens studied.

A thin section of one of the paralectotypes (pl. 1, fig. 14) illustrates features of the species as seen in longitudinal section. This section was cut in the cardinal-counter plane. Only the peripheral parts of the

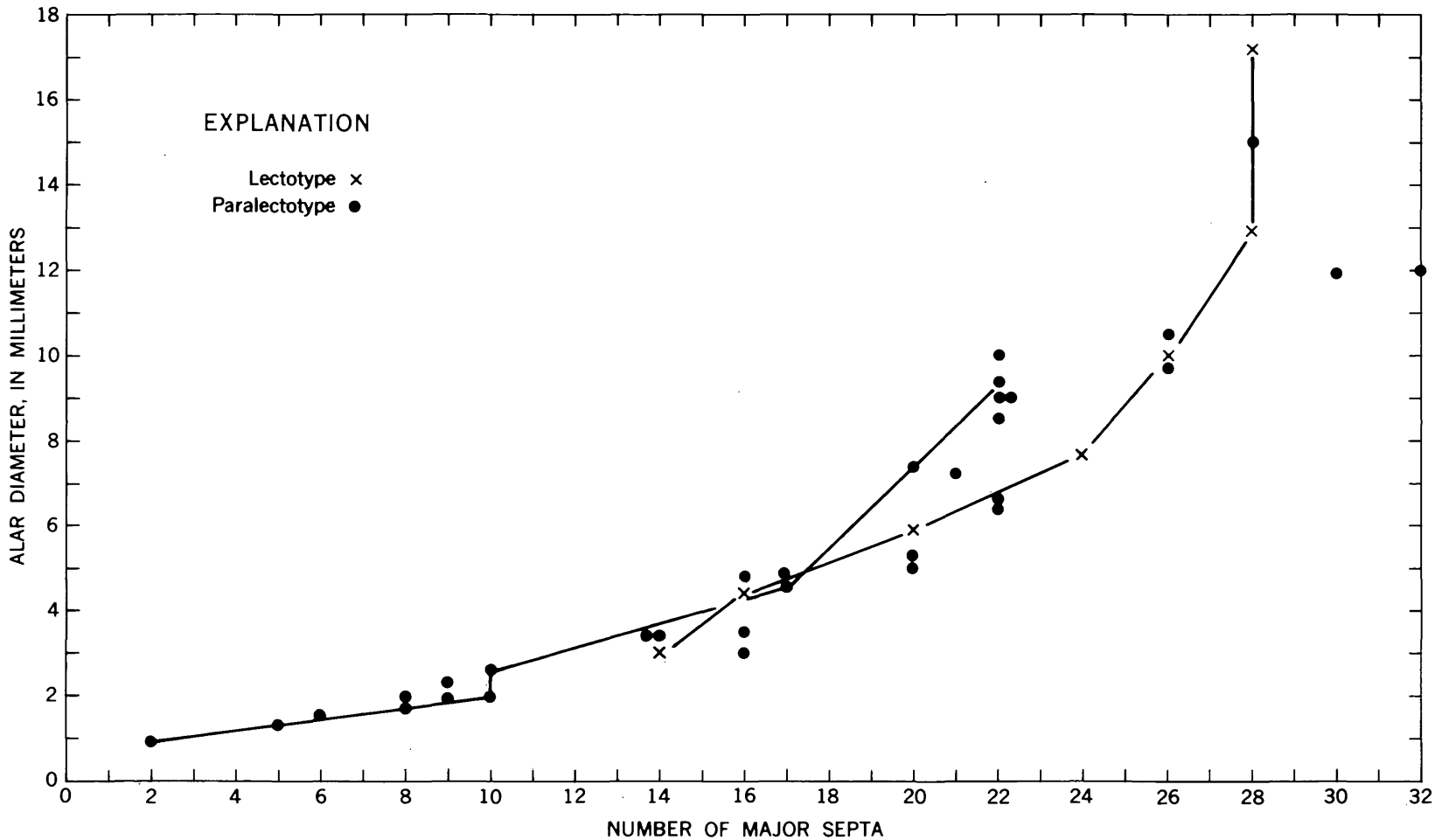


FIGURE 1.—Scatter diagram showing relation between alar diameter and number of major septa by means of 39 measurements on 10 specimens of *Zaphrentites arkansanus* Girty). Straight lines connect measurements made from serial sections of lectotype (USNM 158785) and one of the paralectotypes (USNM 158787).

tabulae are distinguishable in this section; the axial parts are buried in stereoplasmic thickening of the axial ends of the major septa. Tabulae are spaced approximately 1–2 mm apart. They appear to be convex axially, reflexed upward peripherally, and slope into the cardinal fossula.

Early growth stages were studied in three paralectotypes by means of the serial peel technique described by Sando (1967). These specimens were all small individuals having lengths of 18 mm or less, maximum diameter of 10.1 mm or less, and a maximum of 22 major septa. The four earliest growth stages examined, exhibiting 2, 5, 10, and 10 septa, respectively, from one of these specimens are illustrated on plate 1, figures 10–13. The earliest stage (pl. 1, fig. 10) shows a median plate from which the cardinal and counter septa were later differentiated. In the next stage (pl. 1, fig. 11), the cardinal, counter, and two alar septa are present, and addition of metasepta has begun in one of the counter quadrants. Acceleration in the counter quadrants is evident in all the specimens studied. Metasepta are not introduced in the cardinal quadrants until the counter quadrants have between three and six metasepta.

*Discussion.*—Girty originally proposed this taxon as a variety of *Menophyllum excavatum* Girty, a species that occurs widely in rocks of Early Mississippian age in the Madison Group of the Cordilleran region. Sando (1960, p. 173–174) presented reasons for regarding *M. excavatum* as a species of *Zaphrentites*. Under the present rules of zoological nomenclature, Girty's "variety" would be regarded as a subspecies. However, the Fayetteville taxon is sufficiently distinct from *Zaphrentites excavatus* Girty as to be regarded as a separate species, *Zaphrentites arkansanus*.

*Z. arkansanus* differs from *Z. excavatus* in having a conspicuous peripheral stereozone and a parallel-sided rather than axially-expanded cardinal fossula. Detailed information on the size, shape, and number of major septa in *Z. excavatus* is not yet available, but one of the syntypes of *Z. excavatus* (Girty, 1899, pl. 67, fig. 1a) is larger and appears to have more septa than any of the specimens belonging in *Z. arkansanus*.

**Order TABULATA**
**Family FAVOSITIDAE**
**Subfamily MICHELINIINAE**
**Genus MICHELINIA de Koninck, 1841**

**Michelinia meekana Girty, 1910**

Plate 2, figures 6–9

1910. *Michelinia meekana* Girty, p. 189.
1915. [Part] *Michelinia meekana* Girty, Snider, p. 71, pl. 3, figs. 9–11.
1942. *Michelinia meekana* Girty. Easton, p. 84.
1943. *Pleurodictyum meekanum* (Girty). Easton, p. 130, 136.
1950. *Michelinia meekana* Girty. Bassler, p. 219.

*Original description.*—"Zooarium lenticular, attaining a large size, about 85 mm in diameter and 45 mm in thickness, more or less. Upper surface irregular. Corallites very variable in size; the large ones reach a diameter of 7 mm, but very few are of this size. The rudimentary septa consist of fine ridges, more distinct in some specimens than in others, and are very numerous. They are so fine and obscure that no satisfactory count can be made on the material available. Mural pores apparently are small and regularly disposed. They seem to occur in longitudinal rows near the angles of the cells. Tabulae very closely arranged and irregular. In some instances, they are one fifth to one eighth of a cell diameter apart and seem to extend completely across in parallel plates. In other instances, they are somewhat farther apart, oblique and vesicular. Walls moderately thick."

*Type material.*—The type lot consists of five syntypes labeled by Girty. The specimen (USNM 158783) from USGS locality 7088, herein illustrated on plate 2, figure 6–9, is chosen as lectotype. Girty's unpublished notes indicate that this is the specimen he intended to use as the type. A specimen (USNM 158784) questionably from USGS locality 7088 is regarded as a paralectotype. Three fragments from USGS locality 7086(?) belong to a different species of *Michelinia* distinguished from *M. meekana* by its irregularly hemispherical coralla composed of smaller corallites with thicker walls, more abundant mural pores, and more regular tabulae. Four specimens from USGS locality 1412A labeled "*Michelinia*—to be worked up" by Girty also belong to this other species.

*Discussion.*—Girty's original description for the most part adequately presents the essential morphological characters of the species as based on the lectotype. I can only add measurements of a few features which may be of value in comparing this species with others. As stated by Girty, the maximum corallite diameter at the surface of the colony is 7 mm but most corallites have a diameter of 5 mm or less. The septal ridges described by Girty are not visible in the calices of the corallites but can be seen in thin sections, where they appear as indistinct swellings of the wall having a relief of about 0.05 mm. The walls are 0.1–0.3 mm thick. Mural pores are 0.1–0.15 mm in diameter and generally are near the angles of the corallites. Tabulae are mostly vesicular and are spaced approximately 1 mm apart.

The apparently concentric growth patterns exhibited by both the lectotype and paralectotype are an interesting feature of this species. Although neither specimen is perfectly preserved, no attachment scars or epitheca are evident. It seems possible that the coralla were rolled about on the sea floor, permitting concentric growth

until they attained their present tabular shape, at which time a stable growth position was assumed.

*Michelinia meekana* is similar to two Early Pennsylvanian species, *M. exilimura* Mather and *M. referta* Moore and Jeffords. *M. exilimura* differs from *M. meekana* in its generally larger coralla (as much as 125 mm in diameter), slightly smaller corallites (maximum diameter 6 mm) and nonconcentric growth pattern that develops from a broad basal expansion. *M. referta* is distinguished from the Fayetteville species by its ovoid coralla whose height is greater than width and by its more closely spaced tabulae.

**Subfamily PALAEACINAE**
**Genus PALAEACIS Haime in Milne-Edwards, 1857**

**Palaeacis carinata Girty, 1910**

Plate 1, figures 18–21; plate 2, figures 1–5

1910. *Palaeacis carinata* Girty, p. 190.
1915. *Palaeacis cuneata* Snider, p. 70, pl. 3, figs. 1–6.
1950. *Palaeacis carinata* Girty. Bassler, p. 219.
1950. *Palaeacis cuneata* Snider. Bassler, p. 219.
1955. *Palaeacis carinata* Girty. Jeffords, p. 9, table 1.
1955. *Palaeacis cuneata* Snider. Jeffords, p. 9.

*Original description.*—"Corallum much compressed, having flattened sides, narrowly rounded ends and carinated lower portion. The height is less than the breadth, and the ends are considerably lower than the middle. The cell-like cavities in the specimens examined open onto the upper surface. They are few in number, only four or five, and very shallow. The walls which separate them are low and moderately thin. Fine and strong lirae cross the external surface. The lirae are slightly narrower than the striae and begin near the point of attachment as tubercles, which arrange themselves in rows and become connected into continuous linear elevations."

*Type material.*—The type lot consists of three syntypes. The specimen (USNM 158780) from USGS locality 2839, herein illustrated on plate 2, figures 1–5, is chosen as lectotype. Paralectotypes include another specimen (USNM 158782) from the same locality, figured on plate 1, figures 18–21, and a specimen (USNM 158781) from an unknown locality.

Girty's unpublished notes indicate rather clearly that he based his description of the species on the two specimens chosen herein as paralectotypes. These specimens, however, are immature individuals and in both specimens the upper parts of the corallite walls have been broken away. The third syntype, from the same locality as one of the specimens used by Girty in his description, had its top surface covered with matrix when Girty made his examination, so that important details of the corallum were not visible. Cleaning of this specimen revealed a well-preserved corallum exhibiting more corallites than the other syntypes. For this reason, the third syntype was chose as the lectotype. A fourth specimen from USGS locality 5553A, labeled *Palaeacis* sp. by Girty, evidently was not a part of the type lot. This specimen is too fragmentary for specfic identification.

*Description of lectotype.*—The corallum is cuneate; its sides diverge at an angle of 50°–60° along its shortest dimension and 100° along its longest dimension. The corallum is 13.3 by 21.1 mm in minimum and maximum diameter, respectively, at the top and 22.4 mm in height. The lateral surfaces of the corallum are slightly curved and are covered by an anastomosing pattern of low ridges and nodes about 0.2 mm wide. Nine corallities, arranged in two rows and ranging from 5 to 7 mm in diameter, are present at the top of the corallum. The corallites have rounded polygonal, mostly quadragonal, outlines and are separated by walls 0.6–2 mm thick at the surface of the corallum. The calices have walls that diverge at acute angles, so that they resemble inverted cones. The calices are 4–10 mm deep. Distinct longitudinal ribs about 1 mm wide occur on the inner surfaces of two calices; these ridges suggest the beginning of fission. The entire corallum is perforated by numerous anastomosing canals that open into pores 0.1–0.2 mm in diameter on the external surface of the corallum and on the interior walls of the calices.

*Discussion.*—The paralectotypes of this species are not separately described because their morphology conforms in all essential details to that of the lectotype except that they are smaller and have fewer corallites (four or five) because they represent immature growth stages.

Jeffords (1955, p. 9) has summarized the synonomy, homonymy, and stratigraphic distribution of the described American species of *Palaeacis*. *Palaeacis carinata* is one of five cuneate species whose composite age-range is from Kinderhook to Chester. *P. carinata* is the only known species of Chester age. *Palaeacis bifida* Weller, of Kinderhook and Osage age, is distinguished from *P. carinata* by its smaller corallum bearing only two, or rarely three, corallites; the corallum is also lower, having a height that approximates the maximum diameter. *Palaeacis cavernosa* Miller, from the Osage (listed incorrectly as Meramec by Jeffords), has a maximum of 14 corallites arranged in three rows, is larger than *P. carinata*, and its corallum is very elongate transversely (maximum diameter approximately three times minimum diameter). *Palaeacis obtusa* (Meek and Worthen), also of Osage age (listed incorrectly as Meramec by Jeffords), commonly has only four corallites but may have as many as nine arranged in two or three rows. *P. obtusa* is distinguished from *P. carinata* by its low, elongate corallum in which the height approximates the

minimum diameter, and the maximum diameter is about twice the minimum diameter. *Palaeacis cuneiformis* Haime, of Meramec age, is distinguished by its very thin corallum (maximum diameter much greater than minimum diameter) having a maximum of six corallites arranged in a single row.

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# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Pelecypods

*By* JOHN POJETA, JR.

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-C

*Illustration of G. H. Girty's 1910 Fayetteville Shale pelecypod types*

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PLATE 3. *Solenomorpha, Sanguinolites, Sphenotus?, Sphenotus, Edmondia?, Cardiomorpha?, Phestia, Palaeoneilo,* and *Cypricardinia?*

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# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—PELECYPODS

By JOHN POJETA, JR.

ABSTRACT

The 19 pelecypod species named and described by G. H. Girty in 1910 from the Fayetteville Shale are herein figured for the first time. In addition, lectotypes are chosen for those species names based on syntypes, locality data are provided, and Girty's original descriptions are reproduced.

## INTRODUCTION

Girty's 1910 paper on the Fayetteville Shale fauna contained descriptions of 19 new pelecypod species. Although this work included no figures of the new taxa it was Girty's intention to remedy this as he subsequently prepared figures and plates to illustrate the fauna; for some reason the illustrations were never published.

The purpose of the present work is to illustrate the better type specimens of the pelecypod species proposed by Girty in 1910. Previously only Branson (1958) had figured any of the types; he illustrated the holotype of *Conocardium peculiare*. For the most part, Girty's type lots consist of series of syntypes, of which the better preserved one, two, or three specimens were figured or indicated for figuring on his unpublished plates. Herein my plates include figures of all of the primary types which Girty had planned to illustrate; the remaining specimens in each syntypic series are not figured, although all specimens have been deposited in the U.S. National Museum type collection. All figured specimens have been rephotographed and none of Girty's original retouched photographs have been used. Lectotypes of the 1910 pelecypod names have been chosen from the lots which Girty figured or indicated for figuring on his unpublished plates; all other specimens, both figured and unfigured, are regarded as paralectotypes.

In addition to illustrations of the new species, Girty's unpublished plates included figures of forms which he assigned to preexisting taxa or placed under manuscript names; these were not mentioned in his 1910 text, and they are not considered here.

Girty's 1910 pelecypod names have been used only occasionally by other workers, and then mostly by persons working in areas adjacent to his. The wider use of his names (or their synonymizing) has been inhibited by the lack of illustrations, and the present work is primarily intended to illustrate his type material. In addition, locality data are provided, lectotypes are chosen where necessary, and Girty's original descriptions are reproduced because the 1910 paper is difficult to obtain. Where necessary, additions to, or corrections of, his original descriptions are made. Synonymies (or at least each use of a Girty binomen known to me) are given for each species. Species descriptions follow the same order as in the original paper, and all type materials are now part of the U.S. National Museum paleontological type collection (USNM). The U.S. Geological Survey (USGS) locality numbers for the various specimens are listed by Gordon (p. 4) in chapter A of this volume.

On the basis of modern concepts of generic level taxa, much of Girty's material must be regarded as inadequately preserved for proper generic placement and better preserved topotype material is needed. This difficulty is especially acute among the pectinaceans where the preservation of ligamental features is often necessary for unequivocal generic assignment. Thus, in several instances generic names are used herein in their older looser senses, as they were used by Girty. Where possible, suggestions are given as to the placement of these species in more restricted genera. Thus as far as possible, both Girty's taxonomy and nomenclature have been updated, although the binomen he used for each species is indicated in the first entry of each synonomy.

Pelecypods from the Fayetteville Shale tend to be small and include representatives of at least 14 families. The forms described by Girty included: astartids, aviculopectinids, conocardiids, ctenodontids, edmondiids, nuculanids, sanguinolitids, and cypricardiniids. In addition to these his Fayetteville Shale collections contain myalinids, myophoriids, nuculids, parallelodontids, pholadomyids, and pterineids. No new species of the latter groups were described in 1910, and none of them is figured here.

## ACKNOWLEDGMENTS

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## SYSTEMATIC PALEONTOLOGY

### Phylum MOLLUSCA
### Class PELECYPODA
### Family SANGUINOLITIDAE Miller
### Genus SOLENOMORPHA Cockerell, 1903

#### Solenomorpha nitida (Girty), 1910

Plate 3, figures 1, 2

1910. *Solenopsis nitida* Girty, p. 223.
1911. *Solenopsis nitida* Girty?, Girty, p. 81, pl. 12, fig. 12.
1915. *Solenopsis nitida* Girty?, Snider, p. 99.
1930. *Solenopsis nitida?* [Girty], Croneis, p. 70, pl. 18, fig. 7.
1957. *Solen* (?) cf. *S.* [*olenomorpha*] *nitida* (Girty), Elias, p. 741, pl. 90, fig. 4.
1965. *Solenomorpha nitida* (Girty), Driscoll, p. 87.

*Original description.*—"Shell of medium size, linguliform [soleniform], very transverse [elongate]. Width [length] nearly three times the greatest height. Convexity low, compressed posteriorly. Beak very small and inconspicuous, situated posterior to the front margin by one half or one third the height. Anterior end gaping, especially above. Upper and lower margins subrectilinear and parallel over the median portion, curving together symmetrically toward the posterior extremity, and abruptly rounded at the end. Anterior extremity broadly and regularly rounded.

"Surface marked by concentric striae and very fine concentric lirae."

*Types.*—The type lot of this species consists of nine syntypes, of which the specimen figured on plate 3, figures 1, 2 (USNM 155894, USGS loc. 3651C) is herein chosen as the lectotype of the species. The remaining eight specimens are regarded as paralectotypes; five of these are from USGS locality 3651C (USNM 155940), two are from USGS locality 3651B (USNM 155941), and one is from USGS locality 5550A (USNM 155942).

*Remarks.*—Girty's description of this species is largely drawn from the lectotype. Concerning the apparent anterior gape which he described, the part of the lectotype anterior to the beak is slightly turned laterally out of the plane of the rest of the shell edge. This suggests that the shell gaped in a fashion similar to that of the species of *Solenomorpha* illustrated by Driscoll (1965, pl. 13, figs. 15–26).

### Genus SANGUINOLITES McCoy, 1844

Much uncertainty exists concerning the use of the names *Sanguinolites* McCoy and *Sphenotus* Hall, 1885, and some authors (for example, Hind, 1900) have regarded them as being synonymous. However, Driscoll (1965) listed a number of features by which he felt the two could be distinguished. I have treated the two as separate genera, although many of the characteristics used by Driscoll to differentiate them are not present on Girty's specimens.

#### Sanguinolites simulans Girty, 1910

Plate 3, figures 3–5

1910. *Sanguinolites simulans* Girty, p. 224.

*Original description.*—"Shell rather small, very transverse [elongate], subelliptical. Convexity moderate. Umbonal ridge not very prominent, but very distinct. Post-cardinal slopes compressed. Beaks small, strongly incurved, situated near the anterior extremity. Cardinal line long, apparently over two thirds the entire width [length], nearly straight. Lower border gently convex, nearly parallel to the hinge, bending upward more strongly behind. The short anterior end is strongly rounded beneath the beak. The posterior outline is doubly truncated, the lower truncation being nearly vertical and the upper slightly oblique, so as to make an obtuse angle with the hinge. There appears to be a small but distinct lunule, while the shell back of the beaks is sharply inflected so as to form an elongated escutcheon the entire length of the hinge line.

"The shell is thin, and the surface is marked by strong, regular, subequal, concentric plications, extending from the front to the umbonal ridge. At the umbonal ridge they abruptly cease, the post-cardinal slope being marked by much finer, less conspicuous striae, which are, however, stronger and coarser than growth lines. The umbonal ridge is an angular plication. A second somewhat similar radiating line divides the post-cardinal slope about midway. It is scarcely distinguishable as an elevation, however, though very noticeable as a line along which the striae and the posterior outline abruptly change direction."

*Types.*—The type lot of this species consists of the holotype (pl. 3, figs. 3–5, USNM 155895, USGS loc. 3636).

*Remarks.*—In ornamentation and general body form this species is very similar to some of the specimens figured under the name *S. angustatus* (Phillips) by Hind (1900, pl. 40). Both Hind and Driscoll (1965) regarded *S. angustatus* as the type species of *Sanguinolites*.

The lunule mentioned by Girty as being present in *S. simulans* is not obvious, although there seem to be remnants of this structure on the right valve of the holotype of the species.

### Genus SPHENOTUS Hall, 1885

Girty placed four species in this genus. On the basis of the criteria suggested by Driscoll (1965) to distin-

guish *Sphenotus* from *Sanguinolites*, none of Girty's species can be unequivocally placed in *Sphenotus*, although several of the species show one or two features more characteristic of *Sphenotus* than of *Sanguinolites*.

**Sphenotus? branneri Girty, 1910**

Plate 3, figures 6–8

1910. *Sphenotus branneri* Girty, p. 224.
1915. *Sphenotus* aff. *branneri* Girty, p. 78.

*Original description.*—"Shell small, transversely [elongately] subovate, strongly contracting toward the front. Greatest width [length] about twice the greatest height or a little more. Convexity strong. Umbonal ridge indistinct. A constriction more or less pronounced passes across the shell, meeting the lower border a little anterior to the middle. The beak is small, strongly depressed and almost terminal. The cardinal line is nearly straight or gently convex, about three fourths of the entire width [length]. The lower border converges with it toward the front, having a slightly sinuous course. The posterior outline is strongly and rather regularly rounded, sometimes more or less straightened or obliquely truncated above. The anterior outline below the almost terminal beaks is narrow and strongly rounded.

"The surface is marked by radiating plications or costae, which are confined to the posterior portion back of the constriction. The highest of the plications marks an inflection of the shell near the hinge to form a long, rather broad escutcheon. Below and anterior to this, there are about nine regularly disposed costae, diminishing in strength toward the front. Where well preserved, the surface shows traces of fine radial lirae intermediate with the costae. In most specimens, these and all but three or four of the costae are obscured. There are also numerous concentric striae and sharp, regular, concentric lirae.

"The internal characters are unknown, save that some specimens show a large anterior scar."

*Types.*—The type suite of this species consists of seven syntypes, of which the specimen figured on plate 3, figure 6 (USNM 155896, USGS loc. 3651B) is herein chosen as the lectotype of the species. Of the figured paralectotypes the specimen shown on plate 3, figure 7 (USNM 155897) is from USGS locality 3651B, whereas the specimen shown on plate 3, figure 8 (USNM 155898) is from USGS locality 3651C.

Of the unfigured paralectotypes, two specimens are from USGS locality 3651B (USNM 155943), one is from USGS locality 3651A (USNM 155944), and one is from USGS locality 1339E (USNM 155945).

*Remarks.*—This species is the least like *Sphenotus* of the four species assigned to that genus by Girty. In its overall aspect, *S.? branneri* resembles forms assigned to the Kalenteridae (Permophoridae) and may belong to that family.

**Sphenotus washingtonensis Girty, 1910**

Plate 3, figures 9–11

1910. *Sphenotus washingtonense* Girty, p. 224–225.
1915. *Sphenotus washingtonensis* Girty, p. 77, pl. 8, fig. 4.
1915. *Sphenotus washingtonense* Girty, Snider, p. 101, pl. 6, fig. 4.

*Original description.*—"Shell of medium size, subquadrate, very transverse [elongate]. Greatest width [length] distinctly more than twice the greatest height. Cardinal line straight, somewhat longer than half the greatest width [length]. Lower margin subrectilinear and parallel with the hinge, curving up rather strongly in front. Anterior outline concave above for about one third the height, rather strongly convex below, more abruptly rounded near the emarginate portion. Posterior outline somewhat obscurely truncated in a broken line. The upper truncation, which covers about one half the height, is very oblique, while the lower is nearly perpendicular to the lower margin. No distinct angles are formed where the lines join. The convexity is high. The beak, rather small and strongly incurved, is situated but a short distance posterior to the margin. The umbonal ridge is strongly elevated and angular. A second distinct, though not very prominent ridge divides the post-cardinal slope longitudinally, and the shell is abruptly inflected near the cardinal line to form a large, long escutcheon with sharply angular outlines. The post-cardinal slope is somewhat compressed, as is also the anterior portion. A broad, shallow constriction occurs just in front of the umbonal ridge.

"The surface is marked by regularly arranged, moderately fine and deep concentric striae, which toward the front and back, and possibly all over when the preservation is good, are separated by rather thin, high, concentric lirae. Traces of fine radial lirae have been seen on the post-cardial slope of one or two small specimens.

"There is a large subcircular anterior scar."

*Types.*—The type series of this species consists of six syntypes. One of these was figured by Girty on his unpublished plates, and is herein chosen as the lectotype of the species (pl. 4, figs. 9–11, USNM 155899, USGS loc. 3651C).

Of the unfigured paralectotypes, four are from USGS locality 3651C (USNM 155946) and one is from USGS locality 3651 (USNM 155947).

*Remarks.*—*S. washingtonensis* shows a well-defined umbonal ridge and a rib on the median part of the

posterior umbonal slope; both of these features were regarded as being characteristic of *Sphenotus* by Driscoll (1965, p. 85).

