THE UNIVERSITY OF KANSAS
PALEONTOLOGICAL CONTRIBUTIONS

# ARTHROPODA

ARTICLE 7
Pages 1-32, Plates 1-6, Text-Figures 1-15

## FAUNAL DESCRIPTION OF OSTRACODA OF THE MARLBROOK MARL (CAMPANIAN), ARKANSAS

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## ABSTRACT

Twenty-five samples collected from three outcrops of the Marlbrook Marl exposed in southwestern Arkansas have yielded specimens representing 44 species of fossil marine ostracodes. One new species was named and described, *Krithe swaini*; one new name was assigned to a previously described form, *Cytherella coryelli*; five species, including three forms of *Cythereis*, were described but not named for lack of sufficient material; 37 additional previously described species were identified and are discussed and illustrated.

The fauna is Upper Cretaceous in character with greatest similarity to the assemblages above the Marlbrook Marl. Division of the Marlbrook fauna into poorly defined upper and lower biofacies seems possible. *Cytherelloidea crafti* is abundant, distinctive, and could be used as a stratigraphic guide fossil; however, the overlapping ranges of at least seven other species are more promising for age correlation.

This study suggests promise for ostracodes as sensitive stratigraphic indicators in the Upper Cretaceous, but with need for more attention to morphologic detail in carapace ornament than has been the practice in the past. Surprisingly few faunas of Late *Cretaceous* age in North America have been described, and almost no phyletic lines of species development have been demonstrated, such as has been done elsewhere.


## INTRODUCTION

Interest in the ostracodes of the Marlbrook Marl began for us with the discovery of a large number of samples from this formation in the collections of the Museum of Invertebrate Paleontology at the University of Kansas. With the recently published works of SKINNER (1956) on the ostracodes of the Arkadelphia Marl, BUTLER & JONES (1957) on strata of Saratoga age in Louisiana, and HOWE & LAURENCICH (1958) on a general summary of Cretaceous ostracodes, it seemed appropriate to re-examine the fauna of the Marlbrook Marl, which had been sampled and partially described by ISRAELSKY in 1929. This also presented a first opportunity for us to study Cretaceous ostracodes, one (RHB) of us having spent most recent years in study of Recent ostracodes.

The purpose of this study was to describe the ostracode fauna of the Marlbrook Marl so that it could be used, with other forms, stratigraphically to date and correlate this unit and others of similar age. With the present knowledge of Upper Cretaceous ostracodes in North America the correlations are necessarily crude, but with growing interest in the stratigraphic usefulness of ostracodes and with the description of additional fauna, the comparisons will become more refined.

## PREVIOUS STUDIES

Study of Cretaceous ostracodes began in Europe in the 1830's and 1850's with such workers as JURINE, BOSQUET, RÖMER, REUSS, and JONES, and continues today, still somewhat advanced in detailed knowledge over that in North America.

The first study devoted to Upper Cretaceous ostracodes in North America, known to us, was by BERRY (1925) who described a fauna from Maryland containing thirteen species belonging to five genera. ISRAELSKY (1929) was first to describe Upper Cretaceous ostracodes from Arkansas. He identified seven species from the Marlbrook Marl. The same year ALEXANDER (1929) described a Cretaceous fauna from Texas, which contained many new forms. Five of his species have been found in the Marlbrook Marl. Subsequently many works on Upper Cretaceous ostracodes have been published that were useful in the present study. The authors and their areas of study include: MORROW (1934), Kansas; JENNINGS (1936), New Jersey; LOZO (1943), Texas; VAN DEN BOLD (1946), Caribbean region; SCHMIDT (1948), Maryland, Delaware, and Virginia; SWAIN (1948, 1952), Maryland and North Carolina; and BROWN (1957), North Carolina. Of special importance to this study were the studies of SKINNER (1956) on the ostracodes of the Arkadelphia Marl in Arkansas, and BUTLER AND JONES (1957) on the Cretaceous forms of Louisiana. Very helpful were the syntheses on Cretaceous and Mesozoic ostracodes of HOWE & LAURENCICH (1958) and CORYELL (1963).

## FIELD AND LABORATORY TECHNIQUES

Before going into the field, samples collected about 15 years ago by R. H. SHIELDS and C. G. LALICKER and left in the collections at the University of Kansas were exam-

ined and found to contain ostracodes in abundance. It was the discovery of these samples and their interesting fauna that led to collection of more material and its subsequent study.

Four localities within widely separate outcrop areas of the Marlbrook Marl were sampled by one of us (JOT) in the summer of 1960. Each outcrop was measured, described, and large samples were collected at 10-foot intervals. About 300 cc. of each of these samples were washed, sieved (60-mesh), and the ostracodes picked before study. The specimen counts were recorded in stratigraphic intervals marked as lower, middle, and upper to simplify the procedure.

The specimens were usually embedded with a calcareous matrix or the valves were cemented together. Although the details of surface sculpture were easily distinguished on most of the specimens, much of the material was not well preserved. An ultrasonic cleaner was used to rid some of the matrix material from the inside of the carapaces illustrated herein. This was not possible, however, for many of the species.

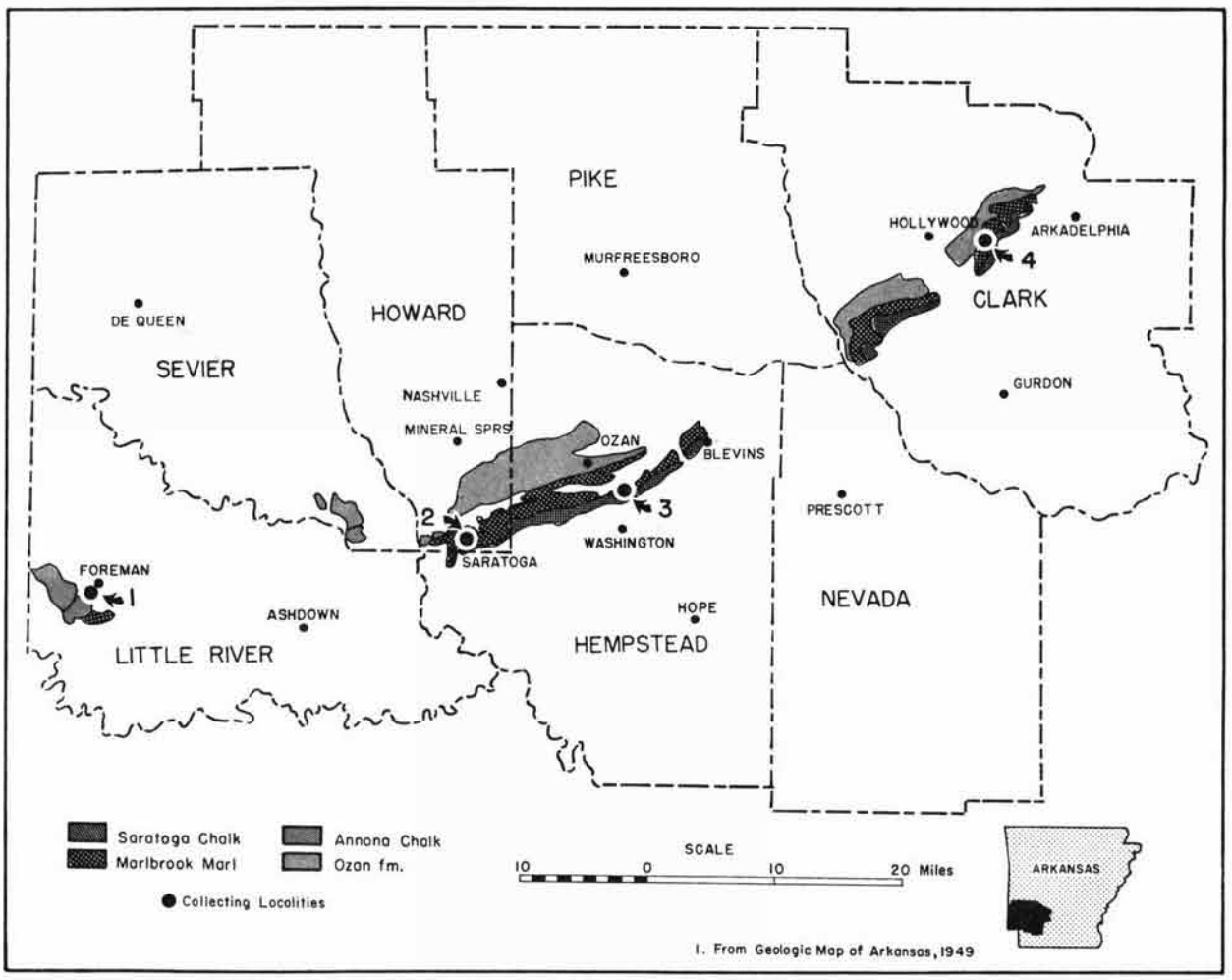
The photographs were prepared with the aid of 32-mm and 22.5 mm microscope objectives using pinhole diaphragms wtih 3200 and 2060 ångstrom-diameter apertures. The specimens were stained with a 5% solution of silver nitrate, heated, and dulled using chlorinated tap water.