**Sphenotus dubius Girty, 1910**

Plate 3, figures 12–15

1910. *Sphenotus dubium* Girty, p. 225.

*Original description.*—"Shell small, transverse [elongate], subquadrate. Greatest width [length] twice the greatest height. Beak about one fourth the width [length] posterior to the margin, small, strongly incurved. Convexity high, somewhat compressed posteriorly. Umbonal ridge rounded. Mesial portion, or the portion just anterior to a line from the beak to the middle of the base, somewhat flattened or slightly depressed into a broad, shallow constriction. Anterior extremity bent inward and downward to form an elongated lunule with very sharply defined, angular border. A long narrow escutcheon is similarly formed along the margin behind the beak. The post-cardinal slope descends somewhat abruptly and is divided longitudinally by a more obscure ridge.

"The hinge line is straight [for] nearly three fourths the entire width [length] of the shell. The lower margin is gently convex, straightened through the middle, subparallel to the hinge, but bent upward behind, so that this end is distinctly narrower than the other. Posterior extremity truncated by a nearly straight outline very slightly oblique, making a distinct cardinal angle somewhat greater than 90 degrees. Anterior outline abruptly truncated by the nearly straight oblique line formed by the flexure of the shell which produces the lunule; sharply rounded below.

"Surface marked by rather strong, more or less irregular and unequal concentric striae, which are distinctly weaker over the post-cardinal slope, and by fine papillae which tend to have a radial arrangement."

*Types.*—The type suite of this species consists of five syntypes, of which the specimen figured on plate 3, figures 12–15 (USNM 155900, USGS loc. 3651B) is herein chosen as the lectotype of the species. Two of the unfigured paralectotypes are from USGS locality 3651B (USNM 155949), one is from USGS locality 3651 (USNM 155951), and one is from USGS locality 5550 (USNM 155950).

*Remarks.*—Although radially arranged papillae of probable organic origin were figured in *Sphenotus obliquus* (Meek) by Driscoll (1965, pl. 12, fig. 5), such structures do not occur in *S. dubius*. The papillae described in this species by Girty are not well preserved, their radial nature is difficult to demonstrate, and they do not seem to be organic (pl. 3, fig. 13).

**Sphenotus meslerianus Girty, 1910**

Plate 3, figures 16, 17

1910. *Sphenotus?* meslerianum Girty, p. 225–226.
1911. *Sphenotus? meslerianus* Girty?, Girty, p. 80, pl. 12, fig. 10.
1915. *Sphenotus* aff. *meslerianus* Girty, p. 80, pl. 8, fig. 8.
1930. *Sphenotus? meslerianus?* [Girty], Croneis, p. 54, pl. 13, fig. 5.
1930. *Sphenotus* aff. *meslerianus* [Girty], Croneis, p. 70, pl. 18, fig. 7.

*Original description.*—"Shell rather small, subcuneate, transverse [elongate]. Greatest height a little less than half the extreme width [length]. Strongly convex; umbonal ridge subangular, distinct. Post-umbonal slope somewhat compressed. A slight constriction defines the anterior third of the shell. The beak is about one third the width [length] back from the front margin, small, strongly incurred. The anterior extremity is nasute. The hinge is straight, about one half the entire width [length]. The lower margin is gently and regularly convex. The posterior outline is gently convex, truncating the shell with a slight obliquity such as to make the posterior superior angle somewhat obtuse and the posterior inferior angle somewhat acute. The anterior outline is abruptly rounded and concave under the beak.

"The surface is marked by very fine subequal concentric striae."

*Types.*—The type lot of this species consists of the holotype (pl. 3, figs. 16, 17, USNM 155901, USGS loc. 3651B).

**Family EDMONDIIDAE King**
**Genus EDMONDIA DeKoninck, 1842**

**Edmondia? equilateralis Girty, 1910**

Plate 3, figures 18, 19

1910. *Edmondia equilateralis* Girty, p. 226.
1915. *Edmondia equilateralis* Girty, p. 81, pl. 8, figs. 9, 9a.
1957. *Edmondia equilateralis* Girty, Elias, p. 745.

*Original description.*—"Shell very small, transversely elliptical [elongate]. Width [height] slightly less than one half the greatest height [length]. Hinge line straight, about one half the width [length]. Basal margin gently convex. Anterior and posterior outlines strongly and regularly curved, nearly equal, gradually merging with the outlines above and below. Convexity rather high and regular. Umbonal ridge indistinct. Beak small, depressed, scarcely projecting beyond the hinge line, only slightly posterior to the margin.

"Surface marked by fine, strong, sharp, subequal concentric lirae. The internal structures are not known, and the reference to the genus *Edmondia* is therefore provisional."

*Types.*—The type suite of this species consists of two syntypes, of which the one figured here on plate 3,

figures 18, 19 is chosen as the lectotype of the species (USNM 155902, USGS loc. 3651C). The second specimen is regarded as a paralectotype (USNM 155952, USGS loc. 1339E).

### Genus CARDIOMORPHA DeKoninck, 1842

#### Cardiomorpha? inflata Girty, 1910

Plate 3, figures 20–23

1910. *Cardiomorpha inflata* Girty, p. 226.

*Original description.*—"Shell of medium size, the largest specimen having a length along the umbonal ridge of 29 mm. Convexity high, equal in the two valves[?]. Upper and lower margins gently convex, somewhat converging toward the front. Posterior margin subrectilinear, strongly oblique, merging with the cardinal border in a gentle curve and with the inferior border in an abrupt turn. Anterior end subtruncate. Beaks nearly terminal. Inferior-anterior angle sharply rounded. Convexity high, especially along the broad, undefined umbonal ridge, from which the shell descends abruptly to the hinge anteriorly and more gently posteriorly. A distinct, though ill defined, sinus passes diagonally across the shell just in front of the umbonal ridge, meeting the lower margin about midway.

"Surface marked by numerous closely arranged subequal lamellose lines."

*Types.*—The type series of *C.? inflata* consists of five syntypes, of which the one figured here on plate 3, figures 22, 23 is chosen as the lectotype of the species (USNM 155903, USGS loc. 3651C); the other figured specimen (pl. 3, figs. 20, 21, USNM 155904, USGS loc. 3651B) is regarded as a paralectotype.

Two of the unfigured paralectotypes are from USGS locality 3651B (USNM 155953), while the third unfigured paralectotype is from USGS locality 3651C (USNM 155954).

### Family NUCULANIDAE Adams and Adams

### Genus PHESTIA Chernyshev, 1951

Late Paleozoic nuculanids with normal concentric prosopon and some sign of an internal rib are usually placed in the genera *Phestia* Chernyshev or *Polidevcia* Chernyshev. There is some uncertainty as to whether or not both of these names are necessary; Dickins (1963) regarded them as synonyms, whereas Kumpera, Prantl, and Ruzicka (1960) and Waterhouse (1965) felt that both generic names were useful.

#### Phestia stevensiana (Girty), 1910

Plate 3, figures 24–29

1910. *Leda stevensiana* Girty, p. 226.

*Original description.*—"The size is small, a larger specimen when complete having a width [length] of 10 mm. and a smaller a width [length] of only 7 mm. The greatest height is one half the width [length]. The beak is situated about one third the width [length] back from the anterior outline. The lower margin is gently convex, the posterior extension long and subangular, the anterior end symmetrically rounded. The posterior border is gently concave. The convexity is moderate and the surface marked by very fine, somewhat inosculating lirae.

"Of this species, our collection contains but two specimens, both right [left] valves, one of them complete but small and failing to show the sculpture, the other larger and retaining the sculpture, but imperfect at the anterior [posterior] end."

*Types.*—The type suite of *P. stevensiana* consists of two syntypes both of which are figured here. The specimen shown on plate 3, figures 24–26 is chosen as the lectotype of the species (USNM 155906, USGS loc. 3651B); the other specimen is regarded as a paralectotype (pl. 3, figs. 27–29, USNM 155905, USGS loc. 3652).

### Family CTENODONTIDAE Wöhrmann

### Genus PALAEONEILO Hall and Whitfield, 1869

There has been a long controversy about the proper spelling of this generic name (McAlester, 1962, p. 16); the spelling used here is that contained in the "Official List of Generic Names in Zoology" Hemming and Noakes, 1958, p. 79).

#### Palaeoneilo sera Girty, 1910

Plate 3, figures 30–32

1910. *Paleoneilo sera* Girty, p. 227.

*Original description.*—"Shell small, attaining a width [length] of 12 mm., transverse [elongate], subovate. Greatest width [length] about 1.5 times the height. Beak about one third the width [length] back from the anterior extremity. Lower margin strongly convex, straighter toward the posterior (longer) end. Cardinal line nearly straight, strongly converging with the lower border. Posterior extremity narrow and abruptly rounded. Anterior extremity broadly and regularly curved. Convexity rather high; umbo small and strongly incurved.

"The surface is marked by regular and closely arranged concentric lines."

*Types.*—The type lot of this species consists of three syntypes of which the specimen figured here on plate 3, figures 30–32 is chosen as the lectotype of the species (USNM 155907, USGS loc. 3651B). The unfigured paralectotypes are from USGS localities 3651C (USNM 155955) and 1339E (USNM 155956).

**Family CYPRICARDINIIDAE Ulrich**

**Genus CYPRICARDINIA Hall, 1859**

As noted by Newell (1955), late Paleozoic shells externally similar to *Cypricardinia* are usually questionably placed in that genus, because of a lack of knowledge of the details of morphology of the Devonian species upon which the genus is based.

**Cypricardinia? fayettevillensis Girty, 1910**

Plate 3, figures 33–36

1910. *Cypricardinia fayettevillensis* Girty, p. 227.
1930. *Cypricardinia fayettevillensis* [Girty], Croneis, p. 70, pl. 18, fig. 9.

*Original description.*—"Shell small, attaining a width [length] of 10 mm., which is about twice the greatest height. Shape subrhomboidal. Cardinal line straight, about one-half the entire width [length]. Ventral border straight in the middle, rounding upward at the ends, more rapidly at the anterior end. Posterior extremity obliquely truncated with a broad, rounded posterior inferior angle and a distinct posterior superior angle of about 150°. Anterior extremity strongly and regularly rounded under the nearly terminal umbo which is large and strongly incurved. Convexity high. Umbonal ridge rounded, undefined. A distinct constriction passes across the shell, meeting the ventral margin a little in front of the middle.

"Surface marked by a few (about 9) strong, regularly arranged striae which give the shell a lamellose appearance. No trace of radial sculpture has been observed."

*Types.*—The type series of this species consists of three syntypes, of which the one figured here on plate 3, figures 33, 34 is chosen as the lectotype of the species (USNM 155908, USGS loc. 1339E); the other figured specimen (pl. 3, figs. 35–36, USNM 155909, USGS loc. 1339E) is regarded as a paralectotype. The unfigured paralectotype is from USGS locality 1339B (USNM 155957).

**Family CONOCARDIIDAE Miller**

**Genus CONOCARDIUM Bronn, 1834**

**Conocardium peculiare Girty, 1910**

Plate 4, figures 1–4

1910. *Conocardium peculiare* Girty, p. 227.
1915. *Conocardium peculiare* Girty, Snider, p. 104.
1957. *Conocardium peculiare* Girty, Elias, p. 758.
1958. *Conocardium peculiare* Girty, Branson, p. 140, figs. 9–10.

*Original description.*—"Shell small, highly convex, triangular. Length along the umbonal ridge distinctly less than the width [length] along the hinge [apparently this observation is based on Girty's projection of the broken rostrum posteriorly]. Umbonal ridge broad, well defined on both sides, prominent, moderately oblique. Beaks subcentral, nearer the anterior [posterior] end. Umbonal ridge sharply defined from and elevated above the posterior [anterior] porter. On the anterior [posterior] side, the shell is strongly compressed.

"The sculpture is different on the three portions of the shell thus defined. On the anterior [posterior] side, the lirae are rounded, separated by angular striae and rapidly decreasing in size toward the extremity. They do not conform to those of the umbonal ridge which is defined by an unusually large rib on the anterior [posterior] side, but [the posterior ribs] run obliquely, so that new ones are introduced at intervals toward the ventral margin. On the umbonal ridge itself, the costae are rather smaller than on the anterior [posterior] portion and separated by broad, flat intervals, about twice the width of the costae. Two or three of the latter are crowded together near the anterior [posterior] boundary of the ridge. The costae on the posterior [anterior] portion are broader than those on the anterior [posterior], flat-topped and separated by narrow, rather flat striae. The whole surface is crossed by fine, equally spaced, lamellose, concentric lines."

*Types.*—The type lot of *Conocardium peculiare* consists of the holotype (USNM 119981, USGS loc. 3651B). This specimen is the only conocardiid in the Girty Fayetteville Shale collection.

*Remarks.*—In the above description I have used the orientation of the conocardiid shell advocated by La Rocque (1950).

**Family uncertain**

**Genus uncertain**

**Caneyella? peculiaris Girty, 1910**

Plate 4, figures 5–8

1910. *Caneyella peculiaris* Girty, p. 227–228.

*Original description.*—"Shell small, the largest specimen referred here having a length of 15 mm., equivalve [?], oblique. The axis sloping slightly backward [prosocline]. Hinge line nearly as long as the greatest width [length], much longer behind than in front. Outline broadly and regularly rounded below and in front, curving strongly inward toward the hinge, where it is slightly straightened. On the posterior side, it is convex below and concave above, sloping strongly outward in a gentle curve below the broad posterior wing. Convexity moderately high. Anterior wing small and undefined. Posterior wing large, triangular, usually though not always abruptly depressed and distinctly defined.

"The sculpture consists of fine regular concentric undulations or striae and fine radiating lirae. The undulations are shallow and rounded, and they are broad in comparison with the angular ridges which separate

them and which are lamellose at least toward the sides. The radial sculpture is on a finer scale than the concentric, subordinate to and more or less interrupted by it. The radii are very fine and slender with relatively broad interspaces. They seem to die out toward the posterior side of the left valve and to be replaced by a few of larger size on the posterior wing of the right [?] valve."

*Types.*—The type series of this species consists of four syntypes. Of these the specimen figured on plate 4, figures 5, 6 (USNM 155911, USGS loc. 3651B) is chosen as the lectotype of the species. The figured paralectotype (pl. 4, figs. 7, 8, USNM 155910) is from USGS locality 3651C, and the unfigured paralectotypes (USNM 155958) are from USGS locality 3651B.

*Remarks.*—It is highly doubtful that this species could be placed in the genus *Caneyella* Girty. It is probably a pectinacean, rather than a pteriacean, and in general shell shape the lectotype shows resemblances to *Pterinopectinella* Newell and some species of *Aviculopecten* McCoy and *Euchondria* Meek. All specimens of this species are probably left valves.

### Family AVICULOPECTINIDAE Meek and Hayden

### Genus AVICULOPECTEN McCoy, 1851

The important characteristics of the dorsal margin necessary to determine the unequivocal generic placement of most Paleozoic pectinaceans are not preserved on Girty's specimens. Therefore, his Fayetteville Shale species are herein treated under the name *Aviculopecten* sensu lato, more or less as that name was used by Girty. Where sculptural features suggest placement in a genus other than *Aviculopecten* this is noted.

#### Aviculopecten squamula Girty, 1910

Plate 4, figures 9–12

1910. *Aviculopecten squamula* Girty, p. 228

*Original description.*—"Shell small, the largest specimen referred here having a length of 7 mm.; length and width [height] about equal; slightly oblique, somewhat inclined backward [prosocline]. Hinge line but little shorter than the greatest width [length]. Outline gently contracted below the hinge, then widening again. Lower extremity broadly rounded. Convexity low. Wings broad and undefined, the posterior one having perhaps for its boundary a low, narrow fold extending obliquely from the umbo to the posterior margin not far below the hinge line.

"The sculpture consists of fine, regular, concentric striae crossed radially by fine irregular costae so obscure that they are made out with more or less difficulty. They are interrupted and obscured to some extent by the concentric markings."

*Types.*—The type suite of *A. squamula* consists of 10 syntypes, of these the specimen shown here on plate 4, figures 9, 10, is chosen as the lectotype of the species (USNM 155913, USGS loc. 5553). The figured paralectotype (pl. 4, figs. 11, 12, USNM 155912) is from USGS locality 3652.

Of the eight unfigured paralectotypes, three are from USGS locality 5553A (USNM 155960), one is from USGS locality 3651A (USNM 155961), one is from USGS locality 5553 (USNM 155959), one is from USGS locality 3641 (USNM 155962), one is from USGS locality 3652 (USNM 155964), and one is from USGS locality 7087 (USNM 155963).

*Remarks.*—The left valve of this species shows some rib multiplication by intercalation.

#### Aviculopecten jennyi Girty, 1910

Plate 4, figures 13–18

1910. *Aviculopecten jennyi* Girty, p. 228.

*Original description.*—"This form resembles *A. squamula*, having a subquadrate shape, a hinge nearly as long as the width [length] below, and subparallel sides with scarcely any deflection defining the wings. The convexity is low. The umbo small and inconspicuous and the axis nearly perpendicular to the hinge line [acline]. In one specimen, the posterior wing has a fold as in *A. squamula.*

"The sculpture consists of somewhat irregularly distributed costae with relatively broad, flat interspaces. The costae, though low and rounded, are well defined, but they do not extend onto the wings. There are also very fine, equal, closely arranged, concentric lirae and numerous stronger incremental striae, especially conspicuous over areas near the hinge where the costae are not well developed."

*Types.*—The type lot of this species consists of seven syntypes, of which the specimen figured here on plate 4, figures 15, 16 is chosen as the lectotype (USNM 155916, USGS loc. 1339A). The two figured paralectotypes on plate 4, figures 13, 14 (USNM 155914) and figures 17, 18 (USNM 155915) are also from USGS locality 1339A.

Of the unfigured paralectotypes, three are from USGS locality 1339A (USNM 155966) and one is from USGS locality 5553 (USNM 155965).

*Remarks.*—The left valve of this species shows some rib multiplication by intercalation.

#### Aviculopecten multilineatus Girty, 1910

Plate 4, figures 19–22

1910. *Aviculopecten multilineatus* Girty, p. 228–229.

*Original description.*—"Shell small and subquadrate, about as in *A. squamula*, which is closely related. Con-

vexity moderate; hinge long, but little shorter than the greatest width [length], which is about equal to the greatest length [height]. Umbo moderately elevated. Axis but slightly oblique, inclined backward [prosocline]. The wings are large, subquadrate and poorly defined either upon the surface or by any deflection in the outline. The posterior one is bounded by a fold which in fact appears to be double.

"Surface marked by very numerous, fine, sharply elevated, radiating lirae, which decrease in size and definition toward the sides and are not developed at all on the posterior wing. The intervening striae are about equal in size and shape to the lirae. There are also many closely arranged, more or less irregular and unequal concentric striae, finer than the radiating lirae and subordinate to them. Occasional varices of growth sometimes deflect the lirae and give them a wavy appearance."

*Types.*—The type series of *A. multilineatus* consists of two syntypes, of these the specimen figured here on plate 4, figures 19, 20 is chosen as the lectotype of the species (USNM 155917, USGS loc. 3636). The paralectotype (pl. 4, figs. 21, 22, USNM 155918) is from the same locality as the lectotype.

*Remarks.*—The paralectotype (pl. 4, figs. 21, 22) shows some rib multiplication by both intercalation and bifurcation, however, the latter method of increase occurs on only a few ribs.

**Aviculopecten morrowensis Girty, 1910**

Plate 4, figures 23–28

1910. *Aviculopecten morrowensis* Girty, p. 229.
1915. *Aviculopecten morrowensis* Girty, Snider, p. 110, pl. 6, fig. 14.

*Original description.*—"Shell small, a length of 11 mm. being about the maximum observed. Length [height] and breadth [length] nearly equal, or the breadth [length] a little in excess. Hinge long but considerably shorter than the width [length] below. Axis slightly inclined backward [prosocline], with a greater development of the shell behind than before. Wings broad, undefined either by being abruptly depressed or by a sinus in the outline which is nearly straight and slightly oblique on the anterior side, slightly concave and strongly oblique on the posterior side. The lower part of the outline is regularly rounded. The anterior wing is larger than the posterior. The convexity is low and the umbones small and inconspicuous.

"The surface is crossed by numerous exceedingly fine lirae which are scarcely visible without a lens. These are sharply elevated, rounded, with interspaces of about their own width, and they are in some cases slightly wavy. They bifurcate occasionally and thus tend to form groups or fascicles, which in one specimen are visible to the naked eye as very obscure, regularly arranged costae, of which there appear to be six or seven. The radii are also more or less alternating. They are crossed in some cases by regular, fine, sublamellose, concentric lirae, which are differently arranged in different examples. In one specimen they are much farther apart then the radiating lirae; in another, only slightly farther apart. In most examples, they do not appear at all, the concentric markings consisting of fine, incremental striae, of which a few at irregular and distant intervals are stronger than the rest. On the wings, the radii become very obscure, while the concentric striae are intensified and conspicuous. In some specimens, the radii are sharp and strong; in others, possibly by exfoliation, they are more obscure. It may be owing to the same causes that the lamellose concentric lirae appear to be absent."

*Types.*—The type lot of this species consists of 10 syntypes from USGS locality 3641A, of which the specimen figured here on plate 4, figures 27, 28 is chosen as the lectotype of the species (USNM 155920). The figured paralectotypes are shown on plate 4, figures 23, 24 (USNM 155921) and plate 4, figures 25, 26 (USNM 155919). The seven unfigured paralectotypes are cataloged under USNM 155968.

*Remarks.*—The paralectotype shown on plate 4, figures 23, 24 is similar in shell form and ornamentation to forms placed in *Euchondria* by Hutchinson and Stumm (1965) and may belong to that genus. The paralectotype figured on plate 4, figures 25, 26 resembles both *Euchondria* and *Streblochondria* in its ornamentation, although the shell shape is more like that of *Euchondria*. In the absence of any knowledge of the details of the hinge line of *Aviculopecten morrowensis* it is not possible to place any of the type specimens unequivocally in *Euchondria*.

The specimen figured on plate 4, figures 23, 24, shows numerous intercalating and only a few bifurcating ribs.

**Aviculopecten inspeciosus Girty, 1910**

Plate 4, figures 29–32

1910. *Aviculopecten inspeciosus* Girty, p. 229–230.

*Original description.*—"Shell small, a length of 16 mm. being about the maximum observed; length [height] and breadth [length] nearly equal. The hinge is rather short, about one half as long as the greatest width [length]. The axis seems to be curved so that the greater development of the shell is on the anterior side [opisthocline]. The posterior wing is small and not defined by a sinus in the outline. The latter contracts strongly as it approaches the hinge, near which, however, it appears to be somewhat straightened on the posterior side. On the anterior side, it rounds strongly inward to the base of the anterior wing, where it changes

direction, becoming nearly straight and sloping gently inward (from below) so as to meet the cardinal line at a slightly obtuse angle. The convexity is rather high. The posterior wing is small, depressed, oblique and undefined; the anterior wing larger, more abruptly depressed and therefore more sharply defined.

"The sculpture consists of rather indistinct, subequal, radiating costae, becoming finer and fainter toward the sides, which, with the wings and umbonal portion, appear to be uncostate. The costae are relatively broad and flat and the striae between them narrow and shallow. Concentric markings are indistinct or absent."

*Types.*—The type series of *A. inspeciosus* consists of 21 syntypes, of which the specimen figured here on plate 4, figures 29, 30 is chosen as the lectotype of the species (USNM 155922, USGS loc. 3651C). A paralectotype from the same locality is figured on plate 4, figures 31, 32 (USNM 155923). The 19 unfigured paralectotypes are from the following USGS localities: seven from 3651B (USNM 155973), four from 3651C (USNM 155969), four from 1339B (USNM 155972), two from 3652 (USNM 155974), one from 5553A (USNM 155970), and one from 7086 (USNM 155971).

*Remarks.*—The opisthocline obliquity of this species suggests a relationship to *Streblochondria* Newell, especially to the Permian species *S.? guadalupensis* (Girty). This species was questionably placed in *Streblochondria* by Newell (1938) and like *Aviculopecten inspeciosus* it has coarse ribs and lacks the normal latticed ornament of *Streblochondria*. Newell felt that *S.? guadalupensis* unquestionably belonged to the Streblochondrinae and that it might represent a new generic taxon level of this subfamily.

Although the nature of the rib subdivision is not known in *Aviculopecten inspeciosus*, there probably was rib multiplication because the ribs vary in size around the shell edge; *A. inspeciosus* may belong to the same group of shells as *Streblochondria? guadalupensis*.

**Family ASTARTIDAE d'Orbigny**
**Genus CYPRICARDELLA Hall, 1858**

**Cypricardella subalata Girty, 1910**

Plate 4, figures 33, 34

1910. *Cypricardella subalata* Girty, p. 230.

*Original description.*—"Shell small, subquadrate, transverse [elongate]. Width [length] about 1.5 times the height. Beak prominent, about one third the width [length] posterior to the margin. Hinge line straight, two thirds of the width [length]. Lower margin gently convex, nearly parallel to the hinge. Posterior outline almost vertically truncated, the posterior cardinal angle being if anything rather acute than obtuse. Lower margin bends up strongly in front to about one half the height, from which point, by an abrupt change of direction, the outline becomes concave to the beak.

"The convexity is moderate to low. There is no distinct umbonal ridge. The post-cardinal portion is, however, somewhat compressed, and a faint constriction crosses the shell to about the middle of the base. Probably there is a well-defined lunule beneath the beak.

"The surface is marked by relatively coarse, deep, regular striae, separated by thin lamellose ridges. In the type, this sculpture dies out along the line where the umbonal ridge should lie, and the post-cardinal slope is crossed only by very fine striae, but in other specimens it appears to be persistent to the hinge line."

*Types.*—The type lot of this species consists of three specimens. Of these the specimen mentioned in the original description as the type can be recognized and is herein regarded as the holotype of the species (pl. 4, figs. 33, 34, USNM 155924, USGS loc. 3651B).

The two unfigured specimens are regarded as paratypes; one is from USGS locality 1339B (USNM 155975) and one is from USGS locality 3651B (USNM 155976).

*Remarks.*—Girty's description of the disappearance of the concentric ornamentation along the posterior umbonal slope of the holotype is probably due to the weathering of the specimen.

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# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Gastropods

*By* ELLIS L. YOCHELSON

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-D

*Illustration and redescription of G. H. Girty's type specimens of seven species of gastropods from the Fayetteville Shale*

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# ILLUSTRATION


[Plate follows index]

PLATE 5. Gastropods and a trilobite from the Fayetteville Shale.

# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—GASTROPODS

By ELLIS L. YOCHELSON

ABSTRACT

Seven species of gastropods are included in Girty's work on the Fayetteville Shale fauna; one of the types is actually from the Batesville Sandstone, but that species ranges up into the Fayetteville. Type specimens are designated, collecting localities are clarified, and original specimens are illustrated. The current placement of his species is: *Oxydiscus venatus* to *Sinuitina*, *Patellostium laevigatum* to *Patellilabia*, *Anomphalus? discus* to *Trepospira* (*Angyomphalus?*), *Bembexia lativittata* to *Mourlonia*, and *Orthonychia compressa* to *Platyceras* (*Orthonychia*). *Platyceras subelegans* is included in the typical subgenus and *Euconospira disjuncta* is not reassigned.