#### ACKNOWLEDGMENTS

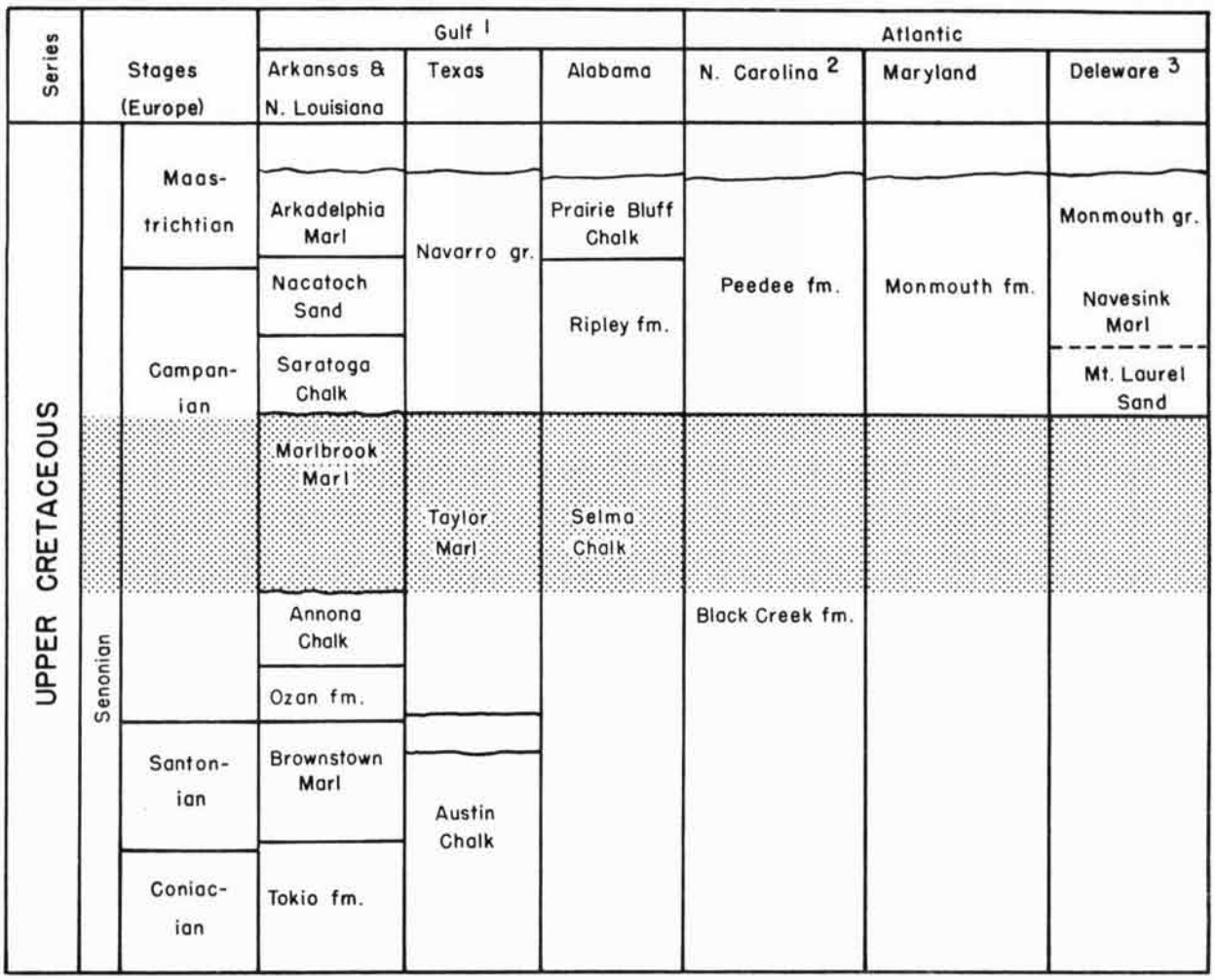
We express our appreciation to H. A. IRELAND for suggestions pertaining to the original manuscript, and to ALICE PAINTER, who prepared internal drawings of several of the species. The University of Kansas provided funds to help with part of this study. Many of the samples were collected by R. H. SHIELDS and C. G. LALICKER to whom we extend our thanks for their use.

## DESCRIPTION OF STUDY AREA

The part of the Marlbrook Marl containing the fossil assemblage studied crops out in the southwestern part of Arkansas (FIG. 1) in Howard, Hempstead, and Clark counties. Most of the information regarding the stratigraphy and some of the lithology of the Marlbrook Marl




TEXT-FIG. 1. Collecting localities and Upper Cretaceous outcrops in Southwestern Arkansas.




TEXT-FIG. 2. The regional stratigraphic correlations of the Marlbrook Marl and other major formations of Upper Cretaceous (Senonian) age in the eastern United States. The sections are taken from the works of (1), MOORE, 1958, p. 375; (2), HERON, 1958, Chart 1; (3), SCHMIDT, 1948, p. 392.

and other Upper Cretaceous formations of Arkansas is taken from DANE (1929).

The Upper Cretaceous formations in Arkansas crop out in a series of five exposures which trend in a northeast to southwest direction. These beds dip generally to the south and southeast from 65 to 80 feet per mile. The areas between these exposures are covered by alluvium and Quaternary terrace deposits of sand and gravel.

In the vicinity of the town of Saratoga in Howard County, the Marlbrook Marl rests conformably on the Annona Chalk, but northeast of this area, the Marlbrook rests disconformably on the Ozan Formation, which occurs stratigraphically below the Annona Chalk.

The Ozan Formation is a fossiliferous glauconite and sandy marl, which is 50 to 250 feet thick.

The Annona Chalk is a pure, white chalk. Near the town of Foreman in Little River County, it is about 100 feet in thickness. The Annona Chalk thins in a northeastern direction and finally pinches out northeast of the town of Saratoga.

The name Marlbrook Marl, as used in this study, is applied to the marl that lies above the Annona Chalk or Ozan Formation and below the Saratoga Chalk. When freshly exposed and moist, the Marlbrook has a dark blue-gray color and weathers to an almost white or light gray. This formation is usually massive, uniform in composition, and devoid of bedding. The Marlbrook Marl is the least resistant to erosion of the Upper Cretaceous formations in the area; it is easily eroded to form gullies in the outcrop area. Part of this gully formation is a result of deforestation of the land for agricultural purposes.

The Marlbrook Marl is thickest in the vicinity of Saratoga where it is about 215 feet thick. It thins northeastward and finally pinches out near the town of Arkadelphia, in Clark County. DANE (1929, p. xii) interpreted

this northeastward thinning of the Annona Chalk and Marlbrook Marl along the outcrop as a thinning toward shallower water and an east-west-trending shore line.

| | COLLECTING LOCALITIES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ❷ | | | | ❸ | | ❹ | | |
| SPECIES | Lower | Middle | Upper | | Upper | | Lower | Middle | Upper |
| Cytherella navarroensis | VA | VA | A | | C | | C | C | A |
| C. scotti | A | C | R | | | | | | |
| C. coryelli | R | A | A | | C | | R | | R |
| Cytherelloidea austinensis | C | R | | | | | | | |
| C. crafti | R | | A | | C | | R | | A |
| C. greenensis | | R | C | | R | | | | |
| Bairdia sp. | C | R | | | | | | | |
| Bairdoppilata pondera | A | A | A | | C | | R | A | C |
| Bythocypris windhami | R | | | | | | | C | |
| Monoceratina montuosa | R | | | | | | | | |
| M. marssonitina | R | R | R | | | | | | |
| M. prothroensis | R | | | | | | | | |
| Paracypris angusta | R | | | | | | R | | |
| P. goodlandensis | R | R | | | | | R | C | R |
| Amphicytherura dubia | | R | R | | | | | | |
| Orthonotacythere hannai | | R | | | | | | R | R |
| O. polita | R | R | | | | | | | |
| Cytheropteron castorensis | R | R | R | | C | | | | |
| C. harrisi | R | | R | | | | | | |
| Loxoconcha fletcheri | R | | | | | | R | R | R |
| L. sp. cf. seraphae | | | R | | R | | | R | R |
| Xestoleberis opina | C | C | C | | C | | C | A | A |
| Haplocytheridea? faboformis | | | R | | R | | R | | R |
| H. councilli | | | R | | R | | R | R | |
| H. monmouthensis | R | C | C | | | | R | R | |
| H.? plummeri | VA | VA | VA | | C | | C | C | C |
| H.? bruceclarki | A | C | A | | C | | R | C | C |
| Krithe swaini | VA | VA | C | | R | | R | C | R |
| Trachyleberis? communis | A | A | VA | | A | | A | R | C |
| T. pidgeoni | | R | C | | C | | | R | R |
| Cythereis costatana | | | R | | R | | R | C | R |
| C. hannai | R | | R | | | | | | |
| C. sp. A | R | | | | | | | | |
| C. sp. B | | R | | | | | | | |
| C. sp. C | | | R | | R | | | | |
| Echinocythereis bartoni | | | R | | | | | C | |
| Veenia arachoides | | C | C | | C | | C | | |
| V. ozanana | C | | | | | | | | |
| Neocythere pseudoconcentrica | R | | R | | R | | | R | |
| Brachycythere ovata | R | R | A | | C | | C | C | A |
| B. ledaforma | R | C | C | | | | | C | |
| B. rhomboidalis | | R | R | | R | | | C | |
| Pterygocythere saratogana | R | C | R | | R | | | C | |
| Alatacythere ponderosana | C | R | R | | | | | | |

The Saratoga Chalk is very fossiliferous, hard, sandy, somewhat glauconitic chalk that rests unconformably on the Marlbrook Marl. It is separated from the underlying marl by a distinct lithologic and faunal break. This break is the best defined and most easily recognized in the whole Upper Cretaceous sequence of Arkansas because of the distinctive lithologies of the Marlbrook Marl and the Saratoga Chalk.

## COLLECTING LOCALITIES

The collections for this study were made from the following sites in Little River, Howard, Hempstead, and Clark counties. Each outcrop was measured, examined, and sampled throughout the exposed thicknesses at about 10-foot intervals.

*Locality 1.* In the vicinity of the Rocky Comfort area, which is several miles southwest of the present town of Foreman in Little River County, the base of the Marlbrook Marl is supposed to be exposed above the Annona Chalk. (FIG. 1). The Annona Chalk was readily identified in this area, but the samples that were collected could not be positively identified as Marlbrook Marl. Therefore, the material from this area will not be dealt with in this report.

*Locality 2.* This locality is 1.3 miles north of the town of Saratoga, Arkansas, on Arkansas State Highway 355. The Marlbrook is about 215 feet thick and the outcrop is about 1 mile wide. The formation is a massive, blue-gray marl and the uppermost 3 or 4 feet are sandy and glauconitic. Eighteen samples collected by SHIELDS and LALICKER (listed in the Appendix) were examined during this study.

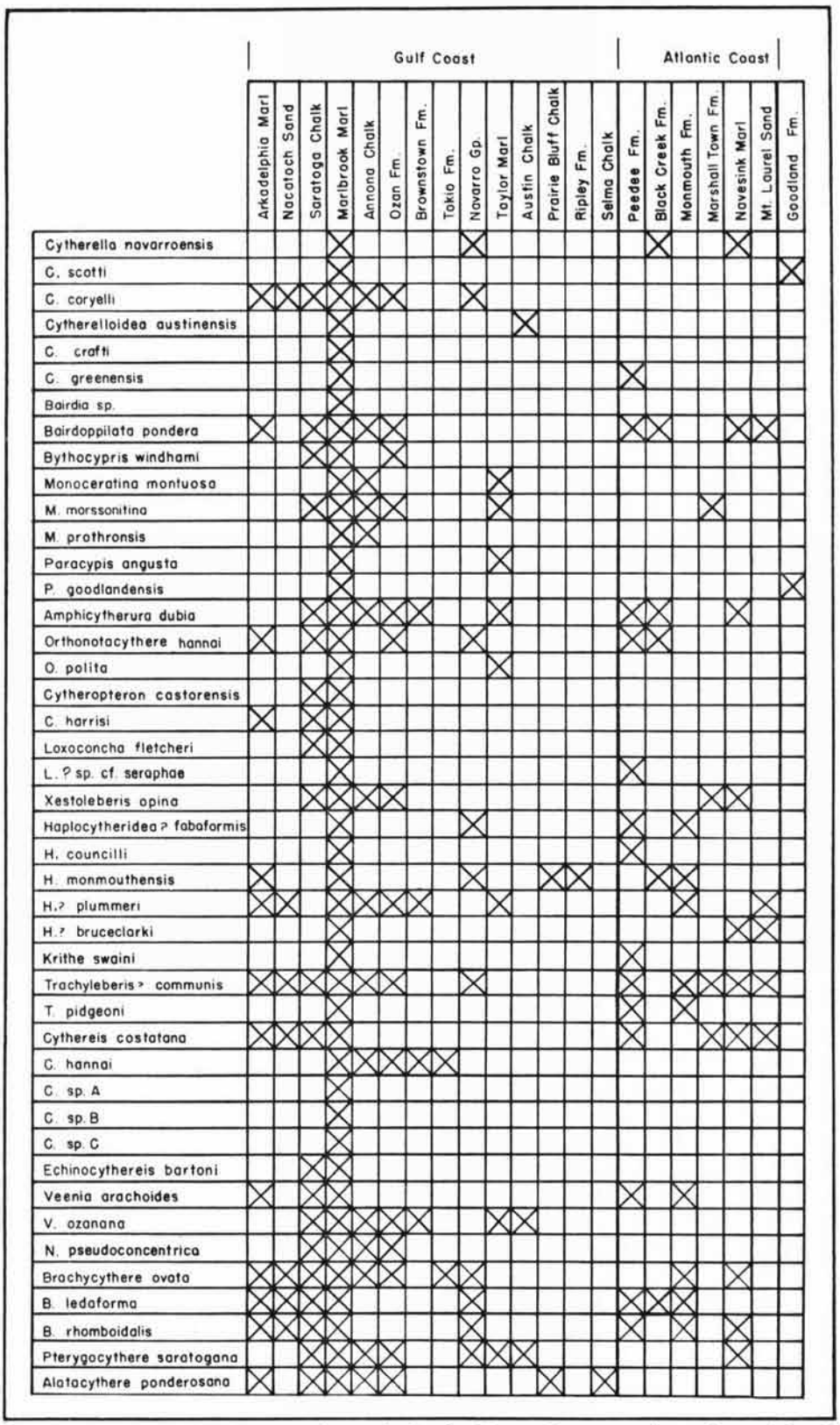
*Locality 3.* This location is 3.3 miles north of the town of Washington in Hempstead County on Arkansas State Highway 4. Only the upper 30 feet of the Marlbrook is exposed at this location. This interval was sampled and the highest sample was taken just below the Marlbrook-Saratoga contact. The samples collected at this site are listed in the Appendix. The lithology of the Marlbrook at this location was a massive blue-gray marl.

*Locality 4.* This locality is 7.8 miles west of Arkadelphia on Arkansas State Highway 26, leading to the town of Hollywood (FIG. 1). The Marlbrook at this location is about 40 feet thick and is a massive blue-gray, slightly arenaceous marl. The base of the Marlbrook contains quartz, glauconite, and black phosphatic grains. Four samples were collected at this site and are listed in the Appendix.

## OSTRACODE ASSEMBLAGE

Species of the ostracode assemblage collected from within the Marlbrook Marl were considered collectively from three points of view in trying to determine their stratigraphic significance: (1) as stratigraphic index species with limited range zones; (2) the percentage of Marlbrook species found in other formations; and (3) the presence of phyletic lines of

TEXT-FIG. 3. The relative abundance of the ostracode species collected from each of three zones of the Marlbrook Marl exposed at localities 2, 3, and 4 in southwestern Arkansas (Fig. 1). Class limits are rare (R), 1-5 specimens; common (C), 5-20 specimens; abundant (A), 20-40 specimens; very abundant (VA), more than 40 specimens.




TEXT-FIG. 4. Distribution of Marlbrook ostracode species in the Upper Cretaceous formations of the Gulf and Atlantic coastal regions.

ostracode evolution represented in and passing through the Marlbrook Marl.

Twenty-six of the 44 species identified herein from the Marlbrook Marl have been found in other Upper Cretaceous formations in Arkansas (FIG. 4). Twenty-two of the species found in the Marlbrook Marl have been identified from Upper Cretaceous strata from the Atlantic Coast, indicating a strong similarity in the faunas, especially with those of the southern areas. The Marlbrook fauna has ten species in common with the assemblage thus far described from the Navarro Group of Texas and eight in common with that of the Taylor Marl. One species previously described from the Selma Chalk of Alabama was found.

Only five species are thus far known only from the Marlbrook Marl and nowhere else. These include a species of *Bairdia*, which is not morphologically distinctive; three species of *Cythereis*, which are distinctive but rare; and *Cytherelloidea crafti*, which is abundant and distinctive, and may be useful as a stratigraphic indicator for rocks of Marlbrook age.

At least seven species have ranges that locally either end or begin in the Marlbrook Marl. These include *Cythereis hannai* and probably *Monoceratina prothroensis*, which are not found in rocks younger than the Marlbrook Marl; and *Cytheropteron harrisi*, *Cythereis costatana*, *Veenia arachoides*, *Brachycythere ledaforma*, and *B. rhomboidalis*, which are not found in formations older than the Marlbrook Marl. At least thirteen species locally occur in rocks both older and younger than the Marlbrook Marl.

Eight species of about 15 that have been found in the Taylor Marl of Texas, of which the upper part is considered to be equivalent in age to the Marlbrook, were also found in the Marlbrook. This does not support or deny any previous correlation as much more work should be done on the Taylor assemblage before further comparisons can be made.

The ostracode assemblage from strata of "Saratogan" age in Louisiana, described by BUTLER & JONES (1957), consists of 40 species of which 27 are common to the Saratoga Formation of Arkansas, which lies immediately over the Marlbrook Marl. Using the identifications of BUTLER & JONES (1957, Fig. 4), and adding to their list the forms we have found, there are 26 species common to the Marlbrook and Louisiana "Saratogan" assemblages. About half of the species of the present study were common to both the Marlbrook and Saratoga formations. From just comparison of percentage of species in common it would seem that the assemblage studied by BUTLER & JONES might be either Saratogan or Marlbrookian in age. The faunas obviously share many of the same species.

None of the ranges of species present in the Marlbrook Marl are known to extend beyond lower Danian? (basal Midway Formation) or to be present in rocks older than Senonian (Tokioan), except two Lower Cretaceous species found earlier in the Goodland Formation. Only about ten percent of the Marlbrook species are known from the Tokio and Brownstown formations; about thirty percent are in common with the assemblages described from the underlying Annona Chalk and Ozan Formation; however, at least fifty percent of the Marlbrook species occur in the overlying Saratoga Chalk and Arkadelphia Marl. Eight species found in the Marlbrook Marl have been listed from the basal Midway Formation of Texas (SCOTT, 1934). This development and persistence of species seems to suggest the establishment and continued environmental preference of a chalk or marl facies fauna.

Certain species of ostracodes seem to be restricted to the lower portion of the Marlbrook and the underlying formations. FIGURES 3 and 4 illustrate the possibility of dividing the Marlbrook assemblage into an upper biofacies and a lower biofacies on the basis of the ostracodes present.

The upper biofacies is the best defined and is characterized by the following species: *Cytherelloidea crafti* SEXTON, *Trachyleberis pidgeoni* (BERRY), *Cythereis costatana* ISRAELSKY, *Echinocythereis bartoni* (ISRAELSKY), *Veenia arachoides* (BERRY), and *Brachycythere rhomboidalis* (BERRY). All of the above-mentioned species also occur in formations stratigraphically just above the Marlbrook.

The lower biofacies is not as well defined as the upper biofacies. The following species are more characteristic of the lower biofacies and Upper Cretaceous formations stratigraphically just below the Marlbrook: *Cytherelloidea austinensis* SEXTON, *Monoceratina marsonitina* CORYELL, and *Veenia ozanana* (IRAELSKY).

Thirteen easily recognized species of ostracodes from the Marlbrook Marl have a sufficiently wide distribution that they may possibly be used as regional stratigraphic indicators for rocks of late Senonian age. They are: *Bairdoppilata pondera* JENNINGS, *Amphicytherura dubia* (ISRAELSKY), *Orthonotacythere hannai* (ISRAELSKY), *Xestoleberis opina* SCHMIDT,

*Haplocythereidea? fabaformis* (BERRY), *H. monmouthensis* (BERRY), *H.? plummeri* (ALEXANDER), *Trachyleberis? communis* (ISRAELSKY), *Cythereis costatana* (ISRAELSKY), *Veenia arachoides* (BERRY), *Brachycythere ovata* (BERRY), *B. ledaforma* (ISRAELSKY), *B. rhomboidalis* (BERRY), and *Pterygocythere saratogana* (ISRAELSKY).

Some of these species were included in a list of those identified by ALEXANDER for the study of GAYLE SCOTT (1934) on the age of the Midway Group. If the conclusions about the age of this unit and the identifications of the species are still valid, then it would appear that the fauna characteristic of the uppermost Cretaceous tends to transcend slightly the stratigraphic boundary between marine Mesozoic and Cenozoic strata.

For the present, actual trends in evolution within the species present in the Marlbrook Marl, or between them and those coming before or after, cannot be seen by us. However, the work of POKORNÝ (1963) on the Cretaceous ostracodes of Bohemia does suggest that it is possible to discern such trends as stratigraphically profitable. We hope that with additional faunal descriptions, future acquisitions, or more and better collections and attention to detail, that ostracodes will be especially useful in phyletic biostratigraphy.