## INTRODUCTION

Girty (1910) described seven species of gastropods as part of the Fayetteville Shale fauna, but did not illustrate them or cite type specimens and collecting localities. These species have been poorly understood and have found little usage in the literature. With one exception, Girty's original description constitutes the entire synonymy of each species.

Girty (1910, p. 232) specifically mentioned two specimens in a discussion following the description of his new species *Orthonychia compressa*. This is the only discussion of any of his seven species of gastropods, so it is not possible to determine from that paper how many specimens of each species were available to the author. For his unpublished and incomplete monograph on the Fayetteville fauna, Girty selected 10 representatives of these seven species for illustration. In addition to the two *Orthonychia* specimens mentioned above, two specimens each of *Bembexia lativittata* and *Patellostium laevigatum* were chosen for drawings. The other four species are each represented by a single specimen.

In addition to these 10 specimens, a few representatives of several of the new species were located among the Fayetteville Shale collections upon which Girty based his 1910 paper. These additional specimens were identified as *Patellostium laevigatum*, *Bembexia lativittata*, and *Euconospira disjuncta*. Girty's labels are written in a fine Spencerian style of penmanship and are distinctive; further, these collections were clearly set aside for description. Thus, there is no question about the propriety of including this supplementary material as part of the type lot.

All the supplementary gastropod specimens of these three species have been given paralectotype status, for each is inferior in preservation to the 10 specimens picked for illustration. The term holotype has been used only in connection with Girty's species *Oxydiscus venatus* and *Anomphalus? discus*, as a unique specimen of each is available.

In describing the fauna of the underlying Batesville Sandstone, Girty (1915) reported the occurrence of one Fayetteville species, *Euconospira disjuncta*. Reexamination of his Batesville material casts doubt on this identification. Girty (1915) neglected to mention that one of the specimens upon which the original description of *Orthonychia compressa* was based was actually collected from the Batesville Sandstone; this specimen has been selected as the lectotype. None of the other five new Fayetteville species was mentioned by Girty (1915) as part of the sparse gastropod fauna of the Batesville. Although one or more of the species may eventually be found to range downward into this formation, it is not within the limits of this study to investigate additional unstudied collections from the Batesville Sandstone.

In addition to representatives of the new species described in his 1910 paper, Girty set aside six other specimens belonging to what he regarded as previously established species, for illustration in his unfinished monograph. One of these is a steinkern showing similarity to *Glabrocingulum*. Two specimens identified as *Knightites* (*Retispira*) have a fine-textured ornament much like that of the common Pennsylvanian species *K.* (*R.*) *textiliformis* (Gurley). Girty referred the three remaining specimens to *Platyceras*. These six additional specimens are mentioned only to indicate that the gastropod fauna is a little more varied than one would conclude from Girty's 1910 work; they are not described in this report, which is concerned only with the new species.

Gastropods constitute a negligible part of the total Fayetteville fauna in Girty's collections. Probably four-

fifths of the individuals belong to one species of *Platyceras*. *Bellerophon* (*Bellerophon*) and *Straparollus* (*Euomphalus*) compose most of the remainder. A few other species, primarily pleurotomariaceans, are represented by several poor specimens each. All the specimens have come from a limestone matrix and many are exfoliated. Because specific identification of these rare forms is not possible, no complete list of the Gastropoda is warranted.

*Worthenia tenuilineata* Girty (1929a, p. 141, 142), the only other gastropod described by Girty from the Fayetteville Shale, came from exposures in the Eureka Springs quadrangle, Arkansas. No specimens assignable to this species were found in the collections examined for this study.

The general stratigraphy of the Fayetteville Shale and details of the collecting localities are given by Gordon on page 2 in chapter A of this report; the localities are cited below only by USGS (U.S. Geol. Survey) locality number. Terminology and generic and suprageneric classification follow Knight and others (1960).

## SYSTEMATIC PALEONTOLOGY

**Class GASTROPODA**
**Order ARCHAEOGASTROPODA**
**Superfamily BELLEROPHONTACEA**
**Family SINUITIDAE**
**Subfamily BUCANELLINAE**
**Genus SINUITINA Knight, 1945**

### Sinuitina venata (Girty), 1910

Plate 5, figures 38, 43

1910. *Oxydiscus venatus* Girty, p. 231.

*Original description.*—"Shell small, sublenticular Whorl section helmet-shaped. Sides somewhat flattened, strongly rounded inward at the broad (?) umbilicus, regularly converging to the periphery, which is keeled, the keel being defined on either side by a slight though distinct groove and bearing a median ridge down its center. The sculpture consists of costae which have a transverse direction for one third the distance across the side and then are strongly and abruptly bent backward. This angular change of direction taking place at a corresponding point causes the surface to appear broken into a distinct band about the umbilicus, an appearance which is enhanced by the fact that after the backward turn, the costae abruptly become much finer, and some of them bifurcate so that the median portion of each side is more finely and more closely costate than the band near the umbilicus. Over the broad, carinated portion, however, the costae again become coarser, stronger and more distant, some of them dying out to allow this transformation to be effected."

*Revised description.*—Compressed sinuate bellerophontaceans ornamented by prominent growth lines. Shell strongly compressed so that cross section is distinctly lanceolate. Early whorls unknown. Umbilici rather wide, but details unknown; umbilical shoulders sharp. Profile from shoulders upward little inflated, proceeding along a very gentle arc to just before the dorsum where there is an abrupt downward bending, tending toward a flattened dorsum, but with the two sides converging at a low blunt angulation. Growth lines prominent, spaced about three times the width of an individual line, their course unknown in the umbilici, but orthocline for about one-third the distance of the sides, abruptly geniculating prosocline and then gradually curving a bit more strongly backward, but following essentially the same curvature until the dorsum is reached, where the lines from both sides converge in a U-shaped sinus. Ornament confined to growth lines, and a median lirum on the dorsum.

*Discussion.*—The holotype and only known specimen is incomplete, the umbilical area and slightly less than half the body whorl being preserved. The specimen also has been slightly distorted so that one side appears more inflated than the other. In spite of these difficulties the specimen may be considered fairly good, as the shell and growth lines are well preserved. A specimen of *Platyceras* (*Orthonychia*) and one fragment, doubtfully of a *Knightites*, are the only other gastropods at the type locality.

The narrow sinus on the dorsum is obvious, and this species is therefore removed from the superficially similar slit-bearing *Tropidodiscus* to *Sinuitina*. Knight (1941, p. 360–361) discussed the nomenclatural complexity surrounding *Oxydiscus* and *Tropidodiscus*.

*Sinuitina annaea* Conkin, 1957, from the New Providence Shale in Kentucky, is similar to this species. Growth lines are more prominent and regular, closer spaced, and form a sharper V on the dorsum. These differences appear to be more than those resulting from preservation in shale and in limestone, as is so with the two species compared here. There may be some differences in the profile, but as it is impossible to determine from the type whether *S. venata* (Girty) is more inflated or more compressed than *S. annaea*, no comparison of this feature may be made.

The only other North American species which need be considered at this time is *Bellerophon cyrtolites* Hall, (1859 [1860]) from the "Goniatites Limestone" of Rockford, Iowa. This species has been referred to *Tropidodiscus* and *Oxydiscus*. It is here placed in *Sinuitina*, but, because of the inherent problems with

our present knowledge of this species, some reservation must remain about its placement.

Hall did not illustrate *B. cyrtolites*. Although the name was used several times in the literature, it was not illustrated until Meek and Worthen (1866) described topotypic material; unfortunately they illustrated a steinkern. Subsequent illustrations by other authors are of sinuate bellerophontaceans probably referable to *Sinuitina*. The various figures, however, are not necessarily *S. cyrtolites* and may well include more than one species. The specimen illustrated by Meek and Worthen (1866) has umbilici which may be larger than those of *S. venata*. No other comparisons can be made.

*Type material.*—Holotype, USNM 161320; from the Fayetteville Shale at USGS locality 3651.

**Family BELLEROPHONTIDAE**
**Subfamily KNIGHTITINAE**
**Genus PATELLILABIA Knight, 1945**

**Patellilabia laevigata (Girty), 1910**

Plate 5, figures 44–48

1910. *Patellostium laevigatum* Girty, p. 231.

*Original description.*—"Shell rather small, rapidly expanding. At maturity, the growth appears to be rather straight than involved, and the widely expanded lip extends completely around the aperture and is continuous, though with a slight emargination, on the inner side. Umbilicus small. Slit band not elevated above the general curvature, except toward maturity, when it is raised into an angular ridge.

"Surface without radiating striae, it would appear, and with only fine incremental lines. These indicate that the aperture has a slight median insinuation, with a shallow notch where the band occurs."

*Revised description.*—Bellerophontacean gastropods lacking spiral ornament and with a rapidly expanding aperture in the mature stage. Early growth stages unknown, seemingly coiled with a well-rounded whorl until the mature stage; umbilici narrow, not known in detail; whorl profile extremely well rounded, following a curve that is nearly the arc of a circle across the dorsum from one umbilicus to the other. Mature stage with a wide, flattened, apertural margin; apertural margin well arched anteriorally and with little extension posteriorally in early stage of expansion, but possibly with a subsequent posterior flaring. Slit in juvenile aperture unknown, the center of the dorsum bearing no obvious selenizone; mature stage with a raised narrow median ridge. Anterior with a narrow shallow wide V-shaped sinus. Shell smooth and without ornament, at least at maturity.

*Discussion.*—The available material consists of an intermediate-size specimen, here designated lectotype, and two others. The lectotype retains a fair amount of shell except on the flaring aperture. The larger paralectotype is a rough steinkern, but it does show the anterior margin for much of its length. The smaller paralectotype is a broken steinkern that only shows the shape of a bilaterally symmetrically coiled shell. One poor specimen in the collection from the type locality was questionably identified by Girty as a member of the species, but it is specifically excluded from the hypodigm. Associated gastropods include about 18 bellerophontaceans, several specimens of *Platyceras*, and a few pleurotomariaceans.

So far as can be determined, there is no clear-cut evidence of spiral lirae heretofore considered one of the generic features. There is evidence of a boss within the aperture, but it is difficult to show photographically. The larger paralectotype is broken posteriorly, and one can see a mass of crystallized material extending through the level of the shell. The lectotype shows a depression in the body whorl such as that illustrated by Knight (1945) as the impression of a boss. On this specimen, however, the detail might possibly be a secondary feature caused by weathering.

In the original description of *Patellilabia*, Knight (1945, p. 336) indicated its range as from Middle Devonian to Pennsylvanian. At that time, only the type species, *P. tentoriolum* of Late Pennsylvanian age, was included in the genus. Yochelson (1960, p. 279) subsequently named *P. junior* and extended the range of the genus into the Lower Permian. Both these species differ from *P. laevigata* in possessing prominent revolving ornament and in having a median cord set off by rather deep bordering depressions.

Girty's specimens are important for they are the first tangible evidence of *Patellilabia* in the Mississippian. It remains to be determined whether the genus does occur in the Devonian.

A restudy of the types for the two-named late Paleozoic species, *P. tentoriolum* and *P. junior*, along with other supplementary specimens of Mississippian and Permian age, indicates one modification that should be made in the generic diagnosis. In the mature stage, characterized by a flaring aperture, the indentation of the anterior margin is both small and shallow. It is definitely in the shape of a sinus rather than a slit and as such could not generate a selenizone. It is not possible to determine if this is an ontogenetic change developing from an earlier slit, as no growth series of any of the species of the genus are known.

In addition to *P. laevigata* (Girty), two other American Mississippian species have been referred to *Patellostium*. Weller (1900, p. 115, pl. 6, fig. 6) trans-

ferred *Bellerophon scriptiferus* White (1862, p. 21) to that taxon. White's species is here tentatively transferred to *Patellilabia*. White did not figure his type specimen, but Weller illustrated a topotype specimen from the Chonopectus Sandstone at Burlington, Iowa; some authors now classify this unit as Devonian in age. An old plaster cast of this specimen (University of Chicago, 11719) is available in the National Museum collections (USNM 67256). It is about 50 percent larger than the largest specimen of *P. laevigata;* presumably the size difference is a valid characteristic for distinguishing this species from *P. laevigata*. In *P. scriptiferus*, revolving lirae, if present at all, are obscure. The dorsum bears a raised and well-rounded central cord. The apertural indentation is so slight that this feature may also be a pseudoselenizone.

*Bellerophon branneri* Weller (1897, p. 269, pl. 21, fig. 9) was described and illustrated from the Batesville Sandstone in Arkansas; presumably it is known from a single specimen. Girty (1915, p. 118, pl. 11, fig. 6) transferred it to *Patellostium* and reillustrated Weller's specimen. This specimen shows faint revolving lirae. Two transverse ridges are on one side of the dorsum; the other side bears a single ridge. Specimens with transverse ridges were excluded from this genus by Knight (1945). These features may be accidents of preservation and are judged here not to have significance, though the specimen has not been examined and this must be considered a tentative opinion. The precise character of the median ridge cannot be determined. The apertural margin in this species also has only a slight and shallow indentation. Pending more detailed investigation, this species is also tentatively reassigned to *Patellilabia*. The species seems to differ from *P. laevigata* in having a shallower sinus, but this species is so inadequately known that no precise comparisons are warranted.

The only other late Paleozoic species of *Patellostium* recorded in the North American literature is *P. ourayensis* (Gurley) (1884). This species was described, but not figured, from "shales of the Upper Carboniferous series" at Ouray, Colo. Girty (1899, p. 589) assigned the species to *Patellostium* and later (Girty, 1903, p. 471, pl. 10, figs. 10–106) republished Gurley's description and illustrated what is presumably the holotype. The species does not show a flaring aperture and is here transferred to *Knightites* (*Retispira*). The species was overlooked by Yochelson (1960, p. 224–228) in his review of Pennsylvanian bellerophontaceans.

*Type material.*—Lectotype, USNM 161321; figured paralectotype, USNM 161322a; unfigured paralectotype, USNM 161322b; all from the basal limestone of the Fayettesville Shale at USGS locality 3641A.

**Superfamily PLEUROTOMATIACEA**
**Family RAPHISTOMATIDAE**
**Subfamily LIOSPIRINAE**
**Genus TREPOSPIRA Ulrich and Scofield, 1897**
**Subgenus ANGYOMPHALUS Cossmann, 1916**

**Trepospira (Angyomphalus?) discus (Girty), 1910**

Plate 5, figures 24, 31, 33

1910. *Anomphalus? discus* Girty, p. 231.

*Original description.*—"Shell rather large, discoidal. Diameter 10 mm. Height 3.5 mm. Spire flattened. Volutions probably 4 or 5 in number, rather rapidly expanding. Peritreme section transversely elliptical with slightly pointed ends; flattened above, subangular on the periphery, about one third of the upper surface depressed by contact with the preceding volution. The volutions are embraced up to the keeled periphery, so that the top of the shell is nearly flat. Suture scarcely depressed. Umbilicus probably closed. Surface without ornamentation."

*Revised description.*—Nearly lenticular, possibly phaneromphalous gastropods. Nucleus and early whorls unknown. Whorls few, expanding at a rapid rate. Profile unknown in detail, but exceedingly low spired; sutures possibly distinct; upper whorl surface flattened, nearly horizontal for about half of total width then arching down to rather sharp periphery at or near midwhorl; profile below periphery well rounded, following the arc of a circle for a short distance, but then flattening while continuing downward and more strongly inward, and finally turning upward and rising more steeply into the umbilical area. Probably not anomphalous; steinkern showing a circumbilical angulation. Growth lines unknown.

*Discussion.*—The holotype and only specimen is a steinkern preserving just a patch of a shell layer in the umbilical area. The apical part of the steinkern is worn. One *Platyceras*, one bellerophontacean, and four small pleurotomariaceans are the other gastropods occurring with the holotype.

On the manuscript label of the holotype chosen by Girty for illustration, the generic name is written without a query. The collection from USGS locality 3641A, which contains *Patellilabia laevigata*, includes one specimen questionably assigned to this species. It is a small steinkern with well-rounded whorls and is clearly not conspecific and probably not congeneric. In view of the presumptive evidence of doubt as to identity, which is shown by Girty's label, it is appropriate to exclude this specimen from consideration as part of the type lot.

The only named North American Mississippian species of *Anomphalus* is *A. rotuliformis* Cumings (1906) from the Salem Limestone in Indiana. An

unnamed species was described by Yochelson and Dutro (1960) from the Alapah Limestone in northern Alaska. These species have in common with other species of *Anomphalus* a moderately well rounded outer whorl face. In contrast, Girty's species has a rather sharp outer whorl face, as a consequence of its flattened upper surface and lenticular shape.

The lenticular shape suggests *Trepospira*. This genus is most common in the Pennsylvanian, but specimens referred to the subgenus, *Angyomphalus*, have been described from the Mississippian. The assignment of Girty's species questionably to that subgenus is based on the presumed character of the umbilicus, as the umbilical angulation may have been the result of combination of a funicle and an open umbilicus. In any event, there seems little reason to extend the stratigraphic range of the typical subgenus downward into the Mississippian on such poor material.

It is suggested that use of this species name be restricted to the type lot.

*Type material.*—Holotype, USNM 161312; from the base of the Fayetteville Shale at USGS locality 3651C.

**Family EOTOMARIIDAE Wenz**
**Subfamily EOTOMARIINAE Wenz**
**Tribe PTYCHOMPHALIDES Wenz**
**Genus MOURLONIA DeKoninck, 1883**

**Mourlonia lativittata (Girty), 1910**

Plate 5, figures 25, 32, 34

1910. *Bembexia lativittata* Girty, p. 231.

*Original description.*—"Shell small, subglobose, consisting of three or four rather rapidly expanding volutions. The largest specimen seen has a diameter of about 5mm. The height is equal to the greatest diameter or a little greater. The spire is about one third the entire height. The sutures are deeply depressed. The peritreme section is very nearly circular except for the impressed zone, somewhat flattened above, regularly rounded below. The slit band is very broad, situated on the periphery, defined by thin elevated edges.

"The sculpture consists of fine growth lines which are fasciculated at regular intervals, producing transverse costae. These are more distinct above the band than below, and near the suture they are apt to be especially strong, forming little elongated nodes. They slope backward gently from the suture to the band and are curved, presenting the convex side toward the aperture. On the band, they are distinct and rather strongly concave, but assume the convex curve below and are nearly transverse."

*Revised description.*—Small, moderately well rounded pleurotomariaceans with prominent growth lines only in the juvenile stage. Nucleus and early whorls unknown. Moderately high spired, the body whorl embraces the penultimate whorl well below the periphery. Sutures slightly incised. Whorl profile from suture inclined outward and downward with little arching to a carina forming upper border of selenizone, crossing raised, nearly vertical selenizone to lower carina, below which the profile is smoothly curved following the arc of a circle for a short distance to an obscure, slight basal angulation; the basal surface curves downward, but at a much more gentle rate, and finally turns upward for a short distance. Probably anomphalus, but with an umbilical depression. Growth lines nearly normal from suture for about one-fourth the width of the upper whorl surface then sweeping prosocline to form approximately a 45° angle with upper bordering carina; below selenizone, steeply opisthocline until crossing faint basal angulation and then orthocline into umbilical area. Slit at least one-fifth of a whorl in depth. Selenizone is wide; slightly raised above whorl profile; concave and bordered by carinae, the lower of which forms the periphery; and ornamented by moderately widely spaced, well-curved lunulae. Ornament confined to growth lines which are prominent on the upper whorl surface during early growth stages but become increasing obscure with maturity. Shell relatively thick.

*Discussion.*—Two specimens were picked by Girty (1910) for illustration. Both are well preserved and show the growth lines clearly. The more complete specimen that has parts of three whorls is here designated lectotype. This specimen also has matrix in the slit, which gives some idea of slit depth. In addition to the figured paralectotype, there are 15 other specimens from the same locality. All are in a coarsely crystalline limestone matrix and most have either exfoliated or broken. This species is the only gastropod in the collection.

The generic relations of many middle Paleozoic pleurotomariaceans are by no means clear. This applies in particular to those forms with a more or less median selenizone. While there may be some reason to retain this species in *Bembexia*, increasingly *Mourlonia* has been used for those species with a relatively well rounded whorl profile. In contrast, *Bembexia* is currently used in a rather restricted sense for those species which show an incised profile.

Seven species of North American Mississippian gastropods are currently placed in *Mourlonia*. Only two of these appear to be closely related to *M. lativittata*. *Mourlonia angulata* Easton (1943) from the Pitkin Limestone of Arkansas is comparable to *M. lativittata* in size but is lower spired and has more prominent growth lines. *Mourlonia sablei* Yochelson and Dutro (1963) from the Lisbourne Group in northern Alaska is slightly

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larger. Its profile is similar to that of *M. lativittata*, but the ornament in *M. sablei* is more prominent on both the upper and basal surfaces than in that species.

*Mourlonia mississippiensis* (White and Whitfield) (1862) from "The Chemung Group" at Burlington, Iowa, is much larger than *M. lativittata* and has the selenizone above the periphery and inclined rather than nearly vertical; this species may not be of Mississippian age. *Mourlonia textus* Hyde (1953) from the Byer Member of the Logan Formation in Ohio is larger, higher spired, and far more elaborately ornamented than *M. lativittata*; possible reference to another genus should be considered when the Logan fauna is reinvestigated.

The remaining species almost certainly are not *Mourlonia*. *M. minuta* Weller (1916) from the Ste. Genevieve Limestone in Illinois is also small, but it shows spiral lirae on the base; it cannot be reassigned at present. *Mourlonia northviewensis* Weller (1899) has a narrower whorl and a much more angular profile; as illustrated by Branson (1938) it suggests a *Worthenia*, but the material appears to be too poor for definitive assignment. *Mourlonia solida* Hyde (1953) from the Byer Member of the Logan Formation in Ohio may be a *Spiroscala*.

In addition to the *Mourlonia* species mentioned above, consideration should be given to eight North American Mississippian species assigned to *Bembexia*. Of these, *Bembexia ellenae* Conkin (1957), from the New Providence Shale, and Mississippian specimens referred to the Devonian species *B. sulcomarginata* (Hall) probably belong to the genus. *Bembexia shepardi* Branson (1938) from the Lower Mississippian of Missouri cannot be determined from its illustrations. *Bembexia magna* Girty (1929b) from the Boone Formation is not illustrated. Another species *B.? inumbilicata* Yochelson and Dutro (1960) from the Mississippian of Northern Alaska is only questionably referred to the genus.

*Bembexia elegantula* (Hall) from the Salem Limestone is here transferred to *Spiroscala*. *Bembexia minima* (Rowley) (1895) from the Louisiana Limestone may be a *Neilsonia* but should be reexamined before a definite determination is given. Some uncertainty surrounds the types of *B. nodomarginata* (McChesney) (1859), but this species almost certainly should be transferred to *Lunulazona*. *Bembexia waterlooensis* Weller (1916), from the Ste. Genevieve Limestone in Illinois, cannot be certainly determined, but may be a *Spiroscala*.

*Type material.*—Lectotype, USNM 161313; figured paralectotype, USNM 161314a; unfigured paralectotypes USNM 161314b–n; all from the basal limestone of the Fayetteville Shale at USGS loc. 7082.

**Genus EUCONOSPIRA Ulrich in Ulrich and Scofield, 1897**

**Euconospira disjuncta Girty, 1910**

Plate 5, figures 36, 39, 41, 42

1910. *Euconospira disjuncta* Girty, p. 230; not Girty, 1915, p. 114, pl. 11, fig. 10.

*Original description.*—"Shell of medium size. Maximum diameter 23 mm. Height 20 mm. Volutions about 7, gradually enlarging. Umbilicus small, open (?). Peritreme section very transverse, subrhomboidal, gently concave on the upper interior side, nearly straight on the upper exterior side, gently convex on the lower exterior side and strongly convex on the lower interior side. The upper interior surface slopes gently downward; the upper exterior surface slopes strongly downward in the opposite direction, and the lower exterior surface slopes gently downward. The periphery is therefore acutely angular and carries a narrow slit band defined by sharply projecting edges. The volutions do not embrace quite to the slit band, so that the conical shape of the shell, as a whole, is broken into steplike descents. The peripheral portion on which the slit band occurs is rendered more or less carinate by two relatively narrow sulci, one above and one below, of which the latter is the more conspicuous, because of being more distinctly defined on its outer side, where there is a fairly distinct shoulder. It is up to this shoulder that each volution embraces the preceding one.

"The surface is marked by regular transverse striae having a gently convex curvature and a strong backward direction. On the lower surface of the peritreme, they have a sigmoidal curve, concave toward the band and convex toward the umbilicus. They also have a strong backward sweep, so that the aperture is very oblique. In crossing the slit band, they make strong, regular crenulations, which do not extend onto the elevated edges of the band. Traces of revolving lines are present also, especially on the lower surface."

*Revised description.*—Trochiform pleurotomariaceans with body whorl embracing penultimate whorl below selenizone. Nucleus and early growth stages unknown. Apical angle nearly 80°, possibly increasing with maturity so that the profile follows a slight catanary curve. Sutures distinct, overhung by previous whorl. Upper whorl surface with a narrow subsutural flattening, but otherwise inclined outward and downward for almost its entire width, the amount of inclination lessening with increasing maturity. At outer edge of upper whorl surface, a thickened carina forms the periphery as well as the upper edge of the selenizone; this carina is hardly distinguishable in early growth stages but prominent on the body whorl. Lower border-

ing carina not as prominent. Below carina, profile curves strongly inward and downward for a short distance to a wide low ridge, the area between being distinctly concave; this ridge forms the zone of juncture of the whorls; beyond the ridge, basal whorl surface distinctly flattened with only slight curvature to the narrow umbilicus where the sides abruptly turn vertical. Growth lines simple, sweepingly prosocline from suture to selenizone, far less sweepingly opisthocline on outer third of basal surface, and orthocline from there to umbilicus. Slit depth unknown. Selenizone narrow; distinctly concave between the two bordering carina, ornamented by closely spaced, well-formed, lunulae. Shell thin, ornamented by faint spiral lirae on early whorls but mainly by closely spaced prominent growth lines; the lines become slightly less pronounced at maturity.

*Discussion.*—Two specimens from separate localities are available. The larger is here designated the lectotype. It has part of the body whorl broken away and has been slightly distorted, particularly on the broken side. In contrast to some of Girty's (1910) other types, however, it is well preserved and the growth lines are shown clearly. Associated gastropods are five pleurotomariaceans and one bellerophontacean, all poorly preserved.

The paralectotype is less complete and only shows features on the upper whorl surface; because the specimen is not distorted, the "disjunct" whorls are less evident. Comparison of this specimen with the lectotype is particularly instructive in showing how coarse colabral ornament on the outer shell layer may result in relatively fine ornament reflected onto the steinkern. No other gastropods occur with the paralectotype.