## SYSTEMATIC PALEONTOLOGY

All type material has been deposited with the Smithsonian Institution at the U.S. National Museum in Washington, D.C.

### Subclass OSTRACODA Latreille, 1806
### Order PODOCOPIDA Sars, 1866
### Suborder PLATYCOPINA Sars, 1866
### Family CYTHERELLIDAE Sars, 1866
### Genus CYTHERELLA Jones, 1849

*Cytherella* JONES, 1849, p. 28.

*Type-species. Cytherina ovata* ROEMER, 1840, p. 104, fig. 21; see OERTLI, 1958, p. 1502; described originally from Campanian of Germany.

*Diagnosis.* Recognized by its thick-shelled, ovate to elliptical, smooth to punctate carapace. Hinge adont. The right valve overlaps the left around the entire periphery. Adductor muscle-scar pattern pinnate, consisting of a double row of ten or more scars. Sexual dimorphism distinct. Females have an indistinct internal ridge which separates the posterior and anterior parts of the valve's interior. *Jur.-Rec.*

#### CYTHERELLA NAVARROENSIS Alexander, 1929

Plate 1, Figures 4-7.

*Cytherella navarroensis* ALEXANDER, 1929, p. 53, pl. 2, figs. 1, 2 (male), (Navarro Formation, Texas); SWAIN, 1952, p. 68, pl. 8, fig. 1, (Black Creek Formation, North Carolina); HOWE & LAURENCICH, 1958, p. 250.

*Cytherella moremani* ALEXANDER, 1929, p. 53, pl. 1, figs. 4, 5 (female), (Navarro Formation, Texas); JENNINGS, 1936, p. 40, pl. 6, fig. 1, (Navesink Formation, New Jersey).

*Cytherella ovata* ALEXANDER, 1932, p. 303, pl. 28, figs. 1, 2.

*Dimensions.* Length of adult male 0.90 mm; height 0.54 mm; width 0.33 mm. Length of adult female 0.95 mm; height 0.49 mm; width 0.36 mm.

*Diagnosis.* Distinguished by its large, ovate carapace. Males, when viewed dorsally, are thickest in the middle. The right valve of females overlaps the left valve dorsally and, when viewed dorsally, is thicker.

*Remarks.* Resembles *Cytherella ovata* (ROEMER) very closely in lateral view (compared with illustration by OERTLI, 1958, pl. 1, figs. 10-29). When viewed dorsally, *C. navarroensis* is thickest in the middle, whereas *C. ovata* is thickest well behind the middle (HOWE & LAURENCICH, 1958, p. 251). *Cytherella ovoidea* ALEXANDER is also similar to *C. navarroensis*, but is smaller. The right valve of *ovoidea*, like that of *navarroensis*, strongly overlaps the left dorsally and ventrally; however, the ventral overlap of *navarroensis* is weak. The greatest thickness of *ovoidea* is well behind the middle. *C. navarroensis* can be distinguished from *C. austinensis* ALEXANDER by its greater anterodorsal overlap and weaker posterior overlap.

#### CYTHERELLA SCOTTI Alexander, 1929

Plate 2, Figures 3-4.

*Cytherella scotti* ALEXANDER, 1929, p. 48, pl. 1, figs. 12, 15, (Goodland Formation, Texas); CALAHAN, 1939, p. 49, pl. 7, fig. 12; LOZO, 1944, p. 530, (Fredericksburg Ls.); HOWE & LAURENCICH, 1958, p. 255.

*Dimensions.* Length of adult specimen 0.90 mm; width 0.29 mm; height 0.47 mm.

*Diagnosis.* Distinguished by its oblong to ovate carapace with parallel ventral and dorsal margins that are constricted slightly in the middle. Anterior and posterior ends are broadly and equilaterally rounded. Wedge-shaped in dorsal view and thickest posteriorly.

*Remarks.* Similar to *Cytherella comanchensis* ALEXANDER but has neither as much overreach nor the slight posterodorsal truncation. Distinguished from *C. navarroensis* by its smaller size, slightly constricted dorsal and ventral margins and lack of prominent anterodorsal overreach. Also very similar to *Cytherella parallela* REUSS (1946), with which it may possibly be conspecific.

**CYTHERELLA CORYELLI Benson & Tatra, nom. nov.**

Plate 1, Figures 9, 11, 12.

*Cytherella tuberculifera* ALEXANDER, 1929, p. 52, pl. 2, fig. 3, (Navarro Formation, Texas); ALEXANDER, 1934, p. 212, (Navarro Formation, Texas); BUTLER & JONES, 1957, p. 9, pl. 6, fig. 7, (Upper Cretaceous, Louisiana); CORYELL, 1963, p. 754 (*non Cytherella tuberculifera* (GUMBEL), 1869).

*Dimensions.* Length of complete carapace 0.83 mm; height 0.54 mm; width 0.39 mm.

*Diagnosis.* Distinguished by its large, oblong to ovate carapace. Dorsal margin arched, ventral margin convex; strongest overreach in the middle of dorsal and ventral margins, and along posterior margin where right valve bears a short, blunt, posterior projection.

*Remarks.* Distinguished from *Cytherella scotti* by its strong dorsal and ventral overreach, and lack of constricted dorsal and ventral margins. Distinguished from *C. navarroensis* by its strong overreach. *C. navarroensis* shows strong valve overreach only anterodorsally. The specimens from the Marlbrook Marl are smaller than those originally described by ALEXANDER from the Navarro Formation of Texas. Otherwise they are identical. The name is changed because of homonymy; first recognized by H. N. CORYELL (1963, p. 754) after whom the species is renamed.

## Genus CYTHERELLOIDEA Alexander, 1929

*Cytherelloidea* ALEXANDER, 1929, p. 55; HOWE & LAURENCICH, 1958, p. 258.

*Type-species. Cythere (Cytherella) williamsoniana* JONES, 1849, p. 31, pl. 7, figs. 26a-i, (original description from the Cretaceous Chalk of England).

*Diagnosis.* Distinguished from other cytherellid genera by its ornamented surface consisting of longitudinal ridges, plications, pits, and marginal spines. Females usually possess posterior nodes. *Jur.-Rec.*

**CYTHERELLOIDEA AUSTINENSIS Sexton, 1951**

Plate 1, Figures 1-2.

*Cytherelloidea austinensis* SEXTON, 1951, p. 809, pl. 117, figs. 1, 2, (Austin Chalk, Texas); HOWE & LAURENCICH, 1958, p. 260.

*Dimensions.* Length of adult specimen 0.58 mm; height 0.31 mm; width 0.29 mm.

*Diagnosis.* Recognized by its subrectangular, differently ornamented equal valves. Ends bluntly rounded; prominent dorsal, anterior, and posteroventral rim. Left valve (of female?) has two large, rounded, posterior nodes, one above the other, which are connected by a raised marginal rim. A short ridge extends from the uppermost node to the dorsal margin over the subcentral pit and terminates just below the anterodorsal end of the marginal rim. A short, ventral ridge lies below the subcentral pit, but does not join the lower posterior node (HOWE & LAURENCICH, 1958, p. 260).

*Remarks.* Distinguished from *Cytherelloidea crafti* SEXTON and *C. greenensis* BROWN by fewer ridges on the left valve. Both of the above mentioned species have three ridges, whereas *C. austinensis* has only two ridges on the left valve. Distingiushed from *C. williamsoniana* (JONES) by its dissimilar and unequal valves.

**CYTHERELLOIDEA CRAFTI Sexton, 1951**

Plate 1, Figures 3, 8.

*Cytherelloidea crafti* SEXTON, 1951, p. 813, pl. 117, figs. 7-10, (Marlbrook Marl, Arkansas); HOWE & LAURENCICH, 1958, p. 262.

*Dimensions.* Length of a complete carapace 0.65 mm; height 0.33 mm; width 0.29 mm.

*Diagnosis.* Distinguished by its thick, anteroventral, marginal rim that is somewhat removed from the anterior edge, and two large posterior nodes (in female?) from which ridges extend forward three-quarters of the length of the carapace. A short ridge extends anteriorly from the uppermost posterior node and is arched over a small subcentral pit. A second ridge starts just behind the pit, curves below it, and terminates behind the anterior rim. A third ridge starts at the lower-most posterior node and extends anteriorly, terminating behind the anterior rim.

*Remarks.* Differentiated from *Cytherelloidea greenensis* BROWN, described from the Peedee Formation of North Carolina, by its undivided uppermost ridge and lack of a prominent posterior rim. *C. crafti* is also larger than *C. greenensis.* This species may be significant as a stratigraphic indicator.

**CYTHERELLOIDEA GREENENSIS Brown, 1957**

Plate 2, Figures 1, 5.

*Cytherelloidea greenensis* BROWN, 1957, p. 9, pl. 1, figs. 22, 23, 26, 29, (Peedee Formation, North Carolina).

*Dimensions.* Length of an adult specimen 0.55 mm; height 0.34 mm; width 0.25 mm.

*Diagnosis.* Distingiushed by its similar size, and anterior and ventral marginal rim. Two large, rounded, posterior nodes are connected by a raised rim on the left valve. A ridge extends from the ventral node toward the anterior end and parallels the ventral margin. A second ridge extends from the dorsal node

and curves under the subcentral pit. A third short, curved ridge is located between the subcentral pit and the dorsal margin so that the two ridges tend to circumscribe the pit.

*Remarks.* *Cytherelloidea greenensis* resembles *C. ozanana* SEXTON in size and ornamentation of right valve. Both valves of *C. greenensis* are similarly ornamented, whereas those of *C. ozanana* are different.

## Suborder PODOCOPINA Sars, 1866

### Superfamily CYPRIDACEA Baird, 1845

[*nom. transl.* ULRICH & BASSLER, 1923]

### Family CYPRIDIDAE Baird, 1845

### Subfamily PARACYPRIDINAE Sars, 1923

### Genus PARACYPRIS Sars, 1866

*Paracypris* SARS, 1866, p. 11; BENSON & COLEMAN, 1963, p. 16.
*Type-species.* *Paracypris polita* SARS, 1866, p. 12.

#### PARACYPRIS ANGUSTA Alexander, 1929

Plate 2, Figures 17-18.

*Paracypris angusta* ALEXANDER, 1929, p. 67, pl. 4, figs. 3, 7, (Taylor Formation, Texas); ALBRITTON, 1941, p. 59, (Cretaceous of Texas); HOWE & LAURENCICH, 1958, p. 446.
*Paracypris* cf. *P. angusta* SWAIN, 1948, p. 192, pl. 12, fig. 6, (Cretaceous of Maryland).
*Dimensions.* Length of adult specimen 0.89 mm; height 0.39 mm; width 0.29 mm.

*Diagnosis.* Distinguished by its elongate, posteriorly attenuated, smooth carapace. Dorsal margin is a long low arch; ventral margin straight, except for slight sinuosity at middle; anterior margin narrow and evenly rounded; posterior end produced and acute. Left valve slightly overreaches the right dorsally. Widest medially in dorsal view, tapering posteriorly.

*Remarks.* *Paracypris angusta* is found rarely in the lower portion of the Marlbrook Marl. Differentiated from *P. goodlandensis* HOWE & LAURENCICH by its long, low, arched dorsum and attenuated posterior.

#### PARACYPRIS GOODLANDENSIS Howe & Laurencich, 1958

Plate 2, Figures 19, 21

*Paracypris siliqua* Jones & Hinde, ALEXANDER, 1929, p. 64, pl. 3, figs. 11, 13, (Goodland Formation, Texas).
*Paracypris goodlandensis* HOWE & LAURENCICH, 1958, p. 448.
*Dimensions.* Length of a complete carapace 0.88 mm; height 0.44 mm; width 0.36 mm.

*Diagnosis.* Recognized by its large, elongate carapace with the dorsal margin divided into three straight segments of nearly equal length.

*Remarks.* *Paracypris goodlandensis* is rare to common in the lower and middle portion of the Marlbrook Marl. HOWE & LAURENCICH (1958, p. 448), after examining the type specimens, concluded that the ostracode identified by Alexander (1929) as *Paracypris siliqua* JONES & HINDE is a new species, and therefore renamed it *P. goodlandensis*. *P. goodlandensis* is very similar to *P. siliqua*, but it is larger and has a different dorsal marginal outline.

### Superfamily BAIRDIACEA Sars, 1888

[*nom. transl.* SYLVESTER-BRADLEY, 1948]

### Family BAIRDIIDAE Sars, 1888

### Genus BAIRDIA M'Coy, 1844

*Bairdia* M'COY, 1844, p. 164; VAN MORKHOVEN, 1963, p. 32; BENSON & COLEMAN, 1963, p. 17.
*Type-species.* *Bairdia curta* M'COY, 1844, p. 164.

#### BAIRDIA sp.

Plate 2, Figures 7, 8, 10.

*Dimensions.* Length of adult specimen 0.68 mm; height 0.44 mm; width 0.32 mm.

*Description.* Carapace subtriangular, highest in front of middle; dorsal margin strongly arched. The anterior and posterior ends of dorsal margin are straight; ventral margin almost straight. Anterior end obliquely rounded; posterior end obtusely angulate and upturned. Left valve larger, overlapping the right valve moderately along the dorsum, and weaker ventrally. When viewed dorsally, carapace plump, widest in middle, and tapers gradually to the posterior. Surface smooth. Inside not seen.

*Remarks.* Forty specimens were found in the lower portion of the Marlbrook Marl. The described species could not be identified with any species reported from Upper Cretaceous strata and may be a new species.

### Genus BAIRDOPPILATA Coryell, Sample, & Jennings, 1935

*Bairdoppilata* CORYELL, SAMPLE, & JENNINGS, 1935, p. 43; VAN MORKHOVEN, 1958, p. 366-368; BENSON & COLEMAN, 1963, p. 20.
*Type-species.* *Bairdoppilata martyni* CORYELL, SAMPLE, & JENNINGS, 1935, p. 3, figs. 1, 2.

*Diagnosis.* Carapace has the same characteristics as *Bairdia* M'COY; hingement is adont, but with additional dental areas just below the anterior and posterior cardinal angles. *L. Cret.-Rec.*

*Remarks.* This genus is probably artificial, but for the time being it is used for convenience in recognizing a difference in some of the bairdiid species.

#### BAIRDOPPILATA PONDERA Jennings, 1936

Plate 1, Figures 10, 13-15.

*Bairdoppilata pondera* JENNINGS, 1936, p. 45, pl. 6, fig. 9, (Navesink and Mt. Laurel Formations, New Jersey); SCHMIDT, 1948, p. 408, pl. 61, figs. 21, 22, (Mt. Laurel Formation, New Jersey and Maryland); SWAIN, 1952, p. 71, pl. 8, figs. 8-12, (Black Creek Formation, North Carolina); SKINNER, 1956, p. 183, pl. 1, fig. 4, (Arkadelphia Marl, Arkansas); BUTLER & JONES, 1957, p. 14, pl. 6, figs. 6a-b, (Ozan Formation, Annona Chalk, Marlbrook Marl, Saratoga Chalk, and Arkadelphia Marl, Louisiana); BROWN, 1957, p. 10, pl. 3, figs. 4, 7, 8, (Peedee Formation, North Carolina); HOWE & LAURENCICH, 1958, p. 81.
*Dimensions.* Length of adult specimen 1.25 mm; height 0.86 mm; width 0.65 mm.

*Diagnosis.* Distinguished by its large, tumid, subtriangular carapace. Left valve overreaches right along the entire margin, particularly along dorsum and venter.

*Remarks.* Common in all parts of the Marlbrook Marl. Similar to *Bairdoppilata magna* (ALEXANDER) but smaller, with more dorsal and ventral overlap. Similar to *B. rotunda* (ALEXANDER) but smaller and has less ventral overlap and more dorsal overlap.

### Genus BYTHOCYPRIS Brady, 1880

*Bythocypris* BRADY, 1880, p. 46, pl. 5, figs. 1a-1; VAN MORKHOVEN, 1963, p. 37-39.

*Type-species. Bairdia bosquetiana* BRADY, 1866, p. 364, pl. 57, (*Syn. Bythocypris reniformis* BRADY, 1880, p. 46, pl. 5, figs. 1a-1; which are young instars of *B. bosquetiana*).

*Diagnosis.* Recognized by its thin, fragile, elongate, reniform, or ovate laterally compressed carapace, and smooth surface. Left valve overreaches the right valve dorsally and ventrally. Dorsum convex, venter concave. Marginal area broad with large anterior and posterior vestibules; numerous radial-pore canals, hinge adont. Muscle-scar pattern circular, consisting of many scars; considered cypridid by some workers. *L. Ord.-Rec.*

#### BYTHOCYPRIS WINDHAMI Butler & Jones, 1957

Plate 2, Figure 20.

*Bythocypris windhami* BUTLER & JONES, 1957, p. 12, pl. 1, (Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 103.

*Dimensions.* Length of adult carapace 0.78 mm; height 0.38 mm; width 0.29 mm.

*Diagnosis.* Distinguished by its reniform carapace, large size, strongly arched dorsum, and concave venter.

*Remarks.* Similar to *Bythocypris goodlandensis* ALEXANDER, but has a more arched dorsum and more obliquely rounded anterior and posterior margins (BUTLER & JONES, 1957, p. 12). Specimens from the Marlbrook Marl of Arkansas are smaller than those described from Louisiana. This species is rare and is only found in the lower portion of the Marlbrook.

### Superfamily CYTHERACEA Baird, 1850

[*nom. transl.* ULRICH & BASSLER, 1923]

### Family BYTHOCYTHERIDAE Sars, 1926

### Genus MONOCERATINA Roth, 1928

*Monoceratina* ROTH, 1928, p. 15; VAN MORKHOVEN, 1963, p. 426-429.

*Type-species. Monoceratina ventrale* ROTH, 1928, p. 16, figs. 1a-c.

*Diagnosis.* Recognized by its subrhomboidal carapace with dorsal caudal process, straight dorsal margin, and straight or convex ventral margin. Anterior broadly rounded, sometimes with a rim. Ornamented with alae or strong posteroventral spines; other spines and nodes may be present; surface smooth, pitted, or reticular with a distinct curved, vertical sulcus. Marginal area moderately broad; hinge adont. *Dev.-Rec.*

#### MONOCERATINA MONTUOSA (Jones & Hinde), 1890

Plate 2, Figures 12, 15, 16.

*Cythere (Cythereis) montuosa* JONES, 1875, p. 81, 82 *(nomen nudum).*

*Cytheropteron cuspidatum* var. *montuosa* JONES & HINDE, 1890, p. 38, pl. 3, figs. 14-16, (Greensand, England).

*Monoceratina montuosa* (Jones & Hinde) ALEXANDER, 1934, p. 62, pl. 8, fig. 5, (Annona and Tober Chalks, Texas); SHARAPOVA, 1937, p. 81; BONNEMA, 1941, p. 41, pl. 7, figs. 1-9; HOWE & LAURENCICH, 1958, p. 411.

*Dimensions.* Length of complete carapace 0.70 mm; height 0.36 mm; width 0.32 mm.

*Diagnosis.* Distinguished by its three, distinct, conical, dorsal nodes, and rounded, rimmed, finely nodulose anterior margin; ventral margin broadly curved. Two large spines originate along the ventrolateral surface; the anterior spine is longer and sharper than the posterior spine. A caudal process is drawn out high at the posterodorsum. Interior not seen.