Specimens of *Euconospira* of Pennsylvanian age consistently seem to have a rather smooth whorl surface. This is quite unlike the angulated profile of *E. disjuncta* but most other features are congeneric. Eventually it may be useful to reinstate *Trechmannia* Longstaff, a subjective synonym, for species with this kind of profile. Until a thorough study is made of the genus, discussion of this point is better delayed.

The term "*Euconospira disjuncta*," was employed by Girty in 1915 (p. 114) for a totally different specimen, from the Batesville Sandstone. This specimen (USNM 121321) is a sandstone impression that shows virtually no detail except that the whorl profile was not indented as in *E. disjuncta*. The specimen is best treated as an indeterminate pleurotomariacean. *Bembexia* sp. from the same work (USNM 121320) is more similar to *E. disjuncta*, in that it has both an indented profile and a definite peripheral selenizone. No growth lines or other significant details are available and that specimen also should be treated as an indeterminate pleurotomariacean.

Except for *E. disjuncta*, no species of the genus has been formally named from the Mississippian of North America. Girty (1915, p. 115) mentioned another species but did not illustrate it. Allen and Lester (1954, p. 129, pl. 33, fig. 5) illustrated a Mississippian *Euconospira* species from Georgia; it does not have incised whorls like *E. disjuncta*, but it more closely resembles the smoother profile of Pennsylvanian species.

*Type material.*—Lectotype, USNM 161318; from the Fayetteville Shale at USGS locality 3651B. Paralectotype, USNM 161319; from the Fayetteville Shale at USGS locality 5553A.

**Superfamily PLATYCERATACEA**
**Family PLATYCERATIDAE**
**Genus PLATYCERAS Conrad, 1840**
**Subgenus PLATYCERAS Conrad, 1840**

**Platyceras (Platyceras) subelegans Girty, 1910**

Plate 5, figures 26, 27, 35

1910. *Platyceras subelegans* Girty, p. 232.

*Original description.*—"Shell small, rapidly enlarging, completing about one half a turn, more strongly curved at the apex, but very slightly spiral, broad on the outer side, contracting toward the inner, so that the section is subtriangular; marked by numerous longitudinal plications, especially by a narrow peripheral carina defined by two deep sulci and more persistent toward the apex than the others. Surface crossed by lamellose concentric lines whose direction is made very sinuous by the plications."

*Revised description.*—Early growth stages coiled half a whorl, thereupon expanding with an open coil for about one-fourth a whorl. Shell nearly bilaterally symmetrical. Whorl cross section rather well rounded, but with slight lateral compression "posteriorly." Apertural margin crenulated in detail with more than 10 narrow reentrants and salients, one set of which simulates a dorsal selenizone. Shell with more than 10 longitudinal ridges of varying strength. Ornamented by fairly fine, closely spaced, growth lines.

*Discussion.*—As part of the juvenile whorl can be seen clearly in contact, no reservations are attached to assigning the species to the typical subgenus. Species of *Platyceras* that have a curved horn shape to the body whorl may or may not have the protoconch coiled. The presumed distinction between *Platyceras* in a restricted sense, with half a whorl or more in contact, and the subgenus *Orthonychia*, without any of the juvenile shell in contact, may be artificial, especially in those forms

where the area of contact is extremely small compared to the size of the mature shell.

As is characteristic of most species of *Platyceras*, the holotype has a rather thick, well-preserved shell bearing clear growth lines. The holotype occurs with a bellerophontacean and a *Platyceras* (*Orthonychia*).

In literature on the Mississippian of North America, more than a dozen specific names have been used with *Platyceras* in more or less the strict sense, and for dozens of species in the subgenus *Orthonychia*. Because of the sedentary habitat of *Platyceras* on various pelmatozoans specimens tend toward much individual variation. In absence of any populations of *P.* (*P.*) *subelegans* for study, there is little justification for attempting comparison among the species previously described.

As noted, *Platyceras* is the gastropod in preponderance in the Fayetteville collections. Almost all specimens were identified by Girty as a new variety of the common species *Platyceras* (*Orthonychia*) *capax* Keyes. It is likely that *P.* (*P.*) *subelegans* is an extreme variant of this hook-shaped form. Until such time as the limits of species within *Platyceras* are better understood and more specimens from the Fayetteville Shale are available for study, the specific name should be restricted to use with the holotype.

*Type material.*—Holotype, USNM 161315; from limestone in the lower part of the Fayetteville Shale at USGS locality 3636.

**Subgenus ORTHONYCHIA Hall, 1843**

**Platyceras (Orthonychia) compressum Girty, 1910**

Plate 5, figures 28–30, 37, 40

1910. *Orthonychia compressa* Girty, p. 232.

*Original description.*—"Shell of medium size, oblique, conical, compressed, nearly complanate or bilaterally symmetrical, very rapidly enlarging and slightly bent, making one half a volution or less. Cross section subelliptical, very much longer than broad. Surface nearly smooth, marked only by obscure sublamellose growth lines. No costae or spines."

*Revised description.*—Compressed platyceratid gastropods. Early growth stages unknown. Mature shell expands rapidly, probably open coiled and possibly completes less than one whorl. Nearly bilaterally symmetrical with a prominent ridge near line of pseudosymmetry. Shell strongly compressed so that sides are relatively little arched outward from the ridgelike "dorsum" to near the opposite side of the whorl which is well rounded in contrast. Growth lines poorly known, seeming with nearly a straight margin except for a broad but shallow reentrant at the ridge.

*Discussion.*—Two specimens are available; the larger is here designated lectotype. Both show the compressed shape and appear conspecific. In the lectotype, most of the outer shell layer is exfoliated, and the apex is broken. In the smaller paralectotype, most of the apex is preserved, as well as large patches of the outer shell, but the specimen is gouged in one place and broken in another place near the margin.

The lectotype is from a light colored, coarsely crystalline matrix, not typical of the other Fayetteville specimens. Associated gastropods include a bellerophontacean, another platyceratid, and two euomphalids. The paralectotype is from the same collection which yielded the type of *Sinuitina venata*.

The transfer of this species to *Platyceras* is nothing more than a formal nomenclatural change. *Orthonychia* is commonly considered one of the intergrading subgenera of the genus. It is used when all whorls are completely free. Although the juvenile stage of this species is not well known, there is a high degree of probability that this was an entirely uncoiled form.

It is not necessary to repeat the remarks made above concerning comparison of named species in *P.* (*Platyceras*), though they apply here even more strongly. There are more than 35 specific names that have been employed with *Platyceras* (*Orthonychia*) in the literature on the Mississippian of North America. A senior synonym of Girty's specific name could probably be found, but it seems equally probable that the uncertainties regarding types of earlier named species and the lack of sufficiently large population samples would make formal comparison at this time a most unsatisfying and nonsignificant study.

*Type material.*—Lectotype, USNM 161316; from interbedded limestone and sandstone of the Batesville Sandstone at USGS locality 2840. Paralectotype, USNM 161317; from the Fayetteville Shale at USGS locality 3641A.

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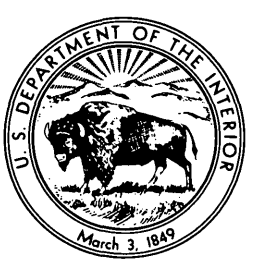
# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Trilobites

*By* MACKENZIE GORDON, JR.

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-E

*Illustration and redescription of G. H. Girty's type specimens of* Paladin mucronatus (*Girty*) *from the Fayetteville Shale*



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# ILLUSTRATION


[Plate follows index]

PLATE 5. Gastropods and a trilobite from the Fayetteville Shale.

# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—TRILOBITES

By MACKENZIE GORDON, JR.

ABSTRACT

*Griffithides mucronatus*, the sole trilobite described by Girty in his preliminary paper on the Fayetteville Shale fauna, is redescribed, figured, and its occurrence documented. Girty's species has been reassigned to the genus *Paladin* by Weller.

## INTRODUCTION

In his paper on new genera and species of Carboniferous fossils from the Fayetteville Shale of Arkansas, Girty (1910) described only one trilobite, *Griffithides mucronatus*. As with the other invertebrates described in that paper, he designated no types and did not cite the localities from which the material was collected, nor did he illustrate the specimens. The purpose of this short article is to provide this information for the trilobite and to bring this species into the focus of present-day classification. Actually, the task is not great because specimens that Girty had intended to figure in a later monograph, which was never completed, were studied by Weller (1936), who assigned *Griffithides mucronatus* Girty to his new genus *Paladin*. Time has not altered this assignment.

Descriptions of cited USGS (U.S. Geological Survey) collecting localities are given by Gordon on page 4 in chapter A of this report.

## SYSTEMATIC PALEONTOLOGY

**Class TRILOBITA Walch**
**Order PTYCHOPARIIDA Swinnerton**
**Suborder ILLAENINA Jaanusson**
**Superfamily PROETACEA Salter**
**Family PHILLIPSIIDAE Oehlert**
**Genus PALADIN Weller, 1936**

**Paladin mucronatus (Girty), 1910**

Plate 5, figures 1–23

1910. *Griffithides mucronatus* Girty, p. 238.
1915. *Griffithides mucronatus* Girty. Girty, p. 133.
1936. *Paladin mucronatus* (Girty). Weller, p. 707.
1943. *Paladin mucronatus* (Girty). Easton, p. 152, pl. 24, fig. 15.

*Original description.*—"Head: glabella large, inflated, considerably narrower behind; basal lobes triangular, small strongly defined. Neck ring defined from the glabela by a deep sulcus, strongly arched in the middle with moderately long lateral projections. Eye lappets small, oblique. Border anterior to the glabella, moderately narrow, depressed, slightly convex, defined by a groove. Surface of glabella granulose, much more finely in front than behind. Median portion of neck ring and projecting end of eye lappets also marked by coarse granules. Outer margin of anterior border with fine parallel raised lines. The remainder of the surface, including the more depressed portions finely pitted.

"Free cheek with a wide, gently convex border defined by a strong groove. Eye large, prominent, many faceted, bounded below by a curved ridge. Genal angle much produced into an elongated spine. Surface finely pitted, outer margins marked by regular, fine, parallel lirae.

"Thoracic segments nine, strongly lobed, axial portion a little less than one third of the whole. Longitudinally furrowed.

"Pygidium semi-elliptical or shield-shaped, length and breadth about equal. Border broad and gently convex or nearly flat. From its well defined inner margin, the main portion of the pygidium rises abruptly, the axis being also abruptly and strongly elevated above the pleural areas. At its anterior end, the axial and pleural portions are about equally broad, and the border about one half as broad as the three other divisions. In old specimens, the border is relatively narrower. The segments are defined by deep angular grooves. There are 16 on the axis and 9 or 10 on the sides. The lateral segments are sometimes partly divided by indistinct furrows. Besides the number given above, there is a small articulating segment at the front end of the axis, and the anterior of the lateral segments is made double by a groove which divides it into two parts, the posterior having the normal size, the anterior being somewhat smaller. The surface of the lateral segments is rather coarsely granulated, and sometimes the granules are segregated along a raised line. Each of the axial segments is marked by a row of still larger granules. The border is traversed by a few delicate, inosculating lines and is finely roughened."

Girty added: "This species is abundant in the basal limestone of the Fayetteville shale, rare and somewhat doubtfully identified in the Batesville sandstone below."

*Type material.*—Girty identified *Griffithides mucronatus* in 17 of 18 USGS collections from the Fayetteville Shale that contain trilobites; one additional sample came from the Batesville Sandstone. These specimens, 131 in all, constitute the syntypes of *Paladin mucronatus* (Girty) and are as follows:

| USGS locality | Entire | Cephalons | Cranidia | Free cheeks | Hypostomes | Pygidia |
|---|---|---|---|---|---|---|
| 1339B | | | 2 | | | 10 |
| 1339E | | 1 | 1 | 3 | | 9 |
| [1] 1412A | | | 1 | 1 | | |
| 2845 | 1 | | | | | |
| [2] 3638 | | | 2 | 1 | | 5 |
| [1] 3638A | | | | | | 1 |
| [1] 3641A | | | | | | 5 |
| 3651A | | | 1 | | | 4 |
| 3651B | | | 2 | | | 4 |
| 3651C | | | 2 | 4 | 1 | 15 |
| 3652 | | | 1 | 1 | | |
| [2] 5550 | | | | | | 1 |
| 5550A | | 1 | | | | |
| 5553 | | | 1 | 1 | | 1 |
| 5553A | | | 8 | 7 | 3 | 26 |
| [3] 5556 | | | | | | 1 |
| 7084 | | | | | | 1 |
| [2] 7085 | | | | | | 2 |
| Total | 1 | 2 | 21 | 18 | 4 | 85 |

[1] Specimens from this locality were removed from *P. mucronatus* in this paper.
[2] Specimens from this locality referred with question to *P. mucronatus*.
[3] From Batesville Sandstone collection.

One lot (from USGS loc. 3641A) is regarded as belonging to a species other than *P. mucronatus*—at least in part belonging to the species represented in the 18th collection (USGS loc. 1339G) by a well-preserved pygidium that Girty identified only as *Phillipsia* on the label and which appears to be referable to *Kaskia chesterensis* Weller or a closely related form. Another specimen, a small pygidium that Girty had intended to figure, the only specimen from USGS locality 3638A, was lost while out on loan. As the specimen is unavailable for examination and as no photographs of it have been found, there is no need to consider it further. A third lot (from USGS loc. 1412A) is eliminated as unidentifiable because it consists only of a fragment of an eye and part of an internal mold, perhaps of a cranidium.

Of the 123 specimens that remain, those from USGS localities 3638, 5550, and 7085 are poorly preserved and not positively identified as *P. mucronatus*, although so considered by Girty. This leaves 112 specimens that are sufficiently well preserved to refer with confidence to Girty's species.

A cranidium (USNM 160902; pl. 5, figs. 1, 2) has been selected as the lectotype. This specimen was set aside by Girty for figuring as "*Griffithides*" *mucronatus*. From the type locality, a bluff near Wyman, Ark., 34 paralectotypes are available in four collections (USGS locs. 3651A, B, C, 3652). A virtually complete specimen (USNM 160900; pl. 5, figs. 5, 23) was not selected as the lectotype because excessive weathering has obliterated the glabella and the axial lobe of the pygidium. A well-preserved cephalon (USNM 160912; pl. 5, figs. 4, 6) although selected by Girty for figuring as *Griffithides mucronatus*, was not chosen as the lectotype because the only mature pygidium associated with it is not typical in that it is ornamented by finer nodes than are normal for this species and because this pygidium and the rest of the material from the same locality (USGS loc. 5550A) bear Girty's identification as *Griffithides granulatus* (Wetherby). Selection of a cranidium as the lectotype is consistent with the fact that every American species of *Paladin* is based on a type specimen that is either a cephalon, a cranidium, or an enrolled entire specimen.

Two other localities, together with the type locality, have yielded 108 of the primary types of this species. Forty-seven paralectotypes from the south end of Webber Mountain (USGS locs. 5553, 5553A) and 26 paralectotypes from a locality 5½ miles southeast of Springdale (USGS locs. 1339B, E) are available. In fact, all but two of the 111 paralectotypes referred with confidence to *P. mucronatus* come from outcrops over a linear zone about 7 miles long, from Webber Mountain south to the type locality.

*Cephalon.*—Head parts among the primary types of *P. mucronatus* consist of two cephalons, 18 cranidia, 16 free cheeks, and four hypostomes, besides the one complete though weathered specimen. The dimensions, in millimeters, of the lectotype (USNM 160902) are: length, 11.7; greatest width (at palpebral lobes), 8.7; width at anterior border, 8.6; height, 3.2; length of glabella, 8.8; greatest width of glabella (at frontal lobe), 6.0; maximum width posteriorly (at preoccipital lobes), 5.6; width of occipital ring, 5.2. The complete specimen (USNM 160900), which is 24.3 mm long, has a cranidium 8.7 mm long; its cephalon is 9.0 mm long and 15.0 mm wide at the genal angles, and the nearly complete genal spine is 5.4 mm long. A free cheek (USNM 160915) is 11.0 mm long, including a genal spine 4.5 mm long and 3.8 mm wide, the eye lobe is 2.7 mm long.

The glabella, outlined by shallow preglabellar and axial furrows, has its greatest elevation posteriorly, although the lateral preoccipital lobes are rather low. The glabella is gently convex dorsally but appears flattened in the posterior region, where the steeply sloping sides are separated from the dorsal surface by a dorsolateral zone of much greater curvature; this zone dies out anteriorly where the glabella is lower, more expanded, and more evenly convex. From the highest point of the glabella, near the posterior end, the surface slopes down steeply backward to the broad, moderately deep, sinuous preoccipital furrow. The basal glabellar furrows are

deepest in the middle and die out toward the palpebral lobes. No lateral glabellar furrows are visible, either externally or on internal molds. Faint palpebral furrows set off the rather prominent palpebral lobes. Anteriorly the glabella encroaches somewhat on the anterior border, which slopes gently away from the glabella. The anterior margin is narrowly convex.

The cheeks slope outward and partly forward and are bounded by a moderately wide flat smooth lateral border with a sharp angulation at its outer edge that sets the border off from the rather steep flat sides. The posterior border is bounded anteriorly by a rather deep furrow, and the genal angles are produced into moderately long genal spines. The eye lobe is about one-third the length of the cephalon, the eyes being posterior in position.

Surface ornament on the cephalon is strongest on the elevated posterior part of the glabella and consists of moderately coarse tubercles and granules that lie mostly within the area enclosed by the outer edge of the dorsolateral zones. Tubercles and granules are also on the occipital ring, and granules only on the palpebral lobes. The tubercles and granules on the glabella are interconnected by an irregular network of microscopic anastomozing threadlets; anteriorly the tubercles and granules become smaller and die out, leaving only the irregular network of threadlets and tiny enclosed pits ornamenting the anterior half of the glabella.

The occipital ring bears a moderately large, low mesial tubercle near its posterior margin and scattered fine sharp tubercles, including a row of nine or 10 along its posterior edge, which appear hollow and spinelike, though short. The anterior and lateral borders are marked by five to six fine striae that parallel the margin, and an equal number, more closely spaced on the underside.

In early moult stages the glabella tends to be more oval and does not spread anteriorly as in the adult stages. A small cranidium (USNM 160914b) figured with the pygidium (pl. 5, figs. 14, 17), is 2.9 mm long.

Among the four hypostomes, only one represents the adult stage. The most complete one (USNM 160916a), from an early moult stage, is figured on plate 5, figures 12, 13. This specimen is 1.6 mm long and 1.3 mm wide at the anterior wings, which extend dorsad at roughly a 120° angle to each other. The adult form is proportionally more slender, and its anterior wings extend outward at a wider angle. A moderately complete external mold of a hypostome (USNM 160916b; unfigured) measures 5.4 mm long, 4.0 mm wide at the anterior wings (one of which is missing), and 3.1 mm wide at the widest bulging part of the lateral borders, 2 mm from the posterior end. Both anterior and posterior borders are convex outward; the posterior border is narrow and bounded at either end by a short pointed protuberance at the postero-lateral angles.

The lateral border of the hypostome is not strongly set off from the anterior wings, but a narrow border furrow intervenes between it and the median body and posterior lobe. The lateral border appears flat but is narrowly and gently convex, as is the posterior border. The hypostome is slightly pinched between its median body and posterior lobe, and the posterior end slopes rather steeply.

Sculpture of the hypostome includes four or five threads along each side of the median body; these threads curve but do not close around its posterior end; near their terminations, three or four short threads are intercalated. Another four or five threads ornament each anterior wing, and two continue on to the lateral border; the posterior border is smooth. The surfaces of the median body and posterior lobes of the hypostome are covered by scattered shallow pits.

*Thorax.*—The only thorax available is included in the one entire specimen (USNM 160900) and consists of nine segments. The axial part has been damaged by weathering that has obliterated all surface sculpture; some axial rings have been worn off or broken away in places, which exposes the articulating half rings. The proximal parts of the pleurae are horizontal, and the distal parts slope steeply. The pleural furrow on each pleura is moderately deep and is over the fulcrum, not quite half way back from the anterior edge. The anterior three pleurae are faceted and narrow, tapering distally; succeeding pleurae are increasingly longer (exsagitally), with rounded terminations. On these latter pleurae the articulating facets are not clearly defined distally.

*Pygidium.*—Among the paralectotypes of *P. mucronatus*, 70 unarticulated pygidia are available. Although the original description said that the length and width of pygidia in this species are about equal my measurements show that the width is constantly a little greater than the length. The dimensions, in millimeters, of six pygidia are as follows:

| | *USNM 161324* | *USNM 160914a* | *USNM 160909* | *USNM 161323* | *USNM 160907* | *USNM 160906* |
|---|---|---|---|---|---|---|
| Length | 11.6 | 7.4 | 6.4 | 3.4 | 2.6 | 1.6 |
| Width | 13.3 | 8.5 | 7.3 | 4.2 | 3.4 | 2.0 |
| Height | 4.4 | 2.8 | 2.9 | 1.8 | 1.6 | 0.6 |

Though the outline of the margin varies slightly, most pygidia have a somewhat shield-shaped or parabolic outline as in plate 5, figure 17. The axial lobe is moderately narrow, has steeply sloping sides, and is very gently rounded on top. The pleural area is somewhat elevated above the sloping border, as can be seen on plate 5, figures 19, 21, and 22.

In early moult stages, more pleurae and fewer axial rings are present than is normal in the adult; the pleurae appear narrow and elevated, and the interpleural grooves are very distinct, about half as wide as the pleurae. The smallest pygidium (USNM 160906, pl. 5, figs. 3, 11), a topotype 1.6 mm long, has 13 axial rings and 11 pleurae. A larger pygidium (USNM 160907 unfigured) from the same locality is 2.6 mm long and has 14 axial rings and 10 pleurae. Another pygidium (USNM 161323) unfigured 3.4 mm long, from USGS locality 5553A, has 15 axial rings and 10 pleurae, as does another (USNM 160914a, pl. 5, figs. 14, 17), 6.4 mm long, from the same locality. Pygidia longer than 3.5 mm normally have 15 axial rings and 9 pleurae, but larger ones such as the one from the Batesville Sandstone (USNM 161324, pl. 5, figs. 8–10) may have 16 axial rings.

*Discussion.*—*Paladin mucronatus* (Girty), which was described originally as a *Griffithides*, is also related to *Phillipsia mucronata* M'Coy, 1844, which some European authors have assigned to *Paladin*. Such an assignment makes *Paladin mucronatus* (Girty) a junior secondary homonym of *P. mucronatus* (M'Coy). Were such an assignment to stand, it would be necessary to relieve the homonymy by proposing a new name for Girty's species.

Reed (1942, p. 653), however, made *Phillipsia mucronata* M'Coy the type species of a new genus *Weberides*, which differs from *Paladin* in having an even more widely expanded glabella anteriorly, the pygidium commonly terminating in a spine, and the sculpture of small nodes confined to the occiptal rings and the axial rings of the thorax and pygidium. The writer, following Harrington and others (1959), regards *Weberides* as distinct from *Paladin* and therefore, according to Article 59(c) of the present International Code of Zoological Nomenclature (Stoll and others, 1961), it is not necessary to propose a new name for Girty's species.

*Comparisons and affinities.*—Characteristic of *P. mucronatus* are: the relatively coarse nodes and granules that ornament the posterior part of the glabella; the shield-shaped or semielliptical outline of the pygidium; the moderately narrow axial zone; the 15 to 16 axial rings and nine to 10 pleurae in adult shells; the row of prominent elongate spinelike nodes, commonly eight in number, ranged along the posterior edge of each axial ring; the rude lineation of fine granules on the pleurate dominated by a row of tiny nodes on the posterior riblet where present; and the abrupt termination of the pleurae at the smooth border which is divisible into two zones, the outer concave one being the narrower.

These characters differentiate *P. mucronatus* from the type species of the genus, *P. morrowensis* (Mather, 1915, p. 244) from the Morrow Series (Lower Pennsylvanian) of the same region, which typically has the glabella a little more expanded anteriorly and the posterior part of it ornamented by smaller nodes and granules than in *P. mucronatus*. The pygidium tends to be a trifle shorter in *P. morrowensis*; the axial rings in the adult are 12 to 13 in number and the pleurae, eight to nine. Several sizes of fine granules are present on the axial rings, smaller and more numerous than in *P. mucronatus* and apparently not ranged along the posterior edge as in *P. mucronatus*. On the smooth border of most specimens of *P. morrowensis*, the outer concave zone is as wide as or wider than the inner convex zone.

*Paladin helmsensis* Whittington (1954, p. 7–11), from the Helms Formation of west Texas, has a gently convex glabella bearing four pairs of glabellar furrows, its surface sculpture limited to tiny irregular shallow pits; in these respects, *P. helmsensis* differs markedly from *P. mucronatus*. The axial rings have finer tubercles than those of *P. mucronatus*; some tubercles are ranged along the posterior edge as in *P. mucronatus*.

*Paladin granulatus* (Wetherby, 1881, p. 81), from the Chester Series of southeastern Kentucky, has not been adequately described, nor has well-documented comparative material been available to the writer. It appears from the original description, however, to have more finely granulose ornamentation than *P. mucronatus*, the number of axial rings and pleurae being uncertain.

*Griffithides moorei* Branson (1937, p. 659), from the Horseshoe Shale Member of the Amsden Formation in south-central Wyoming, is perhaps the closest species to *P. mucronatus*, and an examination of the holotype (Univ. Missouri 6605) indicates that it should be referred to *Paladin*. It is similar in ornamentation to Girty's species in having fairly coarse nodes and granules over the posterior part of the glabella and generally seven to nine elongate nodes along the posterior edge of the thoracic and axial rings. It differs, however, in having at least one (and probably more) weak glabellar furrows and a greater number of axial rings (17 to 18).

*Types.*—Lectotype, USNM 160902; paralectotypes, USNM 160898–160901, USNM 160903–160917, and USNM 161323–161325.

*Occurrence.*—Fayetteville Shale, basal limestone unit, USGS localities 1339B (USNM 160898), 1339E (USNM 160899), 2845 (USNM 160900), 3651A (USNM 160901), 3651B (USNM 160902–160904), 3651C (USNM 160905–160909), 3652 (USNM 160910), 5550? (USNM 160911), 5550A (USNM 160912), 5553 (USNM 160913), 5553A (USNM 160914–160917, 161323), Washington County, Ark.; 7084 (USNM)

161325), Boone County, Ark.; 7085? (USNM 161326), Carroll County, Ark.; 3638? (USNM 161327), Cherokee County, Okla.; Batesville Sandstone, USGS locality 5556 (USNM 161324), Searcy County, Ark.

For descriptions of these localities see page 4 of chapter A of this report.