*Remarks. Monoceratina montuosa* is very rare. It

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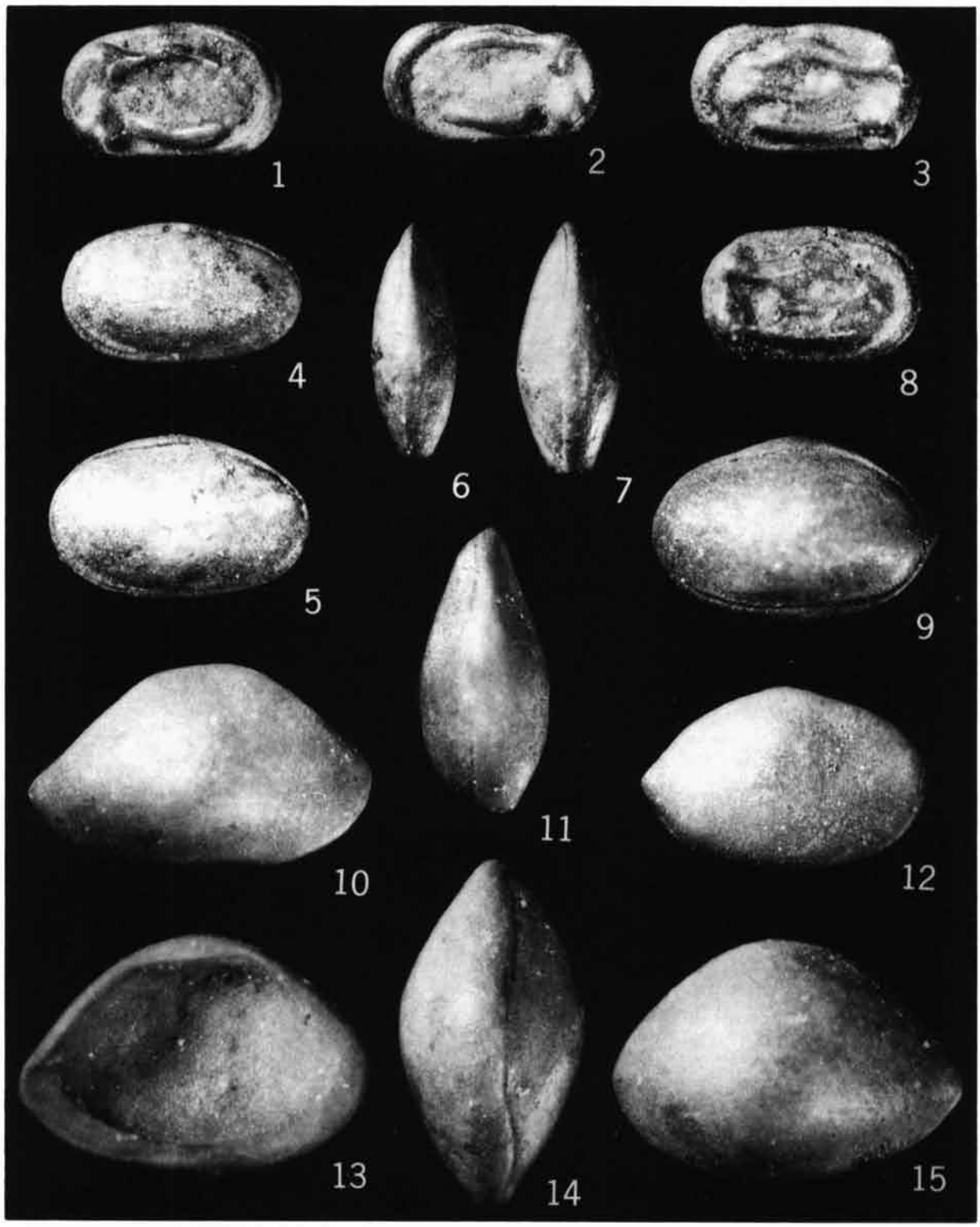
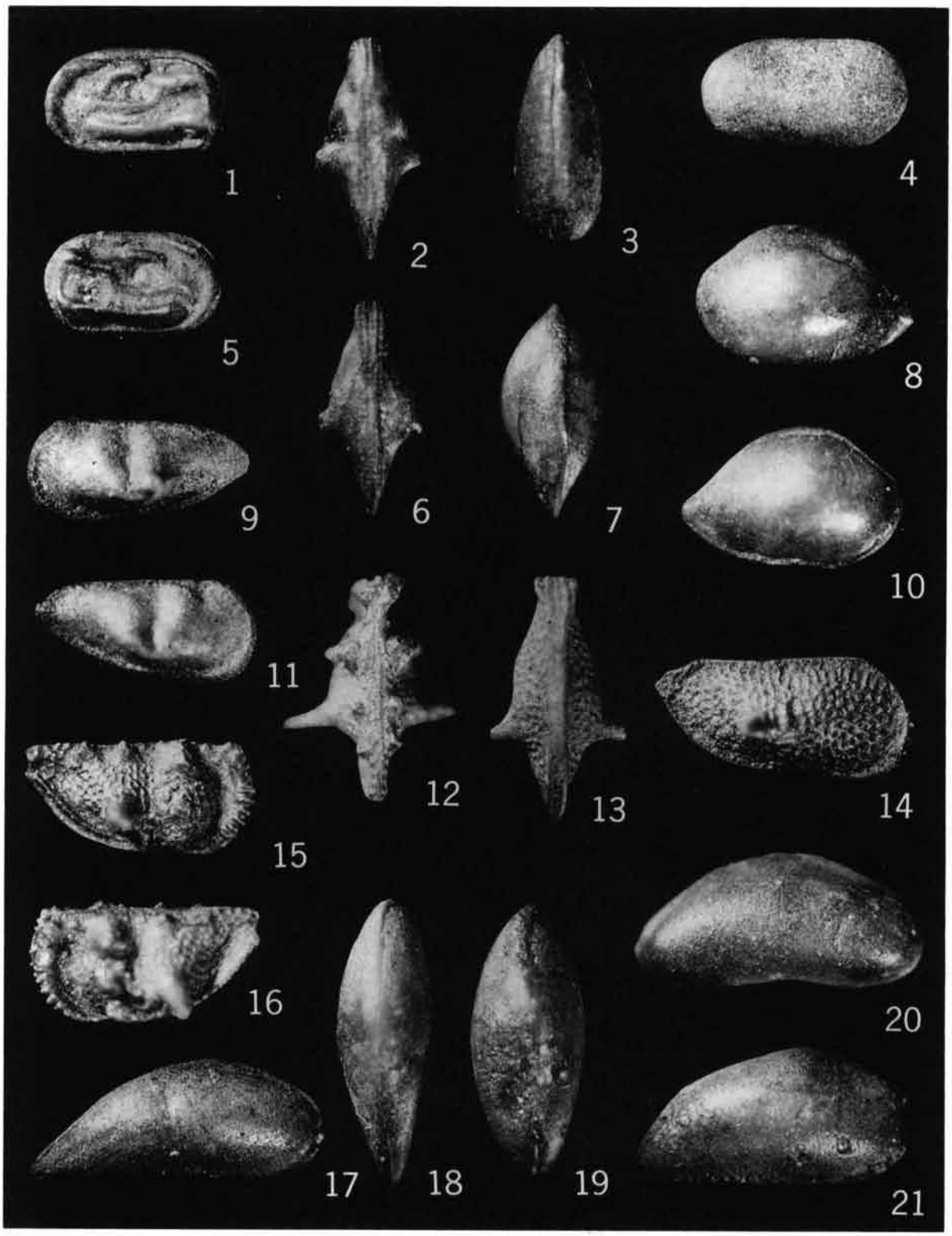
## EXPLANATION OF PLATE 1

CYTHERELLOIDEA, CYTHERELLA, BAIRDOPPILATA

(All illsutrated forms are from the Marlbrook Marl, x55 except *Bairdoppilata pondera,* x45)




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas

was found only in the lower portion of the Marlbrook Marl. Differentiated from *M. prothroensis* BUTLER & JONES by its five prominent nodes and spines. *M. prothroensis* has only one prominent lateral spine. Figured specimen is reticulate whereas the species from Europe is described as being smooth (HOWE & LAURENCICH, 1958, p. 412).

**MONOCERATINA MARSSONITINA Coryell, 1963**

Plate 2, Figures 13, 14.

*Cythere pedata* MARSSON, 1880, p. 46, pl. 3, fig. 16a; (*non Cythere pedata* GEINITZ, 1843, p. 46).

*Cytheropteron pedatum* JONES & HINDE, 1890, p. 38, pl. 4, figs. 33-35, (Cretaceous of England and Ireland).

*Cytherura spooneri* ISRAELSKY, 1929, p. 6, pl. 4A, fig. 7, (Ozan Formation and Marlbrook Marl, Arkansas).

*Monoceratina pedata* (Marsson) ALEXANDER, 1933, p. 203, pl. 27, figs. 15a,b, (Cretaceous of Texas); ALEXANDER, 1934, p. 60, (Taylor formation and Annona Chalk, Texas); BONNEMA, 1941, p. 29, pl. 6, figs. 27-30; VAN DEN BOLD, 1946, p. 116, pl. 14, fig. 8, (Cretaceous of Caribbean); SCHMIDT, 1948, p. 411, pl. 61, fig. 10, (Marshalltown Formation, Delaware); BUTLER & JONES, 1957, p. 24, pl. 4, fig. 3, (Ozan Formation, Annona Chalk, and Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 415.

*Monoceratina marssonitina* CORYELL, 1963, p. 1019, *nom. nov.*

*Dimensions.* Length of adult specimen 0.86 mm; height 0.39 mm; width 0.34 mm.

*Diagnosis.* Distinguished by its tapered posterodorsal caudal process and obliquely rounded anterior, with a prominent marginal rim on the lower two-thirds; both the margin and rim are dentate. Surface strongly reticulate; numerous short spines arising from the union of the reticulated ridges; and a strong ventrolateral spine.

*Remarks. Monoceratina marssonitina* occurs rarely throughout the entire vertical extent of the Marlbrook Marl. It is differentiated from *Monoceratina montuosa* (JONES & HINDE) by its larger size and reticular surface, which has numerous short spines arising from the union of the reticulated ridges. *M. montuosa* is also reticulate but lacks these short spines; it also has five prominent nodes on each valve.

**MONOCERATINA PROTHROENSIS Butler & Jones, 1957**

Plate 2, Figures 2, 6, 9, 11.

*Monoceratina prothroensis* BUTLER & JONES, 1957, p. 22, pl. 4, figs. 1a-d, (Annona Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 417.

*Dimensions.* Length of complete carapace 0.68 mm; height 0.32 mm; width 0.32 mm.

Diagnosis. Recognized by its very elongate carapace, a well defined sulcus that extends from the dorsal margin to the tip of the ventrolateral ala, and a "smooth surface ornamented with longitudinal rows of beadlike spines" (BUTLER & JONES, 1957, p. 22).

*Remarks. Monoceratina prothroensis* is very rare and is found only in the lower portion of the Marlbrook Marl. It is differentiated from *M. marssonitina* (CORYELL) and *M. montuosa* (JONES & HINDE) by its smooth surface, which is ornamented with longitudinal rows of beadlike spines.

## Family CYTHERIDEIDAE Sars, 1925

## Subfamily CYTHERIDEINAE Sars, 1925

## Genus HAPLOCYTHERIDEA Stephenson, 1936

*Cytheridea* BOSQUET (part), 1852, p. 37.

*Cytheridea (Haplocytheridea)* STEPHENSON, 1936, p. 700.

*Cytheridea (Leptocytheridea)* STEPHENSON, 1937, p. 156.

*Cytheridea (Phractocytheridea)* SUTTON & WILLIAMS, 1939, p. 571.

*Haplocytheridea* STEPHENSON, 1944, p. 159; BENSON & COLEMAN, 1963, p. 27.

*Type-species. Cytheridea montgomeryensis* HOWE & CHAMBERS, 1935, p. 17, pl. 1, fig. 1; pl. 2, figs. 1-3, 7, 9; pl. 6, figs. 17, 18.

**HAPLOCYTHERIDEA? BRUCECLARKI (Israelsky), 1929**

Plate 3, Figures 3, 8, 12, 14.

*Cythere bruceclarki* ISRAELSKY, 1929, p. 11, pl. 2A, figs. 5, 6, (Marlbrook Marl, Arkansas); ISRAELSKY, 1935, p. 481, pl. 2A, figs. 5, 6, (Marlbrook Marl, Arkansas).

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## EXPLANATION OF PLATE 2

CYTHERELLOIDEA, CYTHERELLA, MONOCERATINA, BAIRDIA, PARACYPRIS, BYTHOCYPRIS

(All illustrated forms are from the Marlbrook Marl, x50)

FIGURE — PAGE

*1, 5—Cytherelloidea greenensis* BROWN; *1,* exterior lateral view of left valve; *5,* exterior lateral view of right valve. ..... 12

*3-4—Cytherella scotti* ALEXANDER; *3,* dorsal view; *4,* exterior lateral view of left valve. ..... 11

*2, 6, 9, 11—Monoceratina prothroensis* BUTLER & JONES; *2,* dorsal view; *6,* ventral view; *9,* exterior lateral view of left valve; *11,* exterior lateral view of right valve. ..... 15

*7, 8, 10—Bairdia* sp.; *7,* dorsal view; *8,* exterior lateral view of left valve; *10,* exterior lateral view of right valve. ..... 13

*12, 15, 16—Monoceratina montuosa* (JONES & HINDE); *12,* dorsal view; *15,* exterior lateral view of right valve; *16,* exterior lateral view of left valve. .... 14

*13, 14—Monoceratina marssonitina* CORYELL; *13,* dorsal view; *14,* exterior lateral view of right valve. ..... 15

*17, 18—Paracypris angusta* ALEXANDER; *17,* exterior lateral view of right valve; *18,* dorsal view. .... 13

*19, 21—Paracypris goodlandensis* HOWE & LAURENCICH; *19,* dorsal view; *21,* exterior lateral view of right valve. ..... 13

*20—Bythocypris windhami* BUTLER & JONES; exterior lateral view of right valve. ..... 14

*Haplocytheridea? bruceclarki* (Israelsky) HOWE & LAURENCICH, 1958, p. 349-350.
*?Cytheridea punctilifera* JENNINGS, 1936, p. 59, pl. 7, fig. 11, (Mt. Laurel and Navesink Formations, New Jersey).
*?Cytheridea sepulchra* JENNINGS, 1936, p. 59, pl. 7, fig. 12, (Mt. Laurel and Navesink Formations, New Jersey).

*Dimensions.* Length of adult male 0.52 mm; height 0.31 mm; width 0.31 mm. Length of adult female 0.43 mm; height 0.18 mm; width 0.23 mm.

*Diagnosis.* Distinguished by its very small, uniformly and coarsely pitted carapace. The pits near the middle tend to be arranged in vertical rows; accommodation groove in left valve.

*Remarks.* Common in all portions of the Marlbrook Marl. Similar to *Haplocytheridea grangerensis* HOWE & LAURENCICH (1958, p. 349) but is smaller and more coarsely pitted. Like *H.? plummeri,* this species has an accommodation groove in the left valve, which is not characteristic of the genus *Haplocytheridea.*

### HAPLOCYTHERIDEA COUNCILLI Brown, 1957

Plate 3, Figures 18-19.

*Cytheridea (Haplocytheridea) councilli* BROWN, 1957, p. 17, pl. 2, figs. 12-16, (Peedee Formation, North Carolina).

*Dimensions.* Length of complete carapace 0.69 mm; height 0.36 mm; width 0.30 mm.

*Diagnosis.* Distinguished by its coarsely pitted surface and subtly rimmed anterior margin.

*Remarks.* Occurs rarely in the Marlbrook Marl. Differentiated from *Haplocytheridea macropora* (ALEXANDER) by its anterior rim and rounded posterior.

### HAPLOCYTHERIDEA? FABAFORMIS (Berry), 1925

Plate 3, Figure 13.

*Cytherella fabaformis* BERRY, 1925, p. 487, fig. 13, (Monmouth Formation, New Jersey).
*Cytheridea fabaformis* (Berry) ALEXANDER, 1929, p. 76, pl. 5, fig. 18, (Navarro Formation, Texas); ALEXANDER, 1934, p. 224, (Navarro Formation, Texas).
*Cytheridea (Haplocytheridea) fabaformis* (Berry) BROWN, 1957, p. 17, figs. 7, 8 (Peedee Formation, North Carolina).
*Haplocytheridea? fabaformis* (Berry) SCHMIDT, 1948, p. 426, pl. 62, fig. 23, (Monmouth Formation, New Jersey); HOWE & LAURENCICH, 1958, p. 350.

*Dimensions.* Length of complete carapace 0.62 mm; height 0.34 mm.

*Diagnosis.* Distinguished by its two or three parallel vertical or oblique furrows, each bearing a row of pits in the mid-dorsolateral region. A prominent longitudinal furrow extends along the posterior one-third of the valve slightly below the median line (after ALEXANDER, 1929, p. 76).

*Remarks. Haplocytheridea fabaformis* was found occasionally only in the upper portion of the Marlbrook Marl. The surface ornamentation is distinctive and differentiates this species from other members of the genus. As suggested by others, it may not belong to *Haplocytheridea.*

### HAPLOCYTHERIDEA MONMOUTHENSIS (Berry), 1925

Plate 6, Figures 17, 21, 23.

*Cytheridea monmouthensis* BERRY, 1925, p. 486, (Monmouth Formation, Maryland); ALEXANDER, 1929, p. 74, pl. 5, figs. 11-14, (Navarro Formation, Texas).
*Cytheridea (Haplocytheridea)* cf. *C. monmouthensis* (Berry) SWAIN, 1948, p. 212, pl. 14, fig. 14.
*Haplocytheridea? monmouthensis* (Berry) SWAIN, 1952, p. 79, pl. 8, fig. 19, (Black Creek Formation, North Carolina).
*Haplocytheridea plummeri* (Alexander) SKINNER, 1956, p. 196, pl. 4, figs. 2a-d, (Arkadelphia Marl, Arkansas).
*Haplocytheridea monmouthensis* (Berry) HOWE & LAURENCICH, 1958, p. 355.

*Dimensions.* Length of complete carapace 0.71 mm; height 0.43 mm; width 0.31 mm.

*Diagnosis.* Distinguished by vertical rows of pits near the middle of the carapace and a flangelike spine located at the posteroventral angle of the right valve.

*Remarks.* The flangelike spine (see Pl. 6, Fig. 21) on the posteroventral portion of the right valve is unique and differentiates *H. monmouthensis* from other members of the genus. In some specimens the vertical pitting is faint.

### HAPLOCYTHERIDEA? PLUMMERI (Alexander), 1929

Plate 3, Figures 22-27.

*Cytheridea plummeri* ALEXANDER, 1929, p. 73, pl. 5, figs. 5-8, (Taylor Formation, Texas); ALEXANDER & ALEXANDER, 1933, p. 280, figs. 1a,b, 4a,b; ALEXANDER, 1939, p. 66, (Brownstown Formation, Arkansas).
*Haplocytheridea plummeri* (Alexander) SCHMIDT, 1948, p. 425, pl. 62, figs. 27-29, text-fig. 2f, (Mt. Laurel Sand and Monmouth Formation, Maryland); BUTLER & JONES, 1956, p. 198, pl. 4, fig. 9, (Ozan Formation, Annona Chalk, Marlbrook Marl, Nacatoch Sand, and Arkadelphia Marl, Louisiana).
*non Haplocytheridea?* sp. aff *H.? plummeri* (Alexander) SWAIN, 1952, p. 79, pl. 8, fig 15.
*non Cytheridea plummeri* Alexander SKINNER, 1956, p. 198, pl. 4, figs. 2a-d.
*Haplocytheridea? plummeri* (Alexander) HOWE & LAURENCICH, 1958, p. 356.

*Dimensions.* Length of adult male carapace 0.72 mm; height 0.47 mm; width 0.34 mm. Length of adult female 0.72 mm; height 0.48 mm; width 0.37 mm.

*Diagnosis.* Distinguished by its large, attenuated, coarsely punctate carapace bearing three or four vertical, pitted, median furrows. Posterior somewhat beaklike in appearance. Accommodation groove above hinge of left valve.

*Remarks.* Common in all portions of the Marlbrook Marl. From exterior this species closely resembles *Cytheridea insolita* (ALEXANDER & ALEXANDER), but the right valve is larger than the left valve. Differentiated from *Haplocytheridea? globosa* (ALEXANDER) by its three or four pitted furrows. *Haplocytheridea rayburnensis* BUTLER & JONES is similar to *H. plummeri,* but is smaller and has more randomly spaced punctae. Because this form has an accommodation groove above the median hinge element of the left valve, its assignment to *Haplocytheridea* is questioned.

### Subfamily NEOCYTHERIDEIDINAE Puri, 1957

### Genus KRITHE Brady, Crosskey, & Robertson, 1874

*Krithe* BRADY, CROSSKEY, & ROBERTSON, 1874, p. 183; BENSON, 1965, p. 00.
*Type-species. Ilyobates praetexta* SARS, 1866, p. 60.

#### KRITHE SWAINI Benson & Tatro, n.sp.

Plate 4, Figures 16, 18-20.

*Krithe cf. K. postprojecta* Schmidt, SWAIN, 1952, p. 87, pl. 9, fig. 11, (Peedee Formation, North Carolina).

*Dimensions.* Length of complete carapace 0.57 mm; height 0.31 mm; width 0.23 mm.

*Material.* Abundant, more than 100 valves examined.