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# Revision of Some of Girty's Invertebrate Fossils from the Fayetteville Shale (Mississippian) of Arkansas and Oklahoma—Ostracodes

*By* I. G. SOHN

GEOLOGICAL SURVEY PROFESSIONAL PAPER 606-F

*Illustration and redescription of G. H. Girty's type specimens of ostracode species from the Fayetteville Shale*


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# REVISION OF SOME OF GIRTY'S INVERTEBRATE FOSSILS FROM THE FAYETTEVILLE SHALE (MISSISSIPPIAN) OF ARKANSAS AND OKLAHOMA—OSTRACODES

By I. G. Sohn

ABSTRACT

Twelve of the 13 ostracode species that were described without illustration by Girty are illustrated and redescribed. The generic assignments of four species are based on topotypes. The hinge of *Glyptopleura* is described and illustrated from serial acetate peels and dissection of carapaces. The species are refered to the following genera: *Amphissites, Bairdia, Geisina?, Glyptopleura, Graphiadactyllis, Kirkbya?, Orthobairdia, Paraparchites? Roundyella, Sansabella,* and *Serenida.*

## INTRODUCTION

Girty (1910) described, without illustrating, 13 new species of Ostracoda in seven genera, including the type species of his new genera *Glyptopleura* and *Amphissites.* A third species, *Kirkbya lindahli* var. *arkansana,* later became the type of *Graphiadactyllis Roth,* 1929. The types of 12 of these species have been found. The recorded single specimen of *Kirkbya oblonga* var. *transversa* has not been found and is here considered a nomen dubium.

The types of the following six species are single valves embedded in matrix.

*Glyptopleura angulata*
*Halliella? retiferiformis*
*Kirkbya reflexa*
*simplex*
*Primitia fayettevillensis*
*seminalis*

The generic affinities of *G. angulata* and *K. reflexa* can be determined from the available types, but the generic affinities of the remaining four are not determinable from the type specimens. By processing scraps of rocks from the same collections as the types, topotype specimens of the remaining four species were found. The generic affinities of these species can be determined from the topotypes. Some of these topotypes are illustrated. One species, *Bairdia cestriensis* var. *granulosa,* was considered a junior subjective synonym of *Orthobairdia cestriensis* (Ulrich), 1891 (Sohn, 1960, p. 65); consequently, the lectotype of Ulrich's species is also illustrated.

Girty's (1910) Fayetteville fauna report was the eighth published paper dealing with late Paleozoic Ostracoda in North America. Girty listed the genera in an arbitrary order; this paper follows with certain modifications, the classification by Moore and Pitrat (1961). The original descriptions are quoted because of their historic value.

Girty's species, listed in the order in which they were described, are here classified as follows:

*Paraparchites nickelsi* var. *cyclopea=P.? cyclopeus*
*Primitia fayettevillensis=Sansabella fayettevillensis*
*seminalis=Serenida seminalis*
*Halliella? retiferiformis=Geisina? retiferiformis*
*Kirkbya lindahli* var. *arkansana=Graphiadactyllis arkansana*
*oblonga* var. *transversa*=nomen dubium
*reflexa=K.? reflexa*
*simplex=Roundyella simplex*
*Amphissites rugosus=A. rugosus*
*Glyptopleura inopinata=G. inopinata*
*angulata=G. angulata*
*Bairdia attenuata=B. girtyi* Sohn, 1961
*Bairdia cestriensis* var. *granulosa=Orthobairdia cestriensis* (Ulrich), 1891

## ASSOCIATED OSTRACODES

Scraps from the six collections that yielded the types contained associated species not described by Girty. Description of these additional species is beyond the scope of this paper; however, they are included in the following lists of species from each USGS (U.S. Geological Survey) locality collection. The localities are described by Gordon on pages 4–5 in chapter A of this report.

USGS locality 1339A.—*Graphiadactyllis arkansana; Glyptopleura inopinata; G. angulata* and abundant to rare specimens of *Amphissites rugosus; A. carinatus* Cooper, 1941; *Bairdia girtyi; Cavellina* spp.; *Cribroconcha* sp.; *Graphiadactyllis fayettevillensis* (Harlton), 1929; *Healdia* spp.; *Kirkbya? reflexa?,* one fragment; *Kirkbya* sp., two broken specimens; *Kirkbyella (Berdanella) quadrata* (Croneis and Gutke), 1939, one valve; *Mammoides* sp., one broken carapace and five valves; *Microcheilinella* sp.; *Microparaparchites* sp.; *Orthobairdia cestriensis* (Ulrich), 1891; *Paraparchites? cyclopeus; Reviya* sp. aff. *Ectodemites planus* Cooper, 1941, one carapace; *Roundyella* sp.; *Tetratylus?* sp., one broken valve; genus indet., small,

smooth, elongate, differs from *Darwinula* in reversal of overlap, muscle scar not visible; and small smooth unidentified ostracodes.

USGS locality 1339E.—*Orthobairdia cestriensis* and rare specimens of *Graphiadactyllis arkansana; G. fayettevillensis* (Harlton), 1929; *Healdia* sp.; *Paraparchites? cyclopeus;* and unidentifiable fragments.

USGS locality 5550A.—*Orthobairdia cestriensis; Sansabella fayettevillensis* and rare *Cavellina* spp.; *Cribroconcha* spp.; *Graphiadactyllis fayettevillensis?; Healdia* sp.; *Hypotetragona?* sp.; *Paraparchites? cyclopeus; Roundyella?* sp.; *Seminolites* sp.; *Seminolites?* sp.; *Sulcella?* sp.

USGS locality 5553.—*Amphissites rugosus; Bairdia girtyi; Kirkbya? reflexa; Paraparchites? cyclopeus; Roundyella simplex* and abundant to rare specimens of *Cavellina* sp.; *Glyptopleura* sp. indet., crushed carapace; *Graphiadactyllis arkansana; G. fayettevillensis?; Healdia* spp.; *Incisurella prima* Cooper, 1941, one carapace; *Kirkbya* sp., one broken carapace; *Kirkbyella* (*Berdanella*) *quadrata* (Croneis and Gutke), 1939; *Mammoides* sp., same as in USGS locality 1339A; *Microcheilinella?* sp., one valve in matrix; *Monoceratina* sp., one valve; *Orthobairdia cestriensis* (Ulrich), 1891 and juveniles of the same or different species; *Reviya* sp. aff. *Ectodemites planus* Cooper, 1941, one valve; *Sansabella fayettevillensis;* gen. indet., small, smooth, elongate, differs from *Darwinula* in reversal of overlap; genus indet., smooth, short, fat.

USGS locality 5553A.—*Geisina? retiferiformis; Orthobairdia cestriensis* (Ulrich), 1891; *Paraparchites? cyclopeus; Serenida seminalis* and common to rare specimens of *Cribroconcha* sp.; *Graphiadactyllis arkansana?*; *G. fayettevillensis* (Harlton), 1929; *Healdia* spp.; *Hypotetragona?* sp., one carapace; *Incisurella? fayettevillensis* (Harlton), 1929; *Monoceratina* sp., one valve; *Sansabella reticulata* (Harlton), 1929, female carapace; *Tetratylis* sp., one carapace; genus indet., Beyrichiopsidae? one broken valve with marginal frill; genus indet., large marginal rim, one fragment.

USGS locality 7084.—*Sansabella fayettevillensis; Orthobairdia cestriensis*, 1 broken valve; genus indet. aff. *Hypotetragona*, two poorly preserved valves.

The above lists indicate that Girty described but a fraction of the ostracodes in the Fayetteville Shale of Arkansas. Cooper (1941, p. 14–21) listed the following additional species from the Fayetteville Shale of Arkansas:

*Bythocypris clorensis* Croneis and Funkhouser, 1938
*Cavellina ovatiformis* (Ulrich), 1891
*Cribroconcha conspicua* (Harlton), 1929
*Graphiadactyllis tenuis* Cooper, 1941
*Healdia fayettevillensis* Harlton, 1929
*vinitaensis* Harlton, 1929
*Hollinella radiata* (Jones and Kirkby), 1886
*Lochriella reversa* (Horey), 1935
*Microcheilinella pergracilis* Croneis and Gale, 1939
*tumidus* Cooper, 1941
*Moorites rhomboidalis* (Croneis and Bristol), 1939
*Polytylites quincollinus* (Harlton), 1929)
*Sansabella harrisi* Croneis and Funkhouser, 1938
*sulcata* Roundy, 1926
*vinitaensis* (Harlton), 1929
*Seminolites sohni* Croneis and Bristol, 1939
*Paraparchites inornatus* (McCoy), 1844

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## SYSTEMATIC PALEONTOLOGY

### Subclass OSTRACODA Latreille, 1802

### Order PALAEOCOPIDA Henningsmoen, 1953

Henningsmoen (1965) discussed the classification of this order as used in Moore and Pitrat (1961), and suggested certain revisions. Because the classification is still unsettled, and a revision is beyond the scope of this paper, the classification of Moore and Pitrat (1961) is used. References to original descriptions, to type-species of the genera involved, and to suprageneric categories are in Moore and Pitrat (1961) and in Howe (1962).

### Suborder BEYRICHICOPINA Scott, 1961

### Superfamily KIRKBYACEA Ulrich and Bassler, 1906

See Gründel (1965) for the most recent discussion of this superfamily; this referral does not imply agreement with all of Gründel's conclusions.

### Family KIRKBYIDAE Ulrich and Bassler, 1906
### Genus Kirkbya Jones, 1859

#### Kirkbya oblonga transversa Girty, 1910 (nomen dubium)

1910. *Kirkbya oblonga* var. *transversa* Girty, p. 234.
1929. *Amphissites oblonga* var. *transversa* (Girty). Roth, p. 9.
1934. *Amphissites oblongus transversus* (Girty). Bassler and Kellett, p. 152.
1891. [not] *Kirkbya oblonga* Jones and Kirby, var. Ulrich, p. 206, pl. 18, figs. 4, 5=*Reviya costellifera* (Croneis and Bristol). Sohn, 1962.

1952. [not] *Kirkbya oblonga* var. *transversa* Girty. Ellis and Messina [no pagination].

*Original description.*—"Our collection contains but a single specimen of this species, which is so similar to the form which Dr. Ulrich identified as *K. oblonga* that I am a little doubtful whether the varietal distinction here suggested is altogether justifiable. The shape is strongly transverse, the dorsal border being straight and extending very nearly the entire width. The ventral border is nearly straight along the middle, more strongly rounded toward the ends. One cardinal angle of our specimen is nearly quadrate, the other is imperfect, but I believe was slightly extended. There is a well marked flange separated from the ventral and lateral borders by a sulcus and defined also upon its upper side by another sulcus. The remainder of the shell is moderately convex, somewhat pinched together near the middle with a subcentral pit a little below the median line. The surface is finely reticulated."

*Discussion.*—Girty's specimen was not found, and the type locality cannot be determined. Ellis and Messina (1952) combined Ulrich's illustrations of *Kirkbya oblonga* Jones and Kirkby, var. (1891, pl. 18, figs. 4, 5) with Girty's description. Because there is no evidence that the two taxa are conspecific, the name is considered a nomen dubium until such time as the specimen is found.

**Kirkbya? reflexa Girty, 1910**

**Plate 6, figures 31–34**

1910. *Kirkbya reflexa* Girty, p. 235.
1929. *Amphissites reflexa* Girty [sic]. Roth, p. 9.
1929. *Amphissites reflexus* Girty [sic]. Roth, p. 292.
1934. *Amphissites reflexus* (Girty). Bassler and Kellett, p. 153.
1941. [not] *Kirkbya* cf. *reflexa* Girty. Cooper, p. 47, pl. 10, figs. 27, 28.
1952. [not] *Kirkbya reflexa* Girty. Ellis and Messina [no pagination].

*Original description.*—"Shell rather large, strongly transverse. Dorsal border straight, very nearly as long as the greatest width. Ventral margin gently convex across the middle, more strongly curved toward the ends. Ends very nearly symmetrically formed. Cardinal angles almost equal, the anterior being slightly more acute than the other. A deep groove surrounds the ventral and lateral borders, the marginal portion of the shell being bent upwards in a broad border or flange. The remainder rises gradually and regularly to the middle of the dorsal border, and this portion of the shell would have the shape of one half of a spreading cone, if it were not that the posterior(?) half of the cone is somewhat compressed, which makes the most elevated portion into a curved oblique ridge.

"The surface is finely and deeply reticulated, the apertures increasing in size toward the reflexed border, upon which they are prolonged into relatively large, transverse grooves, so that the border looks fluted or perforated, though having the margin entire."

*Diagnosis.*—*Kirkbya?* with confluent posterior and ventral lobes.

*Revised description.*—Posterior and ventral lobes confluent, located at approximately central third of greatest length. Posterior lobe trends down and forward, merging into ventral lobe. The posterior and ventral slopes of both lobes are steeper than the anterodorsal slopes. The dorsal margin of these lobes form a shallow broad sulcus. A subcentral kirkbyan pit is below the ventral lobe. Only the inner flange is visible; it is rather broad and makes an angle of almost 90° at the dorsoposterior corner and an angle of about 60° at the dorsoanterior corner. The surface is reticulated; the reticules are small, elongate, and alined subparallel to free margins.

| | *Measurements (mm)* | |
|---|---|---|
| | *Greatest length* | *Greatest height* |
| Lectotype (pl. 6, figs. 31, 32) | 1.71 | 0.92 |
| Paralectotype (pl. 6, fig. 34) | 1.66 | .89 |

*Discussions.*—The reason for questioning the generic assignments is that this species in intermediate between *Kirkbya* Jones, 1859 and *Aurikirkbya* Sohn, 1950. *Kirkbya* does not have any lobes on the lateral surface of the valves, although some species do have a posterior shoulder. *Aurikirkbya* has two dorsal lobes connected ventrally by a ridge, and the species on hand lacks the anterior of the two lobes.

A bottle containing eight specimens, all single valves on matrix, is labeled *Kirkbya reflexa*, USGS locality 5553. The largest and best preserved was cleaned with a needle and selected as the lectotype (pl. 6, figs. 31, 32). The remaining seven are paralectotypes and include four right valves and three left valves; one is on a piece of limestone that also contains a broken left valve better preserved than all the other specimens. This broken left valve is illustrated to show the surface reticulation (pl. 6, fig. 33).

Ellis and Messina (1952) combined Girty's description with Cooper's (1941) illustrations of *Kirkbya* cf. *K. reflexa* Girty. Cooper's illustrated specimen differs from *K.? reflexa* in dorsal outline and in lacking lobes.

**Family AMPHISSITIDAE Knight, 1928**

**Genus AMPHISSITES Girty, 1910**

1910. *Amphissites* Girty, p. 235.
1961. *Amphissites* Girty. Sohn in Moore and Pitrat, p. Q165.
1962. *Amphissites* Girty. Sohn, p. 115 [1961 imprint].

*Type species.*—*Amphissites rugosus* Girty, 1910.

*Original description.*—"A number of ostracod shells

in the fauna of the basal Fayetteville shale belong to types which have been loosely referred to the genus *Kirkbya*, but they really appear to represent three generic or subgeneric groups. *Kirkbya* itself is described as having the right valve larger than the left and overlapping it. This is the condition of *K. lindahli* var. *arkansana*. The shell described below as *Amphissites rugosus* has the two valves equal, meeting each other along a line, neither one overlapping the other. It is furthermore distinguished by having the surface marked by a number of tubercles in addition to the fine reticulations. On both these accounts, it seems that this form can readily and advantageously be distinguished from *Kirkbya* proper. The third type is represented by *Glyptopleura inopinata*, which has the left valve overlapping the right. Conjoined with this difference in configuration is one of sculpture, the sides being without knobs or plications, but ornamented with oblique, inosculating costae instead of the fine reticulations and flanges of the other types."

*Discussion.*—See Sohn (1961) for a monographic study of this genus.

**Amphissites rugosus Girty, 1910**

Plate 6, figures 20–23

1910. *Amphissites rugosus* Girty, p. 236.
1926. *Amphissites rugosus* Girty. Roundy, p. 7, pl. 1, figs. 1a–c.
1961. *Amphissites rugosus* Girty. Sohn in Moore and Pitrat, p. Q165, text fig. 98, figs. 3a–d.
1962. *Amphissites rugosus* Girty. Sohn, p. 121, pl. 7, figs. 35–38, 41, 43 [1961 imprint].

*Original description.*—"Shell small, subquadrate, with the two ends nearly symmetrically formed, so that it is difficult to distinguish which is anterior and which posterior. The dorsal and ventral margins are straight and parallel. The ventral is curved upward at the ends, which are regularly rounded; the posterior is slightly oblique and projecting. Cardinal angles rounded.

"The convexity is rather high, developed especially about the margins. The surface is modified in a rather complicated manner, there being four flanges or ridges, while the median portion of the side is occupied by a large knob or boss. The margins of the base and sides are slightly thickened and projecting, making what may be called the first flange. The second is just above, separated by a narrow, deep groove, and it projects beyond the true margin. The third lies considerably within the second and does not conform to it, since a broader space is left at the inferior angles (especially the anterior one) than along the ventral border, while it meets the dorsal margin at the cardinal angles. The fourth flange or ridge is less distant than the others, tending to become obsolete ventrally, becoming much thicker and more elevated anteriorly, so that where it terminates abruptly at the dorsal border, it forms in the cardinal view a large flat triangular area. The median pit is small and situated just below the inflated umbonate median portion of the shell. The surface is finely reticulated, except along the flanges, which are dense and smooth."

*Discussion.*—See Sohn (1961) for synonymy and discussion of the ontogeny of this species. The type series consists of two specimens from USGS locality 5553, a valve in matrix and a carapace. The carapace (USNM 118485) was illustrated by both Roundy and Sohn (see synonymy). Roundy called it the genotype, consequently it is assumed that he designated it as the lectotype. The paralectotype (USNM 153801) is a broken right (?) valve.

| | *Measurements (mm)* | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 6, figs. 20–23) | 1. 18 | 0. 67 | 0. 67 |

**Superfamily unknown**

**Family SCROBICULIDAE Posner, 1951**

See Moore and Pitrat (1961, p. Q168), note under Placideidae for my opinion regarding the affinities of this family.

**Genus ROUNDYELLA Bradfield, 1935**

**Roundyella simplex (Girty), 1910**

Plate 6, figures 1, 2

1910. *Kirkbya simplex* Girty, p. 235.
1929. *Amphissites simplex* Girty [sic]. Roth, p. 9.
1934. *Amphissites simplex* (Girty). Bassler and Kellett, p. 154.
1962. *Roundyella? simplex* (Girty). Sohn, p. 150, pl. 9, fig. 44 [1961 imprint].

*Original description.*—"Shell small, transverse. Dorsal border long and straight, converging anteriorly (?) with the gently convex ventral outline. Ends nearly equally rounded, the anterior being narrower and more stongly curved. Convexity moderate, chiefly marginal, regular, without sulci or tubercles. Surface strongly and finely reticulate, except marginally, where the shell seems to be smooth and dense. Position of median pit not determined."

*Diagnosis (tentative).*—*Roundyella* with smooth nonreticulate surface around all margins.

| | *Measurements (mm)* | |
|---|---|---|
| | *Greatest length* | *Greatest height* |
| Lectotype (pl. 6, fig. 1) | 0. 53 | 0. 33 |
| Paralectotype (USNM 119854A; unfig.) | . 50 | . 30 |
| Topotype (pl. 6, fig. 2) | . 57 | . 35 |
| Topotype (USNM 153789; unfig.) | . 55 | . 32 |

*Discussions.*—The types are two valves on a single piece of limestone from USGS locality 5553. Because one of them was outlined by a red pencil, I assumed that

this was the holotype and illustrated it as such (Sohn, 1961, p. 150, pl. 9, fig. 44). The presence of the second specimen on the same piece of rock and the fact that Girty did not state that he had only one specimen indicate that the two are to be considered as cotypes. The illustrated specimen (USNM 119854) is therefore designated as the lectotype, and the second specimen (USNM 119854A) as the paralectotype. In addition, two valves in limestone were found by processing scraps from the same collection, and one of these (USNM 153763) illustrated (pl. 6, fig. 2).

The four specimens have a smooth nonreticulated area on all the margins; this area extends as a narrow smooth band on the lateral surface of the valve. *Roundyella augustai* Pokorny, 1950 from the Middle Devonian of Czechoslovakia has a similar smooth periphery; it differs in having much larger reticules, in slightly larger size, in absence of reticulations on anterodorsal corner, and in having a smooth subcentral area. Sohn (1961, p. 148) refered to Pokorny's species as *Amphissella? augustai* (misspelled *angustai*), but examination of the types of *Amphissella papillosa* Stover, 1956, the type species of *Amphissella*, disclosed that the overlap and margins are the same as in *Roundyella dorsopapillosa* Sohn, 1954 from the Permian of Texas (Sohn, 1954, p. 19, pl. 1, figs. 20–26). The types do not have a well-defined marginal rim, and the statement in the original description of *Amphissella* (Stover, 1956, p. 1134)–"Each valve with a narrow, smooth or papillated marginal ridge extending partially or completely around the free border."—does not refer to the structure illustrated in *Amphissella genetiva* (Morey) 1935 (Sohn, 1961, pl. 7, figs. 6, 7). *Amphissella* Stover is here considered a junior subjective synonym of *Roundyella* Bradfield, 1935. Several Devonian species, including *Amphissites genetivus* Morey, 1935 (Devonian or Early Mississippian), belong to an as yet undescribed genus.

**?Order PALAEOCOPIDA Henningsmoen, 1953**
**Suborder KLOEDENELLOCOPINA Scott, 1961**
**Superfamily KLOEDENELLACEA Ulrich and Bassler, 1908**
**Family GEISINIDAE Sohn, 1961**
**Genus GEISINA Johnson, 1936**

**Geisina? retiferiformis (Girty), 1910**

Plate 6, figures 3–9

1910. *Halliella? retiferiformis* Girty, p. 233.
1934. *Halliella retiformis* Girty. Bassler and Kellett, p. 322.
1939. *Perprimitia funkhouseri* Croneis and Thurman, p. 304, pl. 7, figs. 18, 19. Kinkaid Formation, Illinois.
1939. *Jonesina? tumida* Croneis and Thurman, p. 305, pl. 7, fig. 11. Kinkaid Limestone, Illinois.
1941. *Perprimitia funkhouseri* Croneis and Thurman. Cooper, p. 58, pl. 12, figs. 44, 45. Kinkaid Limestone, Illinois.
1891. [not] *Ulrichia emarginata* Ulrich, p. 203, pl. 12, figs. 10a–c. Chester Series, Kentucky.

*Original description.*—"Shell small, subrhomboidal. Dorsal border long and straight. Ventral border gently curved along the middle, strongly curved at the ends, converging anteriorly with the cardinal line. Anterior extremity strongly rounded. Posterior extremity more broadly rounded, subtruncate. Convexity high and inflated at the anterior end, more gentle across the broad posterior end. A deep, somewhat elongated pit is situated a little above and distinctly posterior to the middle. It lies near the dorsal border without apparently extending to it. The shell posterior to the pit is elevated into a sort of low tubercle.

"Surface rather coarsely reticulate."

*Diagnosis.*—*Geisina?* with curved sulcus between ventral and posterior lobes; rounded tubercle on dorsoposterior.

| | Measurements (mm) | | |
|---|---|---|---|
| | Greatest length | Greatest height | Greatest width |
| Holotype (pl. 6, figs. 3–5) | 0. 69 | 0. 44 | 0. 18 |
| Topotype (pl. 6, fig. 7) | . 72 | . 42 | . 23 |
| Topotype (pl. 6, fig. 6) | . 67 | . 40 | . 13 |
| Topotype (pl. 6, figs. 8, 9) | . 61 | . 40 | . 33 |

*Discussion.*—The holotype is from USGS locality 5553A; it is a right valve in matrix, and the dorsocentral part of the shell, including the dorsoposterior tubercle, is missing. Cooper (1941, p. 58) noted that *Jonesina? tumida* Croneis and Thurman, 1939 is based on an internal mold of *Perprimitia funkhouseri* Croneis and Thurman, 1939. Cooper incorrectly considered *Ulrichia emarginata* Ulrich, 1891, as a synonym of *P. funkhouseri*. The type series of *Ulrichia emarginata* (USNM 41383) consists of the holotype, a slightly corroded carapace, and two poorly preserved valves. The holotype of *U. emarginata* differs from the specimens on hand by being slightly smaller in lateral outline, in having an elongate and crested dorsoposterior node, and in that the sulcus between the ventral and posterior lobes is neither as curved nor as deep.

*Perprimitia* Croneis and Gale, 1939, (type species by original designation *P. robusta* Croneis and Gale, 1939, Golconda Formation, Illinois) was defined as having the posterior lobe separated from the anterior lobe by a narrow sulcus. Cooper (1941, p. 58) pointed out that sexual dimorphism in this genus is exhibited by variation in tumidity of the posterior lobe, and he noted that reversal of overlap has not yet been recorded in this genus. I (Sohn in Moore and Pitrat, 1961, p. Q182) questionably considered this genus as a junior synonym of *Geisina* Johnson, 1936, (type species by original designation *Beyrichiella gregaria* Ulrich and Bassler, 1906, Pennsylvanian, Kansas City, Mo.), and recognized *Knoxites* Egorov, 1950 (type species by original designation *K. meneri* Egorov, 1950, Upper Devonian,

U.S.S.R.) as a valid genus in the family Geisinidae Sohn, 1961.

*Knoxites* and *Perprimitia* are similar in having a sulcus between the ventral and posterior lobes and a dorsoposterior tubercle; they differ from *Geisina* Johnson, 1936, in having the ventral sulcus and a dorsoposterior node instead of a spine. The difference between a dorsoposterior node and a spine depends on preservation and on the degree of development. This feature should not be considered of generic significance. The ventroposterior sulcus between the ventral and posterior lobes is better developed in females than in males and probably also should not be considered of generic significance. It is possible, however, that the sulcus may, upon additional study, prove to be a generic character. Consequently, I am referring to this species as *Geisina*?

**Family SANSABELLIDAE Sohn, 1961**

**Genus SANSABELLA Roundy, 1926**

**Sansabella fayettevillensis (Girty), 1910**

**Plate 6, figures 10–14**

1910. *Primitia fayettevillensis* Girty, p. 232.

*Original description.*—"Shell small, transverse, subquadrate. Lower margin gently convex, converging anteriorly with the long, straight hinge line. Anterior extremity strongly rounded. Posterior extremity obliquely truncated, projecting. Convexity high. Umbilical pit deep, elongated but not continued to the hinge, posterior to the middle."

*Diagnosis.*—*Sansabella* with truncated ventroposterior margin, and deep subcentral vertical sulcus.

| | *Measurements (mm)* | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 6, fig. 11) | 0. 82 | 0. 51 | ---------- |
| Paralectotype (pl. 6, fig. 10) | . 85 | . 57 | ---------- |
| Topotype (carapace, pl. 6, figs. 12–14) | . 79 | . 48 | 0. 43 |

*Discussion.*—Two specimens from different collections are labeled "Cotypes." The specimen (USNM 153769) from USGS locality 5550A from the basal limestone of the Fayetteville Shale is here designated as the lectotype; it is a left valve partly embedded in limestone. Scraps from the same collection yielded a carapace (pl. 6, figs. 12–14), two left, and two right valves. The second cotype (USNM 153768) here designated as the paralectotype, is from USGS locality 7084, mislabeled as "7804." USGS locality 7804 is a collection made in the Triassic of Idaho, whereas 7084 is from the top of the Batesville Sandstone (See p. 5 in chapter A of this report). The specimen from this locality is a right valve. Scraps from the same collection yielded two left valves in matrix; one overlapped the right valve, and the second was overlapped by the right. These two specimens confirm the generic designation because reversal of overlap is common in *Sansabella*. *Sansabella truncata* Cooper, 1941, resembles this species in lateral outline, but it differs in having a dorsoposterior spine and in being narrower in dorsal outline.

**Family unknown**

**Genus SERENIDA Polenova, 1953**

**Serenida seminalis (Girty), 1910**

**Plate 6, figures 15–19**

1910. *Primitia seminalis* Girty, p. 233.

*Original description.*—"Shell small, transversely subovate. Cardinal line straight or nearly so, converging strongly toward the front with the gently convex lower margin. Anterior end sharply rounded. Posterior end broadly and rather regularly rounded. Post-cardinal angle distinct. Convexity moderately high, with a flattened band about the margin. This band is narrow and sharply defined around the posterior portion of the shell, broad and not well defined at the front end, narrow and ill defined along the middle of the dorsal and ventral borders. Central pit rather large, subcircular, poorly defined, situated very near the middle of the convex portion, slightly above and distinctly posterior to the middle of the entire shell."

*Diagnosis.*—*Serenida* with more or less continuous flattened band around free margins of both valves, except along the hinge margin of the smaller valve.

| | *Measurements (mm)* | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 6, fig. 19) | 0. 91 | 0. 59 | ---------- |
| Paralectotype (pl. 6, fig. 18) | . 92 | . 59 | ---------- |
| Topotype (pl. 6, figs. 15–17) | . 88 | . 57 | 0. 43 |
| Topotype (USNM 153790; unfig.) | . 94 | ---------- | . 43 |

*Discussion.*—Two specimens from USGS locality 5553A are right valves in matrix. Two broken carapaces were found by crushing limestone from the same collection. One illustrated carapace (pl. 6, figs. 15–17) identifies the species as *Serenida* Polenova, 1953. The other carapace (USNM 153790) has the larger valve partly missing along the venter; the peripheral band of this larger valve can be seen also on the partly exposed internal mold, and a similar band is present also on the

smaller valve. *Serenida* Polenova, 1953 (type species by original designation *S. carinata* Polenova, 1953, Upper Devonian, U.S.S.R.) differs from *Sargentina* Coryell and Johnson, 1939 (type species by original designation *S. allani* Coryell and Johnson, 1939, Clore Limestone, Illinois) by absence of a subcentral pit that extends upward as a sulcus. *Sargentina asulcata* Cooper, 1941, from the Kinkaid Limestone of Illinois lacks the diagnostic sulcus, and Polenova (1953, p. 86) suggested that it might belong to *Serenida*. *Serenida*(?) *incertae* Bushmina, 1965, from the Lower Carboniferous, Kuznets Basin, U.S.S.R., differs from Girty's species in having a slightly more convex dorsal margin of the right valve and in that the peripheral band is not as strongly developed.

**Superfamily unknown**

**Family GLYPTOPLEURIDAE Girty, 1910**

**Genus GLYPTOPLEURA Girty, 1910**

1910. *Glyptopleura* Girty, p. 236.
1931. *Glyptopleura* Girty. Coryell and Brackmier, p. 508.
1950. *Glyptopleura* Girty. Egorov, p. 103.
1961. *Glyptopleura* Girty. Scott in Moore and Pitrat [part], p. Q184.

*Type species.*—*Glyptopleura inopinata* Girty, 1910.

*Original description.*—"Shell rather small, subquadrate, with a backward swing, the posterior end being higher than the anterior and somewhat truncated. Inequivalve; the left valve is much the larger and overlaps the other all around save along the distinct straight hinge. There is a subcentral pit. The surface is marked by inosculating costae.

"*Type.*—*Glyptopleura inopinata.*"

"This type has the general appearance of certain species referred to *Kirkbya*, but it is distinguished from *Kirkbya* by the fact that the left valve is larger than the right —the reverse of *Kirkbya*—and that it overlaps the right strongly and throughout the circumference save along the hinge. This difference, of course, depends partly upon the orientation of the shell. In the Beyrichiidae and in *Kirkbya* itself, the shape is subrhomboidal, and the higher, truncated, more projecting end is called the posterior. If the same criteria are applied to the present species, the left valve is the larger and overlaps the right as described above. In the contrary interpretation, the overlapping of the valves in the present shell would more nearly correspond with *Kirkbya*, though more pronounced, but the other data of orientation would be reversed. It seems to be more probable that the configuration is the same as in *Kirkbya* and the Beyrichias."

*Diagnosis.*—Subquadrate in lateral outline, dorsal margin straight, ventral straight or gently curved; right valve overlaps left including cardinal angles, dorsum channeled. Surface has variable number of discrete, straight or bifurcating ridges, either horizontal or trending towards the venter; deep pit, either round or vertically elongate, at or in front of midlength, above midheight. Hinge grooved in both valves; no internal teeth or sockets at cardinal angles. Dimorphic in width of posterior.

*Revised description.*—The surface ridges are not reflected on the inside of the valve as grooves (pl. 7, figs. 1–7). The ridges vary in number and shape; in some species, including *G. inopinata* Girty, they connect at the end margins. In other species (*G. compta* Croneis and Thurman, 1939 and *G. coryelli* Harlton, 1931), the ridges do not connect in the posterior; they either terminate abruptly, or extend as small spines. In general the number, trend, and position of the ribs are constant in each species; there is, however, considerable individual variation in the coalescence or divergence of individual ribs. On the left valve of the holotype of the type species, the rib below the pit bifurcates at the posterior to form a diamond-shaped pit; on the right valve and on both valves of the illustrated paratype (pl. 7, figs. 18, 19) it does not. (See also Brayer, 1952, p. 167). In some species the subcentral pit is surrounded by the ridges; in other species (*G. alvea* Cooper, 1941, *G. genevievea* Brayer, 1952), a rib may transect the pit. This transection results in two distinct pits. The pit is reflected on the inside of the valve as a node. The overlap of the larger valve along the cardinal angles is not a tooth-and-socket type because the smaller valve does not have external sockets beneath these laps. Guber and Jaanusson (1964, p. 2–5) described this overlap along the cardinal angles as "strangular processes."

*Discussion.*—The original orientation of the genus was reversed by Geis (1932, p. 150, 170), who also noted that sexual dimorphism is exhibited in females of this genus by a slightly wider posterior. Scott (in Moore and Pitrat, 1961, p. Q184) cited the stratigraphic range of this genus to be from mid-Mississippian through mid-Permian, but the range should be extended downward to the Lower Mississippian. Green (1963, p. 89) described and illustrated two species from the Banff Formation (Lower Mississippian) of Alberta, Canada, and Chizhova [Tschigova] (1964) considered *Glyptopleura* as one of the genera that is diagnostic of the Lower Mississippian. Only three species of Devonian age have been described. *G. bipunctata* Kesling and Weiss, 1953, and *G. cracens* Kesling and Kilgore, 1952,

from the Devonian of Michigan, probably belong to the Barychilinidae, and the generic affinities of *G. mesodevonica* Pribyl, 1953, from Givetian of Poland are undeterminable from the published record. Scott (in Moore and Pitrat, 1961, p. Q185, text fig. 125, figs. 1e, f) illustrated the hinge of *G. varicostata* Croneis and Thurman, 1939, as having cardinal teeth in the right valve and sockets that open in the interior of the valve in the left valve. *G. inopinata*, the type-species, does not have these features (fig. 2).

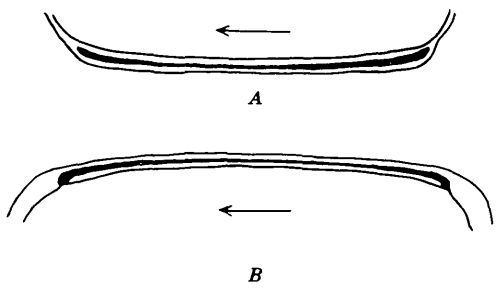


FIGURE 2.—Hinge elements of *Glyptopleura inopinata* Girty, approximately × 37; *A*, left valve; *B*, right valve. Topotypes, USNM 153799, 153800.

Single valves of *Glyptopleura inopinata* are not available for study; consequently, a series of acetate peels was made from a topotype carapace (pl. 7, figs. 1–7). In addition, the hinge of each valve was developed by scraping away the opposing valve on carapaces. Figure 2*A* is a drawing of the hinge of the left valve made from two carapaces; some of the left valve hinge broke in the process of removing the dorsal part of the right valve. Figure 2*B* is a similar drawing of the hinge of the right valve, which for the same reason, is also a composite of two carapaces. The dorsal edges of both valves meet without any observable overlap (pl. 7, figs. 13, 15, 16). The serial peels (pl. 7, figs. 2–5) demonstrate that the ridges bounding the two grooves along the dorsal margins of both valves do not fit into the grooves of the opposing valves. This void possibly represents the space occupied by the postulated ligament (Sohn, 1949).

Harding (1965) presented evidence that there is no real ligament in the hinge of Ostracoda. The two valves of the ostracode carapace and the soft "cuticle" joining them along the dorsal margin are one continuous piece of cuticle that is fundamentally the same as any other joint in the exoskeleton of Arthropoda. The discrepancy between the two views is a matter of semantics. My term, "ligament" (Sohn, 1949), the concept of which was borrowed from bivalve mollusks, and Harding's term, "cuticle," are synonymous. Namely, the hinge elements of certain Paleozoic straight-backed ostracodes, including *Glyptopleura*, do not interlock and the space between the hinge elements is filled with an uncalcified substance that joins the two valves along the dorsum. A similar hinge was illustrated by Guber and Jaanusson (1964, fig. 10) in *Primitiella minima* (Harris), 1957.

In the same paper, Harding (1965, p. 23–26) stated that there is no fusion between the inner and outer lamela along the shell margin. Zalanyi (1929, p. 21–23) described and illustrated two kinds of duplicature, (1) bilamellar (1929, figs. 6a–e), in which the inner and outer lamellae are fused along the margin and (2) monolamellar (1929, figs. 6f–l) in which the two lamellae are continuous as described by Harding. Zalanyi (1929, p. 23) noted that both types of junctions can be present in the same individual, for which he coined the term, "heteromorph;" for those with only one type of duplicature he proposed "homomorph." The term, "heteromorph," was subsequently proposed by Jaanusson and Martinsson (1956, p. 402) for presumed female carapaces in dimorphic genera, and has been accepted in this sense in the literature (Moore and Pitrat, 1961, p. Q50). Sylvester-Bradley (1941, footnote p. 8) aptly illustrated the junction of the inner and outer lamellae as follows: "The familiar apple turn-over affords an example. The region along which it is 'turned over' is 'monolamellar', the margin is 'bilamellar'." The acetate serial peels (pl. 7, figs. 3–5) show a definite bilamellar junction in *Glyptopleura inopinata*. The presence of a calcified inner lamella removes this genus and its nominate family from the order Palaecopida as defined in Moore and Pitrat (1961, p. Q110). The distinctive hingement removes this group from the superfamily Kloedenellacea Ulrich and Bassler, 1908, as defined in Moore and Pitrat (1961, p. Q180).

Melik (1964, 1966) studied the hingement of palaeocopid Middle Devonian ostracodes and described five types of hinge structures. He concluded that hingement appears to have little relation to the present classification of palaeocopid ostracodes. He proposed the term, "biversus," for hingement consisting of a groove in each valve, accommodating a bar of the opposing valve, and with each valve usually having either cardinal teeth or sockets. The hinge of *Glyptopleura* does not fit Melik's definition of biversus hingement because the grooves in both valves do not accommodate opposing bars, and the valves lack teeth and sockets.

I am grateful to my colleague, Jean Berdan, for pointing out the possible relationship of the family Barychilinidae Ulrich, 1894, with the Glyptopleuridae Girty, 1910. Study of the relations of these two families, how-

ever, is outside the scope of this paper. Should further study prove that the two families are synonymous, then the genus *Glyptopleura* would properly be classified in the Podocopida.

### Glyptopleura inopinata Girty, 1910

Plate 7, figures 1–7, 11–20; figure 2

1910. *Glyptopleura inopinata* Girty, p. 237.
1931. *Glyptopleura inopinata* Girty, Coryell and Brachmier, p. 509.
1941. *Glyptopleura inoptina* Girty. Cooper, p. 41, pl. 7, figs. 20–22 (misspelling for *inopinata*). Clore Formation, Illinois.

*Original description.*—"Shell rather small, transverse, subquadrate. Width about 1.75 mm., which is distinctly less than twice the height. Hinge line nearly as long as the greatest width. Lower margin gently convex over the median portion, more strongly curved in front and behind, convergent anteriorly with the dorsal border. Posterior outline distinctly truncate and oblique, so that the postcardinal angle is distinct and obtuse. The anterior extremity is acutely rounded above. The convexity is moderately high and obscurely constricted across the middle, with the anterior portion more inflated than the posterior. A small, deep, circular pit forms a depression a little above and a little posterior to the center. The sculpture consists of large curved, inosculating ridges which cross the surface transversely and more or less obliquely. There is a smooth, finely striated border which surrounds the shell everywhere, save along the hinge.

"The two valves are distinctly unequal, the left being the larger. The left valve thus overlaps the other on all sides save along the hinge, at the ends of which this arrangement appears to produce a primitive sort of articulation."

*Diagnosis.*—*Glyptopleura* with single subcentral pit and 12 or more oblique ribs.

*Revised description.*—Subquadrate, the ends are obliquely rounded; the greatest convexity of the anterior margin is in the lower third of the greatest height, of the posterior margin, in the upper third of the greatest height. The ventral margin is gently convex, almost straight. A single subcentral deep pit is exposed on the inside of the valve as a node in front of the midlength and above the midheight. The ridges are strong, generally oblique to the dorsal margin, trending anteroventrad. A line perpendicular to the dorsal margin through the pit intersects 12 ribs on the left valve and 14 on the right. The dorsal outline is subelliptical, and the sides are evenly convex; the greatest width is behind the midlength. Females are slightly wider than males.

| | Measurements (mm) | | |
|---|---|---|---|
| | Greatest length | Greatest height | Greatest width |
| Holotype (male; pl. 7, figs. 16, 18–20) | 1. 50 | 0. 92 | 0. 75 |
| Paratype (female; pl. 7, figs. 11, 12, 15, 17) | 1. 80 | . 97 | . 78 |
| Topotype (USNM 153791; unfig.) | 1. 63 | . 94 | . 70 |
| Topotype (pl. 7, figs. 13, 14) | 1. 32 | . 77 | . 56 |
| Topotype (USNM 153792; unfig.) | 1. 28 | . 75 | . 61 |

*Discussion.*—The holotype (pl. 7, figs. 16, 18–20), labeled "type 1942," is from USGS locality 1339A, as is the paratype (pl. 7, figs. 11, 12, 15, 17). In addition, I have obtained many topotypes (for example, USNM 153793), including growth stages, by processing scraps from the same collection. The smaller specimens have the same shape and number of ridges as the adults.

Several species have a similar lateral and dorsal outline, many oblique ribs, and only one pit; they all differ from *G. inopinata* in having less than 12 ridges, counted in a line that is perpendicular to the dorsal margin and passes through the pit.

### Glyptopleura angulata Girty, 1910

Plate 7, figures 8–10

1910. *Glyptopleura angulata* Girty, p. 237.
1931. *Glyptopleura angulata* Girty. Coryell and Brackmier, p. 509.

*Original description.*—"Shell small, transverse, subovate. Hinge line straight, nearly as long as the entire width, converging anteriorly with the gently convex lower border. Anterior end strongly rounded. Posterior end more broadly roundly, not much produced beyond the hinge extremity. Convexity high, chiefly centered along a diagonal ridge, extending obliquely from near the upper anterior angle to the lower posterior angle. As the lower margin also is oblique, the descent to this margin is abrupt and regular, while that to the postcardinal angle is long and gradual. Anterior extremity of the ridge very prominent and embellished with a little knob.

"Median pit situated above the middle (above the ridge) and near the middle transversely or a trifle posterior to it.

"Surface marked by a few rather coarse, strong angular lirae, more or less transverse and inosculating."

*Diagnosis.*—*Glyptopleura* with two pits, arrow-shaped dorsal outline, ridges that do not join along posterior margin; eight continuous ridges in the area of the pits. Five of the ridges closely spaced in ventral

third of greatest height; the fifth ridge from bottom bulged in posterior, having a slightly dorsal curve; three upper ridges widely spaced; dorsal two bifurcating in front of pits.

| | Measurements (mm) | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Holotype (pl. 7, figs. 8–10) | 0. 72 | 0. 42 | 0. 26 |

*Discussion.*—The greatest width of the valve is in the position of the fifth ridge from the bottom. Only one left valve in matrix (USNM 153783) from USGS locality 1339A is available, and a search in scraps from this collection did not yield additional specimens. The configuration of the ridges and the bulge on the fifth ridge from the bottom distinguishes this species from all the described species in *Glyptopleura* that have two pits.

**Superfamily PARAPARCHITACEA Scott, 1959**
**Family PARAPARCHITIDAE Scott, 1959**
**Genus PARAPARCHITES Ulrich and Bassler, 1906**

**Paraparchites? cyclopeus Girty, 1910**

Plate 8, figures 15–24

1910. *Paraparchites nickelsi* var. *cyclopea* Girty, p. 232.
1941. *Paraparchites cyclopeus* (Girty), Cooper, p. 61, pl. 13, figs. 17–19. Golconda Formation, Illinois.
1915. *Paraparchites nicklesi* Ulrich. Girty, p. 134, pl. 11, fig. 2. Batesville Sandstone, Arkansas.
1939. *Paraparchites robustus* Croneis and Gutke, p. 37, pl. 1, fig. 11. Renault Formation, Illinois.
1956. *Paraparchites projectus* Harris and Jobe [part], p. 6, pl. 1, fig. 6 (not figs. 7 a-d=undescribed gen. and sp.). Manning zone, Upper Mississippian, Major County, Okla.

*Original description.*—"This species is represented primarily by an extremely large specimen, which agrees with *P. nickelsi* in most characters, except that it is very much larger than any of the associated fossils referred to that species, and the shell is much more coarsely pitted or punctate. The left valve has the base of a well-developed spine, but the right seems to be without a spine. This specimen clearly shows a small subcircular, undefined muscle(?) spot, situated near the center of the shell. It is characterized by being slightly depressed and by being smooth, without the punctae with which the rest of the surface is covered. Traces of a similar spot have been observed also upon specimens referred to *P. nickelsi*."

*Diagnosis.*—*Paraparchites*? with large, robust carapace more than 3 mm in greatest length. Smaller valve overreaches dorsal margin; with dorsoposterior spine at approximately one-fourth greatest length; surface smooth or punctate.

| | Measurements (mm) | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 8, figs. 19–21) | 3. 30 | 2. 23 | 1. 69 |
| Paralectotype (pl. 8, figs. 22–24) | 3. 15 | 2. 27 | 1. 69 |
| Figured specimen (pl. 8, figs. 17, 18) | . 92 | . 70 | . 49 |
| Figured specimen (pl. 8, figs. 15, 16) | . 72 | . 52 | . 38 |
| Topotype (USNM 153794; unfig.) | . 46 | . 34 | . 24 |

*Revised description.*—Adult carapaces are large, more than 3 mm in greatest length, robust; the surface is punctate, except for a smooth circular subcentral muscle spot. The left valve overlaps on the free margins; the right overreaches along the dorsal margin. The dorsal margin of the left valve is straight and fits into a groove of the overreaching right valve. The ends are rounded, and the anterior is more broadly rounded than the posterior; curvatures of the end margins have a blunt angle, below midheight on the anterior margin and above midheight on the posterior margin. The ventral edge in lateral view of the left valve is curved and outlined by a faint subparallel horizontal sulcus. The left valve edge has an acute lateromarginal bend, forming an inclined venter that overreaches and overlaps the right valve. The right valve is subovate in lateral outline; its dorsal margin is gently curved and forms a subtriangular overreaching surface. The right lateral surface is bounded by a shallow sulcus below the dorsum, outlining a dorsal shoulder. A spine is near the dorsoposterior, approximately at one-fourth the greatest length and below the shallow sulcus. The end view is approximately diamond-shaped with curved sides; the greatest width is below midheight. The dorsal outline is lanceolate; the anterior is narrower, and the greatest width is posterior to midlength.

*Discussion.*—The type series consists of two large carapaces: one from USGS locality 5553A, the other from USGS locality 5553. The first carapace (USNM 153787) agrees with the original description in having "* * * a small subcircular undefined muscle (?) spot, * * *" and consequently it is here designated as the lectotype (pl. 8, figs. 19–21). The second specimen (USNM 153788) is designated as a paralectotype (pl. 8, figs. 22–24). Although these specimens are large, they are dwarfed by *Leperditia subaequalis* Reed, 1927 (=*Paraparchites* fide Green, 1963, p. 126), from the Lower Carboniferous (Dinantian) in the Unnan Province, China, which has a recorded length of 8 mm. Specimens from USGS locality 5553A, labeled as *Paraparchites nicklesi*, differ from the type series of *Leperditia nicklesi* Ulrich, 1891 (USNM 41844) in lat-

eral outline and in having a dorsal overreach and horizontal sulcus. These specimens represent young growth stages of *P. cyclopeus*. A growth series, ranging in greatest length from 0.46 mm to 1.78 mm, was obtained by processing scraps from USGS locality 5553. Specimens with a minimum greatest length of 0.84 mm have the diagnostic shoulder and overreach of the dorsal margin, but not all the specimens have the posterodorsal spine. Smaller specimens do not have the dorsal shoulder and overreach.

A slide (USNM 79357) labeled "Plesiotype, *Paraparchites nicklesi* (Ulrich), Fayetteville Shale, Girty's type locality, Ry. cut at Fayetteville, Arkansas" contains two carapaces. The larger, slightly crushed carapace (greatest length 1.66 mm), illustrated by Harlton (1929, p. 255, pl. 1, fig. 1), has the characters of *P. nicklesi*, namely a posterodorsal spine on each valve. The smaller specimen (greatest length 1.06 mm) has a spine only on the right valve, which is diagnostic of *P.? cyclopeus*. *Paraparchites nicklesi* (Ulrich). Girty, 1915 (p. 134, pl. 11, fig. 2) from the underlying Batesville Sandstone, Marshall quadrangle, Arkansas (USNM 121313), may also belong to *P.? cyclopeus;* the carapace (greatest length 1.69 mm) has a spine only on the right valve. A vial labeled *P. nicklesi* from USGS locality 1339A contains a growth series of *P.? cyclopeus* ranging in greatest length from 0.72 mm to 2.14 mm. The smallest carapace has a spine on the right valve. Harris and Jobe (1956, p. 6, pl. 1, figs. 6, 7a–d) described *P. projectus* from a well in Major County, Okla. Professor Harris very kindly loaned me his type series for examination. The holotype and two unfigured paratypes may belong to *P.? cyclopeus*, but the carapace illustrated by Harris and Jobe (1956) on plate 1, figures 7a–d has spines on both valves and belongs to an undescribed genus.

Cooper (1941, p. 61, pl. 13, figs. 17–19) illustrated a specimen from the Golconda Formation of Illinois (greatest length, 1.36 mm) as *Paraparchites cyclopeus* (Girty), and referred *P. robustus* Croneis and Gutke, 1939 (greatest length 1.73 mm) from the Renault Formation of Illinois to this species as a junior synonym. Cooper correctly considered the overreach and dorsal shoulder of the right valve (orientation reversed by Scott, 1959) as distinctive from *P. nicklesi* (Ulrich) and elevated the variety to specific rank.

Scott (1959) revised and redefined *Paraparchites* Ulrich and Bassler, 1906 by reillustrating the types of the type species *P. humerosus* Ulrich and Bassler, 1906. Scott (1959, p. 673) described the genus as follows:

**Ovate to elongate ostracodes; the ends are broadly rounded; the dorsum in lateral view is usually straight but is occasionally gently convex; the hinge channel is strong; the valves asymmetrical, the larger overlaps the free margin of the smaller, reversal of overlap is known; the dorsal umbonal area of each valve is raised to about the same height, but one umbonal area may slightly overreach the other in some species; the inner free margin of the smaller valve (usually the right) consists of a simple selvage ridge with an outer and inner selvage slope; the hinge is simple; dimorphism is unknown.**

Two important facts regarding *Paraparchites* should be noted: (1) there is no mention of a spine in the revised diagnosis of the genus, and (2) the hinge of the type species is incised, with the dorsal umbonal area of each valve raised to about the same height.

Chizhova (1960, p. 174, 177) suggested sexual dimorphism in the Lower Carboniferous species *P. ventriosus* Chizhova, 1960, because adults are present in two shapes. The presumed females have a more convex ventral margin, a smaller greatest length, a shorter hinge margin, a proportionately greater height, and are wider in dorsal outline than the presumed males. Younger growth stages resemble the males in lateral outline and in narrow dorsal outline. Chizhova's species has a dorsoposterior spine on the right valve. *P. ventriosus* and some additional species described in *Paraparchites*, including *P.? cyclopeus* Girty, 1910, have in common an overreaching right valve and a ventrally overlapping left valve. This group belongs to an as yet undescribed genus.

## Order PODOCOPIDA Sars, 1865

The classification of this order was discussed by Sohn (1965, p. B71).

### Suborder PODOCOPINA Sars, 1865
### Superfamily BAIRDIACEA Sars, 1887
### Family BAIRDIIDAE Sars, 1887
### Genus BAIRDIA McCoy, 1844

#### Bairdia girtyi Sohn, 1961

Plate 8, figures 10–14

1910. *Bairdia attenuata* Girty, p. 237 (not Brady, 1880).
1961. *Bairdia girtyi* Sohn, p. 26, pl. 1, figs. 32–36 (new name) [1960 imprint].

*Original description.*—"Shell rather large, very transverse. Lower margin nearly straight across the median portion, strongly and equally turned upward at the ends, which are pointed and slightly lower than the middle. Upper margin strongly convex across the median portion, slightly concave near the ends. The point of greatest convexity, and therefore of greatest height, is distinctly posterior and the outline is more concave near the posterior than the anterior end. Convexity moderate, compressed at the ends. Surface smooth. Left valve slightly overlapping the right at the hinge; elsewhere neither valve seems to extend beyond the other."

*Discussion.*—Sohn (1960, p. 22), in a key, discriminated this species from all other Paleozoic species of

*Bairdia* and discussed the species, including its synonmy (1960, p. 26). The collection contains three specimens labeled "types" (from USGS loc. 5553), on a slide.

| | Measurements (mm) | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (ends broken; pl. 8, fig. 10) | 1. 16 | 0. 73 | 0. 48 |
| Paralectotype (ends broken; pl. 8, figs. 11–14) | 1. 68 | . 72 | . 48 |

**Genus ORTHOBAIRDIA Sohn, 1961**

**Orthobairdia cestriensis (Ulrich), 1891**

Plate 8, figures 1–9

1891. *Bairdia cestriensis* Ulrich, [part], p. 210, pl. 17, figs. 6a–c. Shale of Chester age, Grayson Springs Station, Grayson County, Ky.
1910. *Bairdia cestriensis* var. *granulosa* Girty, p. 237.
1961. *Orthobairdia cestriensis* (Ulrich), Sohn, p. 65, pl. 3, figs. 24–27 [1960 imprint].

*Original description.*—"This form is very closely related to *B. cestriensis*, of which Ulrich figures two specimens, a large and a small. It is a more slender shell than the larger specimen and larger than the other—larger even than the larger of the types, from both of which it appears to be distinguished by having the surface conspicuously roughened over the convex portion but smooth about the margins. The shape is extremely similar to that of the smaller of Ulrich's specimens. This is a highly convex little shell, rather strongly compressed at the ends."

| | Measurements (mm) | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 8, figs. 1, 2) | 1. 44 | 0. 85 | 0. 63 |
| Paralectotype (pl. 8, figs. 6–9) | 1. 16 | . 79 | . 43 |
| Lectotype (Ulrich) (pl. 8, figs. 3–5) | 1. 45 | . 83 | . 55 |

**Suborder METACOPINA Sylvester-Bradley, 1961**
**Superfamily QUASILLITACEA Coryell and Malkin, 1936**
**Family QUASILLITIDAE Coryell and Malkin, 1936**
**Genus GRAPHIADACTYLLIS Roth, 1929**

**Graphiadactyllis arkansana (Girty), 1910**

Plate 6, figures 24–30

1910. *Kirkbya lindahli* var. *arkansana* Girty, p. 234.
1926. *Kirkbya lindahli* var. *arkansana* Girty. Roundy, p. 7, pl. 1. figs. 14–16 (first illustration).
1929. *Bassleria arkansana* (Girty). Harlton, p. 257.
1936. *Graphiodactylus arkansanus* (Girty). Kellett, p. 774.
1941. *Graphiadactyllis arkansana* (Girty). Cooper, p. 45, pl. 9, figs. 9–12. Fayetteville Shale, Arkansas.
1961. *Graphiadactyllis arkansana* (Girty). Sohn in Moore and Pitrat, p. Q375, text fig. 300, figs. 1a, b [not 1c, d=*G. fayettevillensis* (Harlton), 1929].

*Original description.*—"The general appearance and sculpture are like those of *K. lindahli*, though the size is much smaller and the width proportionately greater. The shape is subrhomboidal, narrowing slightly toward the front, and with a distinct backward swing. The surface is finely checkered as in *K. lindahli*, and there is a subcentral pit. The right valve overlaps the left on the free margins. The double rim shown by Dr. E. O. Ulrich's figures seems to be lacking, and the ventral border of the left valve is rather abruptly infolded for a short distance toward the middle. Because of its smaller size, its lack of marginal bands and its infolded margin, I am disposed to regard this as varietally distinct from *K. lindahli*."

*Diagnosis.*—*Graphiadactyllis* without prominent dorsoposterior spine, right valve with very narrow ventroanterior flange; left valve usually without ventroanterior flange, overreaches right valve along venter.

*Revised description.*—The carapace is inequivalved; the left valve overlaps the right along the free margins and overreaches it along the ventral margin. The right valve has a very narrow flange along the free edge that widens slightly along the ventral half of the anterior margin. The left valve generally does not have this flange; however, in some individuals there is a very narrow flange along the ventroanterior margin. Scattered spinelets are present along the end margins of both valves. The hinge of the right valve consists of a narrow groove along the dorsum and terminal elongate teeth below the groove. The hinge of the left valve complements the right. The surface is covered with minute bifurcating riblets that give the surface a fingerprintlike texture. The intersections of many riblets form minute bumps that are smaller than the spinelets and are irregularly scattered along the valve surface. The valves are relatively thick, and the circular subcentral muscle scar pattern is embedded below the inside surface of the valve.

| | Measurements (mm) | | |
|---|---|---|---|
| | *Greatest length* | *Greatest height* | *Greatest width* |
| Lectotype (pl. 6, figs. 24–28) | 1. 32 | 0. 73 | 0. 64 |
| Paralectotype (inside right valve, pl. 6, figs. 29, 30) | 1. 23 | . 66 | [1] . 18 |
| Topotype (USNM 153795; unfig.) | . 96 | . 56 | . 40 |

[1] Exclusive of teeth.

*Discussion.*—Roundy (1926, p. 7, pl. 1, figs. 14–16) described and illustrated *Kirkbya lindahli* var. *arkansana* Girty from the Barnett Shale and underlying limestone of Boone age, San Saba County, Tex. He stated "As the original description of this variety appeared without illustrations I am also giving figures of the type specimen here." His plate 1, figures 14a–c are right, left, and dorsal views of what he called the "type specimen" which was later refigured by Cooper

(1941, pl. 9, figs. 10–12). In addition to the carapace, illustrated herein, the original collection (USGS loc. 1339A) contains two carapaces, one left and one right valve, and two fragments of valves. The illustrated carapace was designated as the lectotype by Sohn in Moore and Pitrat (1961, p. Q375). The remaining specimens are here designated as paralectotypes (USNM 153775), and one, originally illustrated by Cooper (1941, pl. 9, fig. 9), is here reillustrated (pl. 6, figs. 29, 30).

A vial from USGS locality 5553, labeled *Kirkbya lindahli* var. *arkansana*, contains four specimens. Two carapaces and a right valve belong to *G. arkansana;* the fourth, a smaller carapace, probably belongs to *G. fayettevillensis* (Harlton), 1929. Roundy's specimens (1926, pl. 1, figs. 15, 16) are labeled "Type 4012A, coll. 2618 blue [=USGS loc. 2618–PC], Barnett shale" (USNM 153796) and "Type 4038A, coll. 2623 blue [=USGS loc. 2623–PC], limestone of Boone age" (USNM 153797). The first, the original of figure 15, is a poorly preserved left valve on matrix, so that the specific identity is not determinable. The second, the original of figure 16, is a weathered broken left valve also unidentifiable as to species. Roundy stated, however (1926, p. 7), "The faint surface sculpture is preserved only on specimens from station 2623." A vial labeled "*Kirkbya lindahli* var. *arkansana* 4012" contains carapaces and valves showing surface sculpture. These specimens are inferred to be from station 2623 [=USGS loc. 2623–PC] because of the above statement. The carapaces differ in dorsal outline from both Girty's types of *K. lindahli* var. *arkansana* and *Bassleria fayettevillensis* Harlton, 1929 (USNM 79358, 79358A) by having a more wedge-shaped dorsal outline; they may represent an undescribed species. A specimen labeled "*Kirkbya lindahli* var. *arkansana,* Barnett shale, 2613D," the third locality listed by Roundy (1926, p. 7), is a poorly preserved cast of a left valve in matrix and is unidentifiable (USNM 153798).

Cooper (1941, p. 45) described and illustrated *Graphiadactyllis tenuis* from the Fayetteville Shale of Arkansas. He referred *Bassleria fayettevillensis* Harlton, 1929 and *Kirkbya lindahli* var. *arkansana* (part) Roundy, 1926 (pl. 1, figs. 14a-c) to his new species. *Graphiadactyllis tenuis* Cooper, 1941 is a junior synonym of *G. fayettevillensis* (Harlton), 1929.

*Kirkbya lindahli* Ulrich, 1891 is the type species of *Savagella* Geis, 1932. Girty's variety *K. lindahli arkansana* was elevated to specific rank and referred to the new genus *Graphiadactyllis* by Roth (1929a, p. 10), published in April of that year. In September of the same year, Roth (1929b, p. 292) changed the spelling to *Graphiodactylus*. Roth (1929c, p. 293) published a diagnosis and designated Girty's variety as the type species under the binomen *Graphiodactylus arkansana* (Girty). Harlton (1929) described the genus *Bassleria* (type species by original designation *B. fayettevillensis* Harlton, 1929) and referred Girty's variety to this genus as *Bassleria arkansana* (Girty). Because Harlton's paper was published in September, 1929, Roth's genus *Graphiadactyllis*, first published in April, 1929, has priority.

Kellett (1936, p. 773–775) reversed Girty's orientation of the taxon so that the left valve overlaps the right. She erected the family Graphiodactylidae for this genus and described without illustrating an ontogenetic series of *Graphiodactylus arkansanus* (Girty) from the Fayetteville Shale, 1½ miles southwest of Locust Grove, Okla. (USNM 53635). Two of her specimens were later illustrated by Sohn in Moore and Pitrat (1961, text fig. 300, figs. lc, d). Reexamination of Kellett's material indicates that Kellett dealt with *G. fayettevillensis* (Harlton), 1929. This species has a rather wide frill on both valves; the left valve does not overreach the right along the venter; the muscle scar is slightly more to the posterior on the valve surface than in *G. arkansana;* and it is smaller. *G. fayettevillensis* should not be considered as a possible young growth stage of *G. arkansana*, because a measured instar of *G. arkansana* (USNM 153795) is the same size as the holotype of *G. fayettevillensis* (USNM 79358) and has the characters of the adults.

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# PLATES 1–8

# PLATE 1

FIGURES 1–17. *Zaphrentites arkansanus* (Girty) (p. 9).

1–6. Serial transverse thin sections, × 4; lectotype, USNM 158785a–f, respectively; from USGS loc. 3651C.

7–9. Cardinal, counter, and alar views, respectively, × 1; lectotype, USNM 158785; from USGS loc. 3651C; arrows in fig. 9 indicate positions of transverse sections shown in figs. 1–6.

10–13. Serial transverse peel sections, slightly retouched, × 15; paralectotype, USNM 158787a–d, respectlvely; from USGS loc. 7088C.

14. Longitudinal thin section, × 4; paralectotype, USNM 158791a; from USGS loc. 3651B.

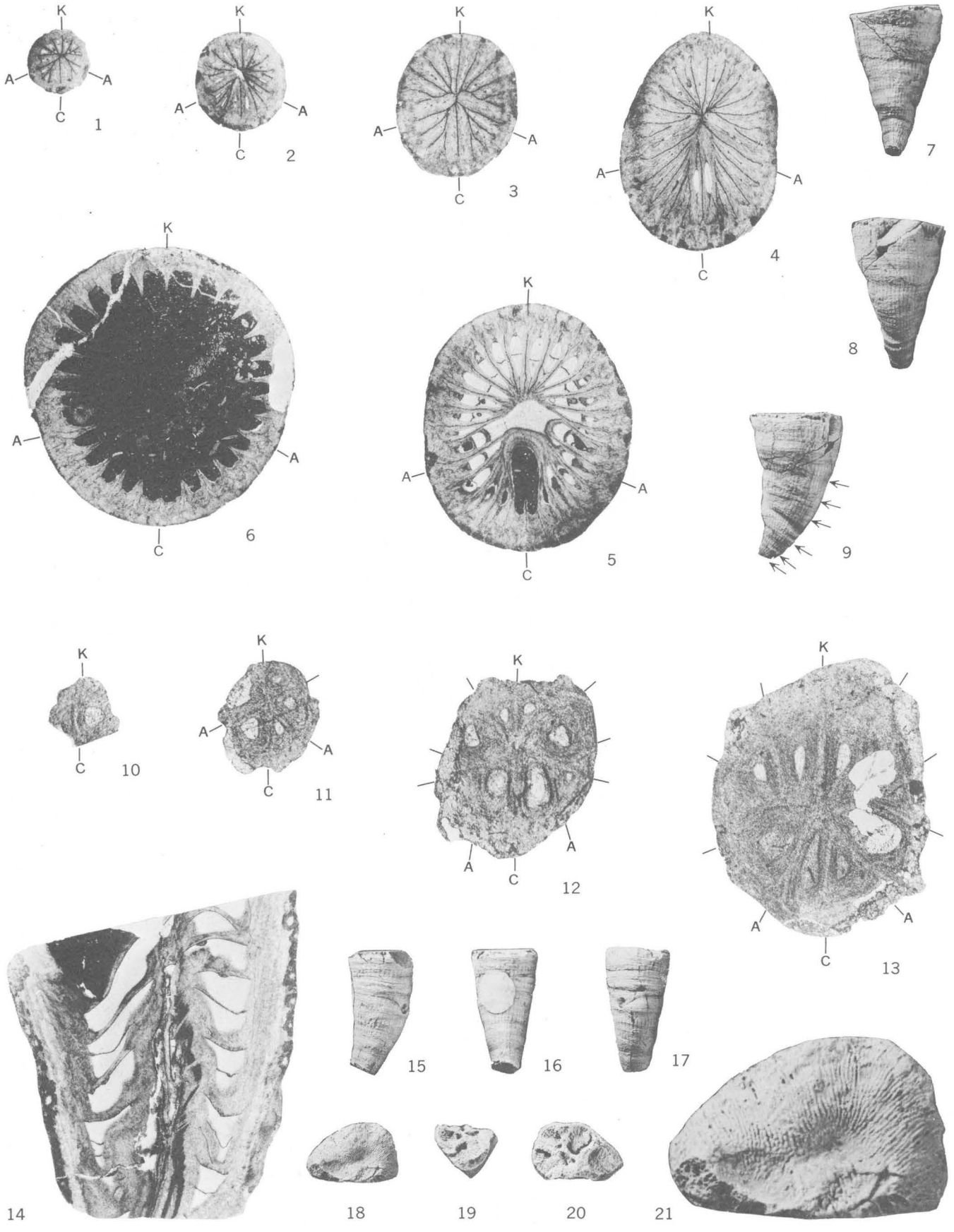
15–17. Alar, cardinal, and counter views, respectively, × 1; paralectotype, USNM 158797; from USGS loc. 3637.

18–21. *Palaeacis carinata* Girty (p. 13).

Paralectotype, USNM 158782, from USGS loc. 2839.

18–20. Side end, and top views, respectively, × 1.

21. Side view, × 3, showing nature of ornamentation.

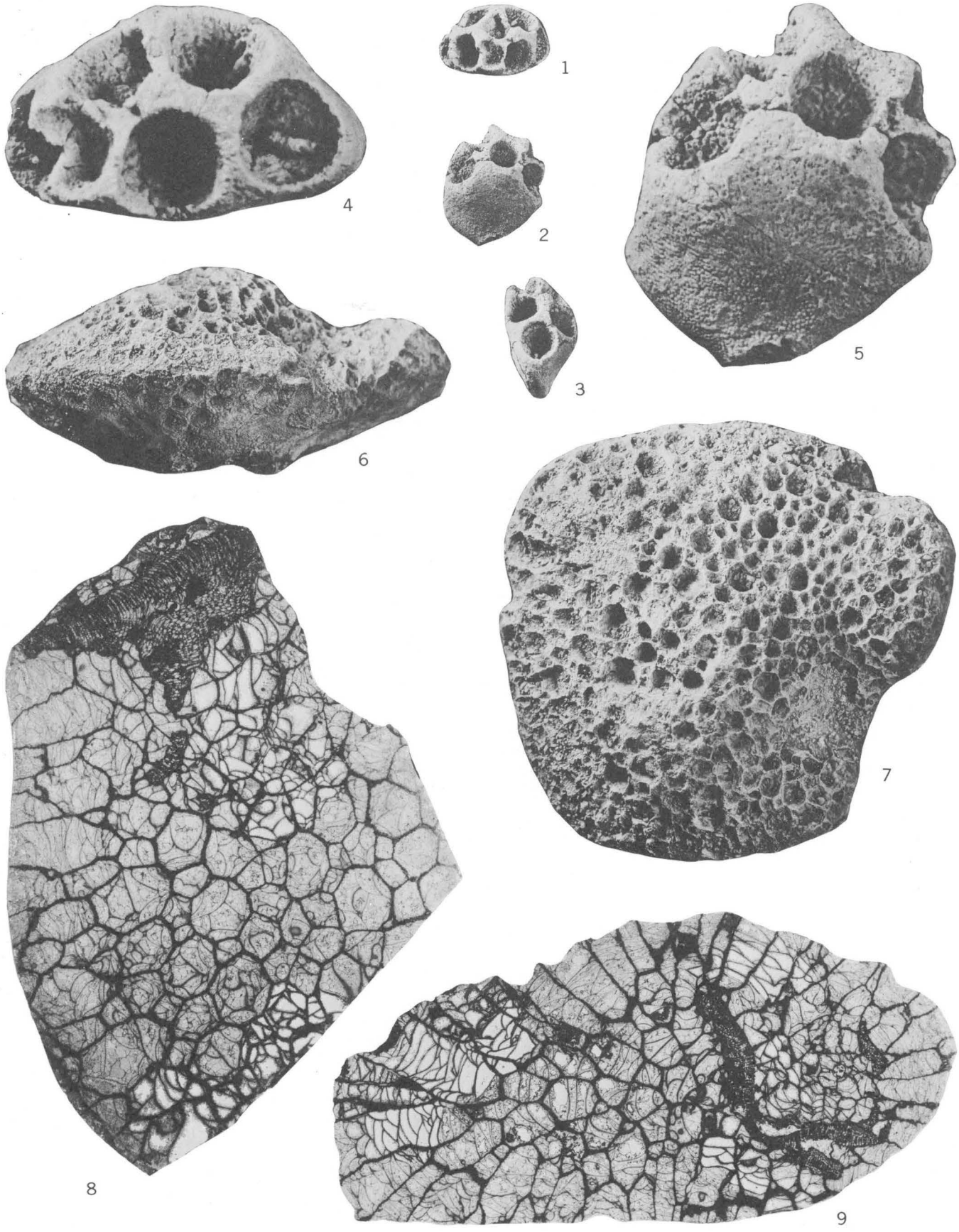



*ZAPHRENTITES ARKANSANUS* (GIRTY) AND *PALAEACIS CARINATA* GIRTY

## PLATE 2

FIGURES 1–5. *Palaeacis carinata* Girty (p. 13).
Lectotype, USNM 158780, from USGS loc. 2839.
1–3. Top, side, and end views, respectively, × 1.
4, 5. Top and side views, respectively, × 3, showing longitudinal ribs on interior of two corallites (fig. 4) and nature of external ornamentation (fig. 5).

6–9. *Michelinia meekana* Girty (p. 12).
Lectotype, USNM 158783, from USGS loc. 7088.
6, 7. Side and top views, respectively, × 1.
8. Transverse thin section, × 2, USNM 158783a.
9. Longitudinal thin section, × 1.5, USNM 158783b.




*PALAEACIS CARINATA* GIRTY AND *MICHELINIA MEEKANA* GIRTY

# PLATE 3



FIGURES 1, 2. *Solenomorpha nitida* (Girty) (p. 16).
Left valve, × 1 and × 2; lectotype, USNM 155894, from USGS loc. 3651C.

3–5. *Sanguinolites simulans* Girty (p. 16).
Left valve, × 1 and right valve, × 1 and dorsal view, × 2; holotype, USNM 155895, from USGS loc. 3636.

6–8. *Sphenotus? branneri* Girty (p. 17).
6. Left valve, × 2; lectotype, USNM 155896, from USGS loc. 3651B.
7. Right valve, × 2; paralectotype, USNM 155897, from USGS loc. 3651B.
8. Right valve, × 2; paralectotype, USNM 155898, from USGS loc. 3651C.

9–11. *Sphenotus washingtonensis* Girty (p. 17).
Right valve, × 1 and × 2 and dorsal view, × 2; lectotype, USNM 155899, from USGS loc. 3651C.

12–15. *Sphenotus dubius* Girty (p. 18).
Left valve, × 1 and × 3, anterior view, × 3, and dorsal view, × 3; lectotype, USNM 155900, from USGS loc. 3651B.

16, 17. *Sphenotus meslerianus* Girty (p. 18).
Left valve, × 1 and × 2; holotype, USNM 155901, from USGS loc. 3651B.

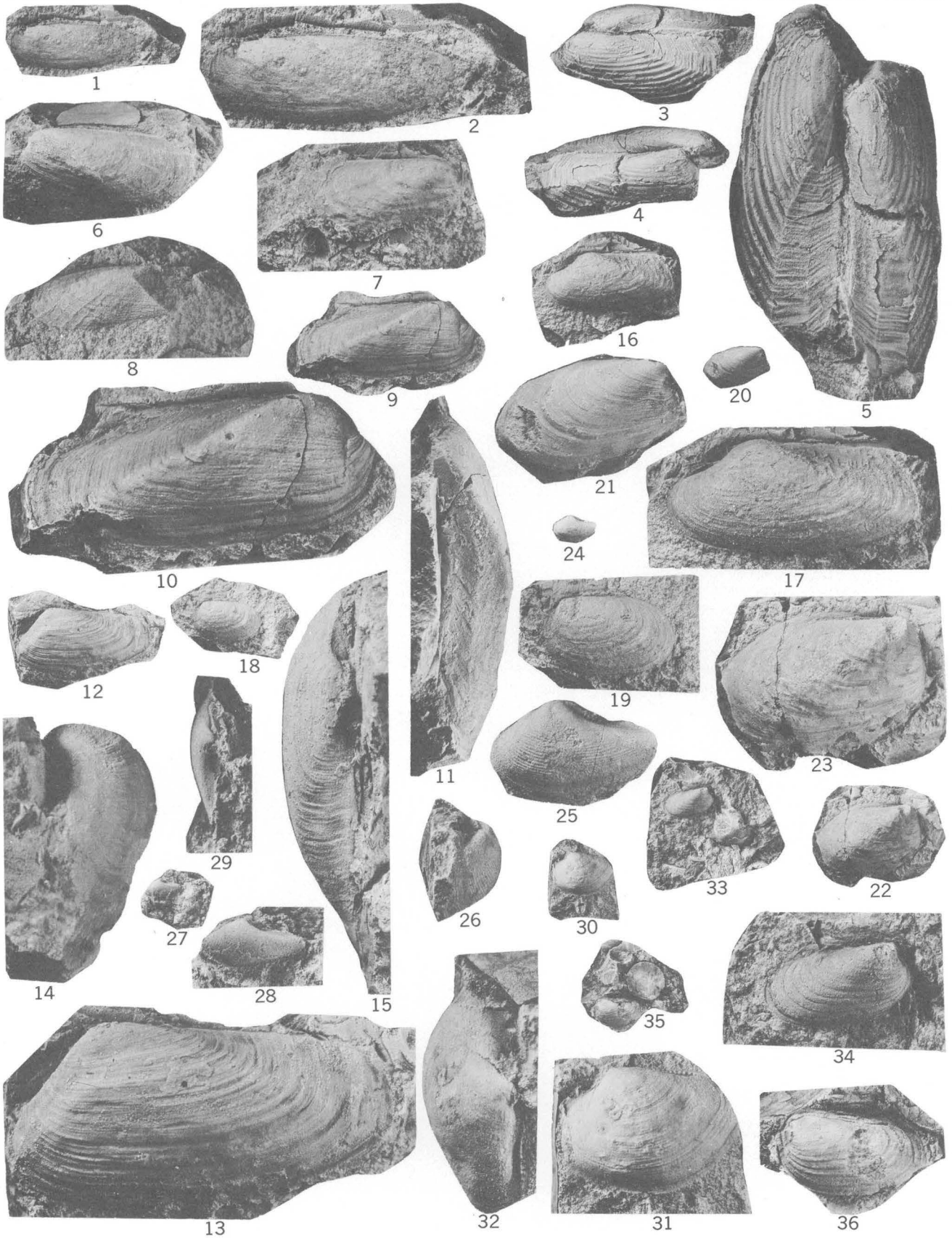
18, 19. *Edmondia? equilateralis* Girty (p. 18).
Left valve, × 1 and × 2; lectotype, USNM 155902, from USGS loc. 3651C.

20–23. *Cardiomorpha? inflata* Girty (p. 19).
20, 21. Right valve, × 1 and × 3; paralectotype, USNM 155904, from USGS loc. 3651B.
22, 23. Right valve, × 1 and × 2; lectotype, USNM 155903, from USGS loc. 3651C.

24–29. *Phestia stevensiana* (Girty) (p. 19).
24–26. Left valve, × 1 and × 4 and anterior view, × 4; lectotype, USNM 155906, from USGS loc. 3651B.
27–29. Left valve, × 1 and × 3 and dorsal view, × 4; paralectotype, USNM 155905, from USGS loc. 3652.

30–32. *Palaeoneilo sera* Girty (p. 19).
Left valve, × 1 and × 3 and dorsal view, × 4; lectotype, USNM 155907, from USGS loc. 3651B.

33–36. *Cypricardinia? fayettevillensis* Girty (p. 20).
33, 34. Right valve, × 1 and × 3; lectotype, USNM 155908, from USGS loc. 1339E.
35, 36. Left valve, × 1 and × 3; paralectotype, USNM 155909, from USGS loc. 1339E.




*SOLENOMORPHA, SANGUINOLITES, SPHENOTUS?, SPHENOTUS, EDMONDIA?, CARDIOMORPHA?, PHESTIA, PALAEONEILO,* AND *CYPRICARDINIA?*

## PLATE 4

FIGURES 1–4. *Conocardium peculiare* Girty (p. 20).
Left valve, right valve, posterior view, and dorsal view (posterior toward top of plate), × 4; holotype, USNM 119981, from USGS loc. 3651B.

5–8. *Caneyella? peculiaris* Girty (p. 20).
5, 6. Left valve, × 1 and × 3; lectotype, USNM 155911, from USGS loc. 3651B.
7, 8. Left(?) valve, × 1 and × 4; paralectotype, USNM 155910, from USGS loc. 3651C.

9–12. *Aviculopecten squamula* Girty (p. 21).
9, 10. Left valve, × 1 and × 4; lectotype, USNM 155913, from USGS loc. 5553.
11, 12. Left valve, × 1 and × 4; paralectotype, USNM 155912, from USGS loc. 3652.

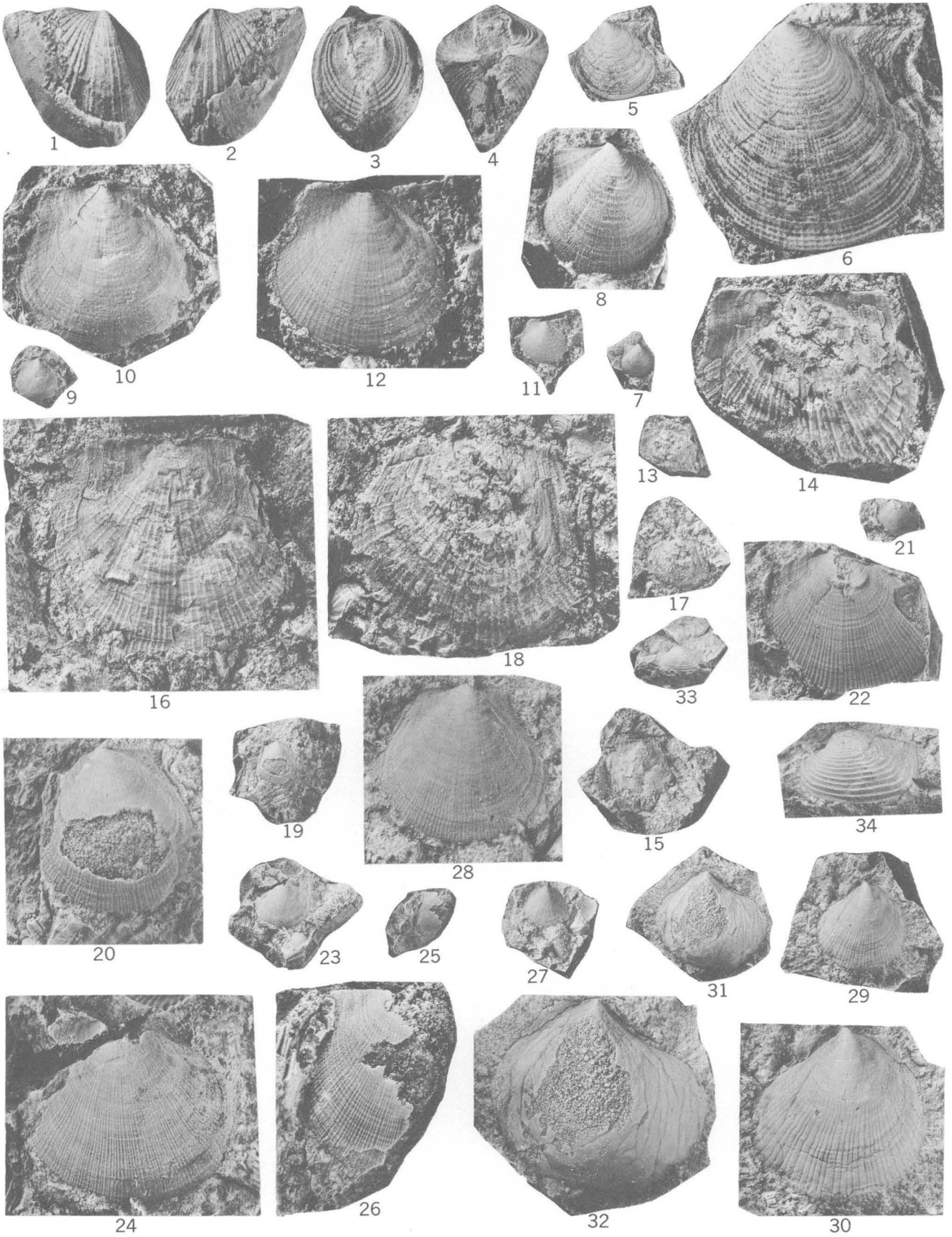
13–18. *Aviculopecten jennyi* Girty (p. 21).
From USGS loc. 1339A.
13, 14. Left valve, × 1 and × 4; paralectotype, USNM 155914.
15, 16. Left valve, × 1 and × 4; lectotype, USNM 155916.
17, 18. Left valve, × 1 and × 4; paralectotype, USNM 155915.

19–22. *Aviculopecten multilineatus* Girty (p. 21).
From USGS loc. 3636.
19, 20. Left valve, × 1 and × 4; lectotype, USNM 155917.
21, 22. Left(?) valve, × 1 and × 4; paralectotype, USNM 155918.

23–28. *Aviculopecten morrowensis* Girty (p. 22).
From USGS loc. 3641A.
23, 24. Left valve, × 1 and × 4; paralectotype, USNM 155921.
25, 26. Right(?) valve, ×1 and × 4; paralectotype, USNM 155919.
27, 28. Left valve, × 1 and × 4; lectotype, USNM 155920.

29–32. *Aviculopecten inspeciosus* Girty (p. 22).
From USGS loc. 3651C.
29, 30. Left valve, × 1 and × 2; lectotype, USNM 155922.
31, 32. Right valve, × 1 and × 2; paralectotype, USNM 155923.

33, 34. *Cypricardella subalata* Girty (p. 23).
Left valve, × 1 and × 3; holotype, USNM 155924, from USGS loc. 3651B.




*CONOCARDIUM, CANEYELLA?, AVICULOPECTEN,* AND *CYPRICARDELLA*

331-599 O - 69 - 7

# PLATE 5

[All figures natural size except as otherwise indicated on plate]

FIGURES 1–23. *Paladin mucronatus* (Girty) (p. 35).

1, 2. Enlarged dorsal and dorsal views of cranidium, lectotype, USNM 160902, from USGS loc. 3651B.

3, 11. Enlarged posterior and dorsal views of pygidium in early moult stage, paralectotype, USNM 160906, from USGS loc. 3651C.

4, 6. Enlarged dorsal and dorsal views of a nearly complete cephalon, paralectotype, USNM 160912, from USGS loc. 5550A.

5, 23. Enlarged dorsal and dorsal views of a nearly complete but poorly preserved specimen, paralectotype, USNM 160900, from USGS loc. 2845.

7, 16, 21. Dorsal and enlarged dorsal and posterior views of a pygidium, paralectotype, USNM 160903, from USGS loc. 3651B.

8–10. Dorsal and enlarged side and dorsal views of a large pygidium paralectotype, USNM 161324, from USGS loc. 5556.

12, 13. Enlarged side and ventral views of a small hypostome, paralectotype, USNM 160916a, from USGS loc. 5553A.

14, 17, 22. Dorsal and enlarged dorsal and posterior views of a pygidium associated in matrix with a cranidium and free cheek, paralectotypes, USNM 160914a–c, from USGS loc. 5553A.

15, 19, 20. Enlarged dorsal and posterior views and dorsal view of a small incomplete pygidium with well-preserved sculpture, paralectotype, USNM 160905, from USGS loc. 3651C.

18. Enlarged view of free cheek, paralectotype, USNM 160915, from USGS loc. 5553A.

24, 31, 33. *Trepospira (Angyomphalus?) discus* (Girty) (p. 28).

Slightly oblique apical, apertural, and basal views of holotype, USNM 161312, from USGS loc. 3651C.

25, 32, 34. *Mourlonia lativittata* (Girty) (p. 29).

From USGS loc. 7082.

25. Apertural view of paralectotype, USNM 161314a.

32, 34. Apical and adapertural views of lectotype, USNM 161313.

26, 27, 35. *Platyceras (Platyceras) subelegans* Gerty (p. 31).

Basal and "dorsal" (side) views and apical view showing coiled juvenile whorl of holotype, USNM 161315, from USGS loc. 3636.

28–30, 37, 40. *Platyceras (Orthonychia) compressum* Girty (p. 32).

28–30, 37. Apical, "dorsal" (side), oblique inner side, and basal views of lectotype, USNM 161316, from USGS loc. 2840.

40. Apical view of paralectotype, USNM 161317, from USGS loc. 3641A.

36, 39, 41, 42. *Euconospira disjuncta* Girty (p. 30).

36. Oblique apical view of paralectotype, USNM 161319, from USGS loc. 5553A.

39, 41, 42. Basal, side, and oblique apical views of lectotype, USNM 161318, from USGS loc. 3651B.

38, 43. *Sinuatina venata* (Girty) (p. 26).

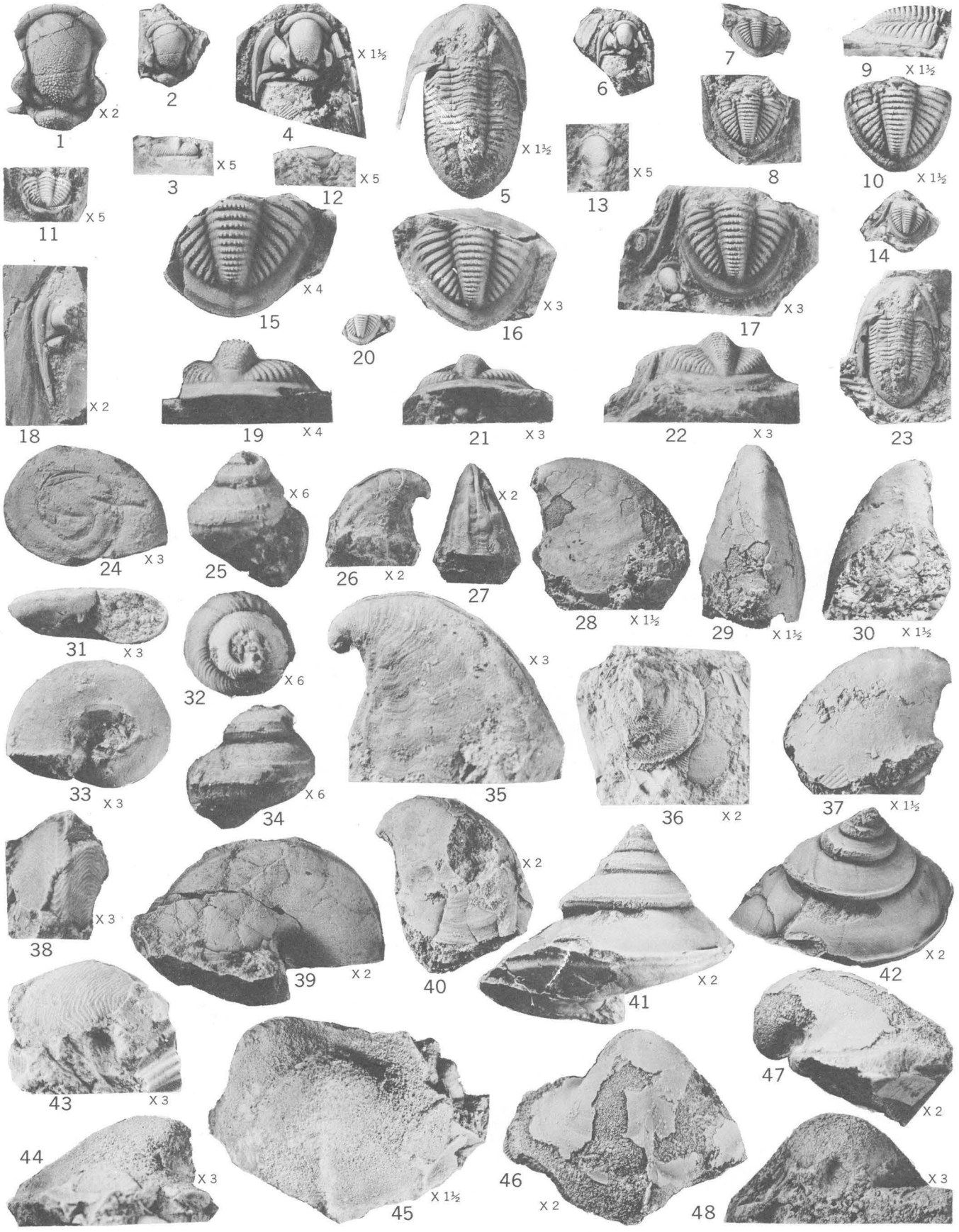
Dorsal and left side views of holotype, USNM 161320, from USGS loc. 3651.

44–48. *Patellilabia laevigatum* (Girty) (p. 27).

From USGS loc. 3641A.

44, 45. Right side and dorsal views of exfoliated paralectotype, USNM 161322a.

46–48. Dorsal, left side, and anterior views of lectotype, USNM 161321. Anterior view shows depression interpreted as impression of inductural boss in penultimate whorl.




GASTROPODS AND A TRIBOLITE FROM THE FAYETTEVILLE SHALE

# PLATE 6

[All magnifications are approximately × 30. Figures 4, 5, and 16 photographed by D. H. Massie; figures 20, 21, 23, and 28 by N. W. Shupe; the rest by R. H. McKinney]

FIGURES 1, 2. *Roundyella simplex* (Girty) (p. 44).
1. Lateral view of left valve. Lectotype, USNM 119854. USGS loc. 5553.
2. Lateral view of right valve. Topotype, USNM 153763.

3–9. *Geisina? retiferiformis* (Girty) (p. 45).
3–5. Dorsal, lateral, and ventral views of right valve. Holotype, USNM 153764. USGS loc. 5553A.
6, 7. Lateral views of two left valves. Topotypes, USNM 153765, 153766.
8, 9. Right and dorsal views of carapace. Topotype, USNM 153767.

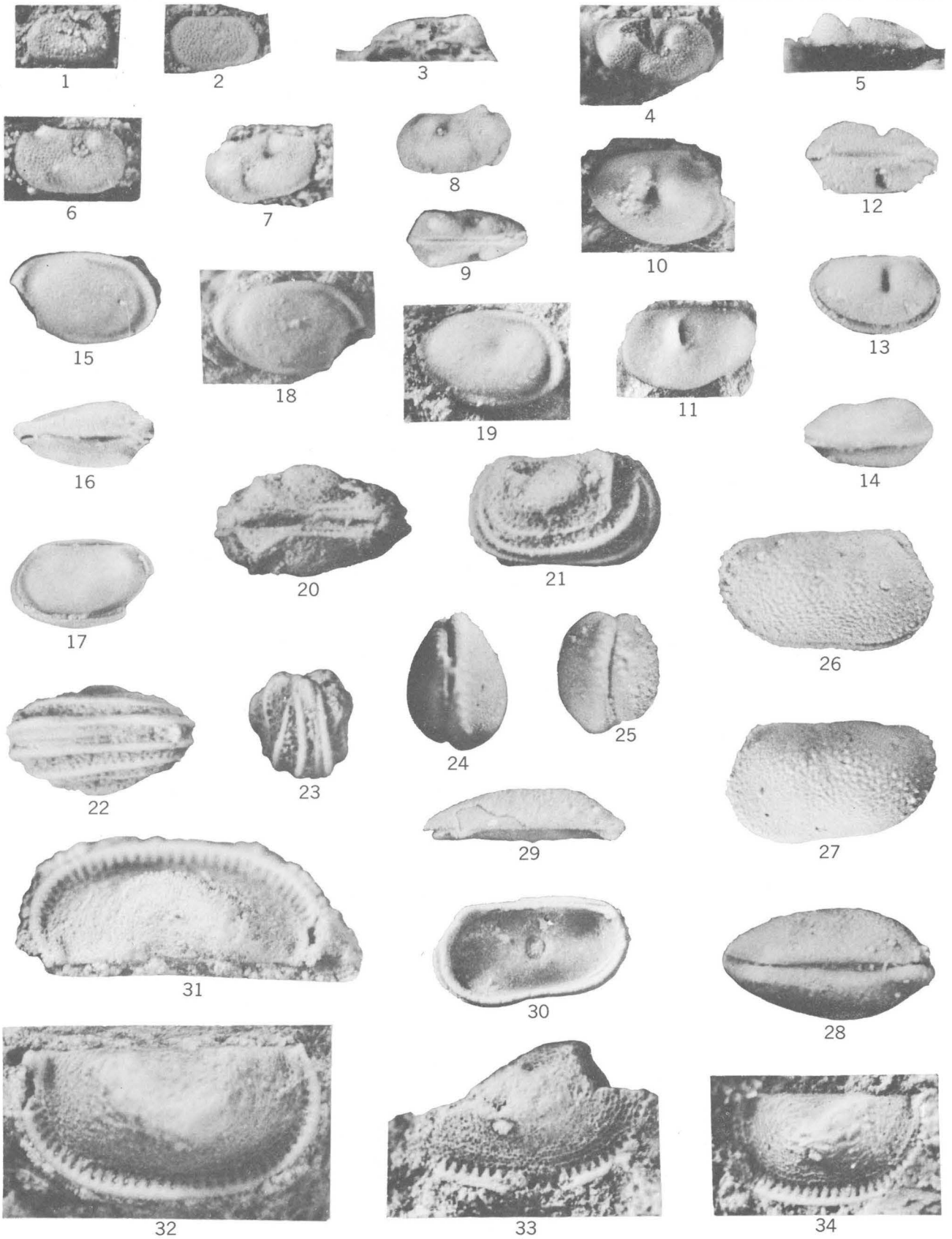
10–14. *Sansabella fayettevillensis* (Girty) (p. 46).
10. Lateral view of right valve. Paralectotype, USNM 153768. USGS loc. 7084.
11. Lateral view of left valve. Lectotype, USNM 153769. USGS loc. 5550A.
12–14. Dorsal, right, and ventral views of carapace. Topotype, USNM 153770. USGS loc. 5550A.

15–19. *Serenida seminalis* (Girty) (p. 46).
15–17. Right ,dorsal, and left views of carapace. Topotype, USNM 153771.
18. Lateral view of right valve. Paralectotype, USNM 153772.
19. Lateral view of right valve. Lectotype, USNM 153773. USGS loc. 5553A.

20–23. *Amphissites rugosus* Girty (p. 44).
Dorsal, left, ventral, and posterior views of carapace. Lectotype, USNM 118485. USGS loc. 5553.

24–30. *Graphiadactyllis arkansana* (Girty) (p. 52).
24–28. Anterior, posterior, right, left, and dorsal views of carapace. Lectotype, USNM 153774. USGS loc. 1339A.
29, 30. Dorsal and inside views of right valve. Paralectotype, USNM 153775.

31–34. *Kirkbya? reflexa* Girty (p. 43).
31, 32. Dorsal and lateral views of right valve. Lectotype, USNM 153776. USGS loc. 5553.
33. Fragment of left valve. Paralectotype, USNM 153777.
34. Lateral view of smaller left valve. Paralectotype, USNM 153778. Specimen damaged in attempt to remove matrix.




*ROUNDYELLA, GEISINA*?, *SANSABELLA, SERENIDA, AMPHISSITES, GRAPHIADACTYLLIS,* AND *KIRKBYA*?

# PLATE 7

[Magnification approximately × 30 for photographs, approximately × 50 for serial sections. Figures 1–9 photographed by D. H. Massie; figures 16, 19, 20, by N. W. Shupe; the rest by R. H. McKinney]

FIGURES 1–7, 11–20. *Glyptopleura inopinata* Girty (p. 49).

1–7 Serial acetate peels through a carapace. Position of sections shown on figure 18. Topotype, USNM 153779.

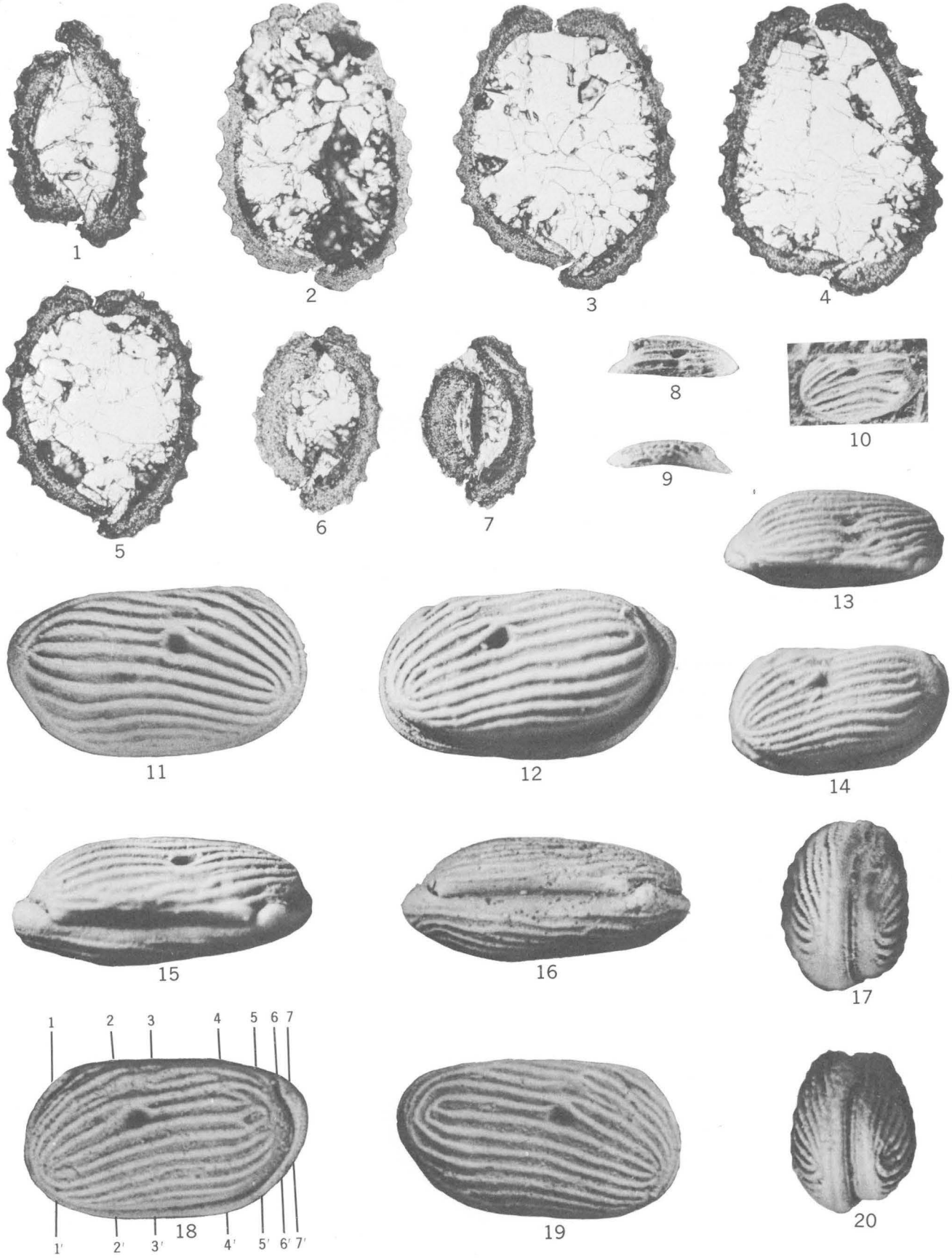
13, 14. Dorsal oblique and left views of carapace, immature individual. Topotype, USNM 153780.

11, 12, 15, 17. Right, left, dorsal, and anterior views of carapace. Paratype, USNM 153781.

16, 18–20. Dorsal, left, right, and anterior views of carapace. Holotype, USNM 153782. USGS loc. 1339A.

8–10. *Glyptopleura angulata* Girty (p. 49).

Dorsal, ventral, and lateral views of left valve. Holotype, USNM 153783. USGS loc. 1339A.




*GLYPTOPLEURA*

# PLATE 8

[Figures 19–24 approximately × 15, the rest approximately × 30. Figures 1, 2, 6, 10, 11, 13, 14 photographed by N. W. Shupe; the rest by R. H. McKinney]

FIGURES 1–9. *Orthobairdia cestriensis* (Ulrich) (p. 52).

1, 2. Dorsal and right views of carapace. Lectotype of *Bairdia cestriensis* Ulrich, 1891, USNM 41789A.

3–5. Right, left, and dorsal views of carapace. "Lectotype" of *B. cestriensis* var. *granulosa*, USNM 119735. USGS loc. 1339E.

6–9. Right, left, anterior, and dorsal views of carapace. "Paralectotype" of *B. cestriensis* var. *granulosa*, USNM 153784. USGS loc. 5550A.

10–14. *Bairdia girtyi* Sohn (p. 51).

10. Right view of carapace. Lectotype, USNM 119725. USGS loc. 5553.

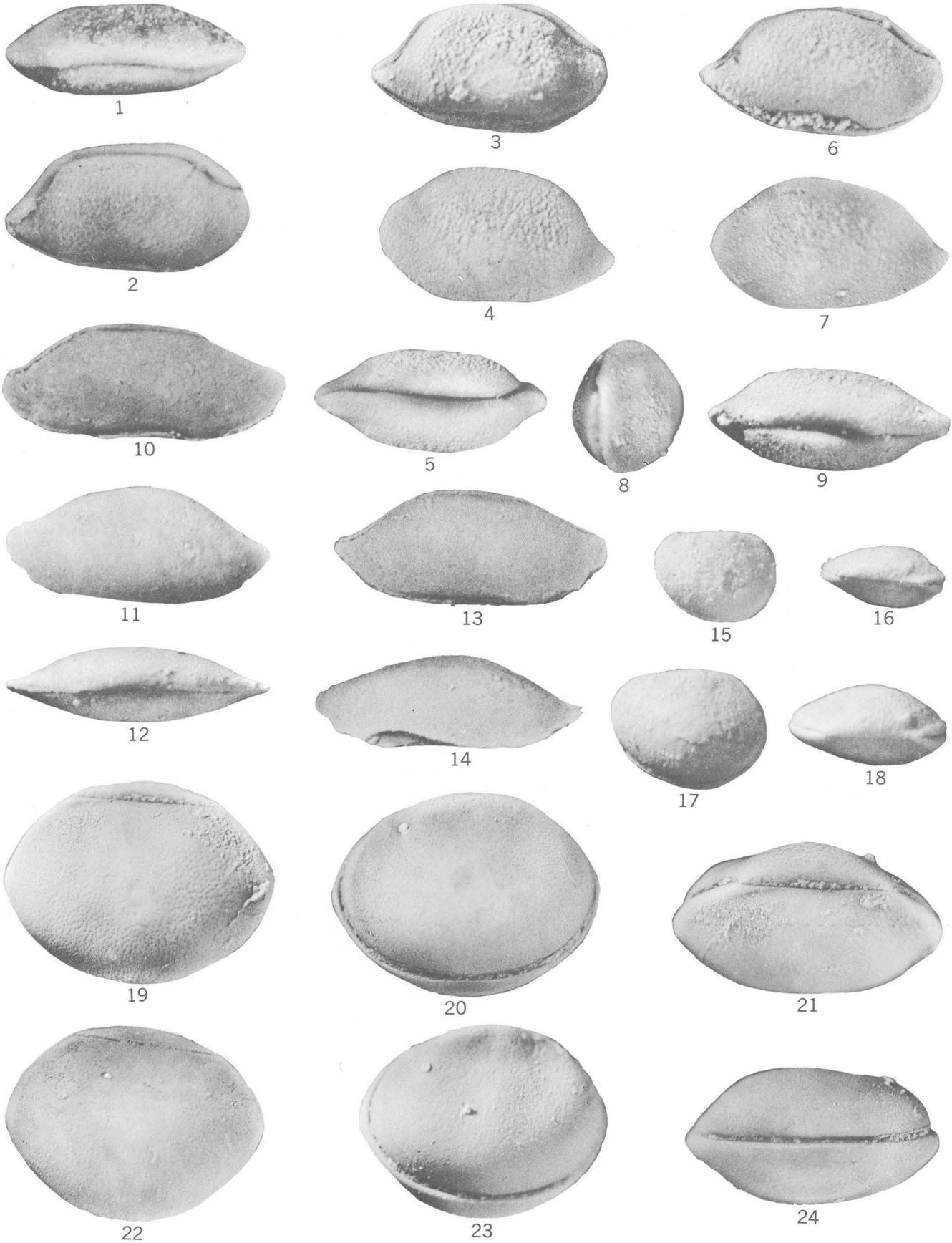
11–14. Left, dorsal, right, and tilted left views of corroded specimen. Paralectotype, USNM 119724. USGS loc. 5553.

15–24. *Paraparchites*? *cyclopeus* Girty (p. 50).

15–18. Right and dorsal views of two carapaces, young instars. Figured specimens, USNM 153785, 153786. USGS loc. 1339A.

19–21. Left, right, and dorsal oblique views of carapace. Lectotype, USNM 153787. USGS loc. 5553A.

22–24. Left, right, and ventral views of carapace. Paralectotype, USNM 153788. USGS loc. 5553.




*ORTHOBAIRDIA, BAIRDIA, AND PARAPARCHITES?*

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