*Description.* Carapace oblong, highest in middle. Dorsal margin rather strongly arched, ventral margin nearly straight. Anterior end broadly rounded and posterior end obliquely truncate. Two large pits, one in each valve, are located in the truncate posterior. When viewed dorsally, greatest thickness behind middle. Surface smooth. Interior not seen; all specimens were cemented together.

*Remarks.* SWAIN (1952) found this species in the Peedee Formation of North Carolina. He says that his specimens are close to *Krithe postprojecta* SCHMIDT. The posterior pits are not mentioned by SCHMIDT (1948); therefore this is probably a new species and will be treated as such.

### Family LOXOCONCHIDAE Sars, 1926

### Genus LOXOCONCHA Sars, 1866

*Loxoconcha* SARS, 1866, p. 61; BENSON & COLEMAN, 1963, p. 36.
*Type-species. Cythere rhomboidea* FISCHER, 1855, (=*Cythere impressa* BAIRD, 1850; =*Loxoconcha bairdi* MÜLLER, 1894).

#### LOXOCONCHA FLETCHERI Israelsky, 1929

Plate 3, Figures 1, 2, 4.

*Loxoconcha fletcheri* ISRAELSKY, 1929, p. 11, pl. 2A, fig. 2 , (not fig. 3), (Saratoga Chalk, Arkansas); HOWE & LAURENCICH, 1958, p. 384.

*Dimensions.* Length of carapace 0.41 mm; height 0.25 mm; width 0.17 mm.

*Diagnosis.* Distinguished by its subparallel margins, thickly rimmed and obliquely rounded anterior end, and slight vertical sulcus. Surface reticular; reticulations are elongated parallel to the margins. Interior not seen.

*Remarks. Loxoconcha fletcheri* is rare in the Marlbrook Marl. *Loxoconcha cretacea* ALEXANDER is similar but has prominent longitudinal ridges in addition to reticulations.

#### LOXOCONCHA? sp. cf. L. SERAPHAE Brown, 1957

Plate 3, Figures 7, 11, 20.

*Loxoconcha seraphae* BROWN, 1957, p. 23, pl. 6, figs. 9-11, (Peedee Formation, North Carolina).

*Dimensions.* Length of complete carapace 0.56 mm; height 0.29 mm; width 0.21 mm.

*Diagnosis.* Distinguished by its subelliptical shape, gently convex ventral margin, and strong posteroventral keel. The posterodorsum is drawn out. Surface strongly reticulate and punctate, with anteroventral to posterodorsal trending ridges.

*Remarks. Loxoconcha?* sp. cf. *L. seraphae* was found rarely in the uppor portion of the Marlbrook Marl. The posterodorsum is somewhat drawn out like *Cytheretta.* All valves were intact so that the inside could not be seen. The identification was tentatively made on the external features, which are like those of *Loxoconcha seraphae.* Distinguished from *Loxoconcha cretacea* ALEXANDER by its subelliptical shape and gently convex ventral margin. Differentiated from *L. fletcheri* by its larger size and posteroventral keel (Figures 7 and 11 of Plate 3 do not show this keel well).

### Family XESTOLEBERIDIDAE Sars, 1928

### Genus XESTOLEBERIS Sars, 1866

*Xestoleberis* SARS, 1866, p. 66; VAN MORKHOVEN, 1963, p. 440-443.
*Type-species. Cythere auriantia* BAIRD, 1838, p. 143, pl. 5, fig. 26.

*Diagnosis.* Recognized by its ovate, smooth, polished carapace. Anterior end narrowly and obliquely rounded; posterior variable. Left valve larger than right valve, overreaching it in the area of the ventral sinuation. Large anterior vestibule; radial-pore canals short and widely spaced to fluted, longer and variously arranged. Hinge merodont. Characteristic crescentic spot is located in the eye region. Muscle-scar pattern variable (see VAN MORKHOVEN, 1963, p. 442). Sexually dimorphous. *Cret.-Rec.*

#### XESTOLEBERIS OPINA Schmidt, 1948

Plate 3, Figures 9, 10, 15, 16.

*Xestoleberis opina* SCHMIDT, 1948, p. 410, pl. 61, figs. 15, 16, text-fig. 2b, (Marshalltown and Mt. Laurel Formations, Delaware); HOWE & LAURENCICH, 1958, p. 517.
*Xestoleberis* cf. *X. opina* BUTLER & JONES, 1957, p. 47, pl. 6, figs. 3a,b, (Ozan Formation, Annona Chalk, Marlbrook Marl, and Saratoga Chalk, Louisiana).

*Dimensions.* Length of carapace of female 0.46 mm; height 0.31 mm; width 0.27 mm. Length of carapace of male 0.48 mm; height 0.26 mm; width 0.27 mm.

*Diagnosis.* Distinguished by its small, inflated subtriangular, smooth carapace. Right valve subtriangular; left valve ovate. Ovate when viewed dorsally.

*Remarks.* Common in all parts of the Marlbrook Marl. Similar to the Recent form *Xestoleberis aurantia* (BAIRD) in dorsal and lateral views. This species is almost impossible to diagnose or evaluate from the external shape. Most of the specimens were joined, cemented valves. Its usefulness stratigraphically is questionable. However, as *Xestoleberis* has a rather restricted ecologic range, it may prove useful for future interpretation of environment.

### Family BRACHYCYTHERIDAE Puri, 1954

### Genus BRACHYCYTHERE Alexander, 1933

*Brachycythere* ALEXANDER, 1933, p. 204; VAN MORKHOVEN, 1963, p. 212-215.

*Type-species. Cythere sphenoides* REUSS, 1854, p. 141, pl. 27, fig. 2a-c.

*Diagnosis.* Distinguished by its subtriangular to subovate, heavy, smooth to punctate, usually alate or ventrolaterally swollen carapace. Anterior margin broadly and obliquely rounded; posterior more narrowly rounded to subacute. Eye spot distinct. Hinge hemiamphidont with accommodation groove in left valve. Marginal area broad with a welded duplicature and numerous long radial-pore canals. The muscle-scar pattern consists of a vertical row of four adductor scars with two anterior scars. *U. Cret.-Rec.*

#### BRACHYCYTHERE LEDAFORMA (Israelsky), 1929

Plate 5, Figures 7-9; Text-Figure 5.

*Cytheropteron ledaforma* ISRAELSKY, 1929, p. 8, pl. 1A, figs. 5-7, (Saratoga Chalk, Nacatoch Sand, and Arkadelphia Marl, Arkansas).

*Cythere acutocaudata* ALEXANDER, 1929, p. 87, pl. 7, figs. 5-6, (Navarro Formation, Texas).

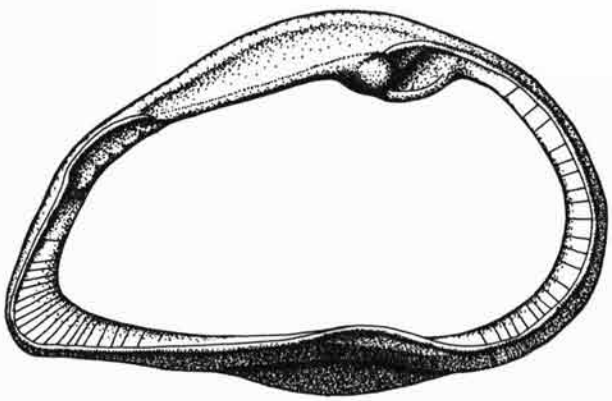
*Brachycythere ledaforma* (Israelsky), ALEXANDER, 1933, p. 206, pl. 25, fig. 20; JENNINGS, 1936, p. 49, pl. 6, fig. 15, (Mt. Laurel and Navesink Formations, New Jersey); CALAHAN, 1936, p. 41, pl. 3, fig. 2; VAN DEN BOLD, 1950, p. 108, (upper Cretaceous, Cuba); SKINNER, 1956, p. 187, pl. 2, figs. 2a-d, (Arkadelphia Marl, Arkansas); BUTLER & JONES, 1957, p. 26, pl. 3, fig. 3, (Marlbrook Marl and Saratoga Chalk, Louisiana); BROWN, 1957, p. 12, pl. 4, fig. 6, (Peedee and Black Creek Formations, North Carolina); HOWE & LAURENCICH, 1958, p. 87.

*Dimensions.* Length of adult specimen 0.67 mm; height 0.40 mm; width 0.42 mm.

*Diagnosis.* Recognized by its small, strongly inflated carapace, broad, flat venter, and punctate ventrolateral surface. Posterior end compressed and produced with acute posteroventral angle. A well defined furrow separates the compressed anterior from the strongly inflated and keeled mid-section.

*Description of Interior.* As seen in Fig. 5 marginal area narrow in anterior end, broad in attenuated, knife-edged posteroventer; ventral sinuation broad, centered adjacent to pouched ventrolateral inflation. Ventral ridges not evident in interior. Radial-pore canals simple, straight, moderately spaced. Flange very high in left valve forming accommodation groove over hemiamphidont hinge with elongate crenulate posterior socket and tooth (in right valve). Muscle-scar pattern as yet unknown.

*Remarks. Brachycythere ledaforma* is fairly common in all parts of the Marlbrook Marl. The very



TEXT-FIG. 5. *Brachycythere ledaforma* (ISRAELSKY), 1929. Interior view of left valve of adult showing the hemiamphidont hinge and shallow accommodation groove (×120).

## EXPLANATION OF PLATE 3

CYTHEROPTERON, HAPLOCYTHERIDEA, LOXOCONCHA, XESTOLEBERIS

(All illustrated forms are from the Marlbrook Marl, x50)

FIGURE — PAGE

*1, 2, 4—Loxoconcha fletcheri* ISRAELSKY; *1,* exterior lateral view of right valve; *2,* exterior lateral view of left valve; *4,* dorsal view. ..... 17

*3, 8, 12, 14—Haplocytheridea? bruceclarki* (ISRAELSKY); *3,* exterior lateral view of right valve of female; *8,* exterior lateral view of left valve of female; *12,* exterior lateral view of right valve of male; *14,* exterior lateral view of right valve of male. ..... 15

*5-6—Cytheropteron harrisi* SKINNER; *5,* dorsal view; *6,* exterior lateral view of left valve. .... ..... 26

*9, 10, 15, 16—Xestoleberis opina* SCHMIDT; *9,* dorsal view of female; *10,* exterior lateral view of right valve of female; *15,* dorsal view of male; *16,* exterior lateral view of right valve of male. .... 17

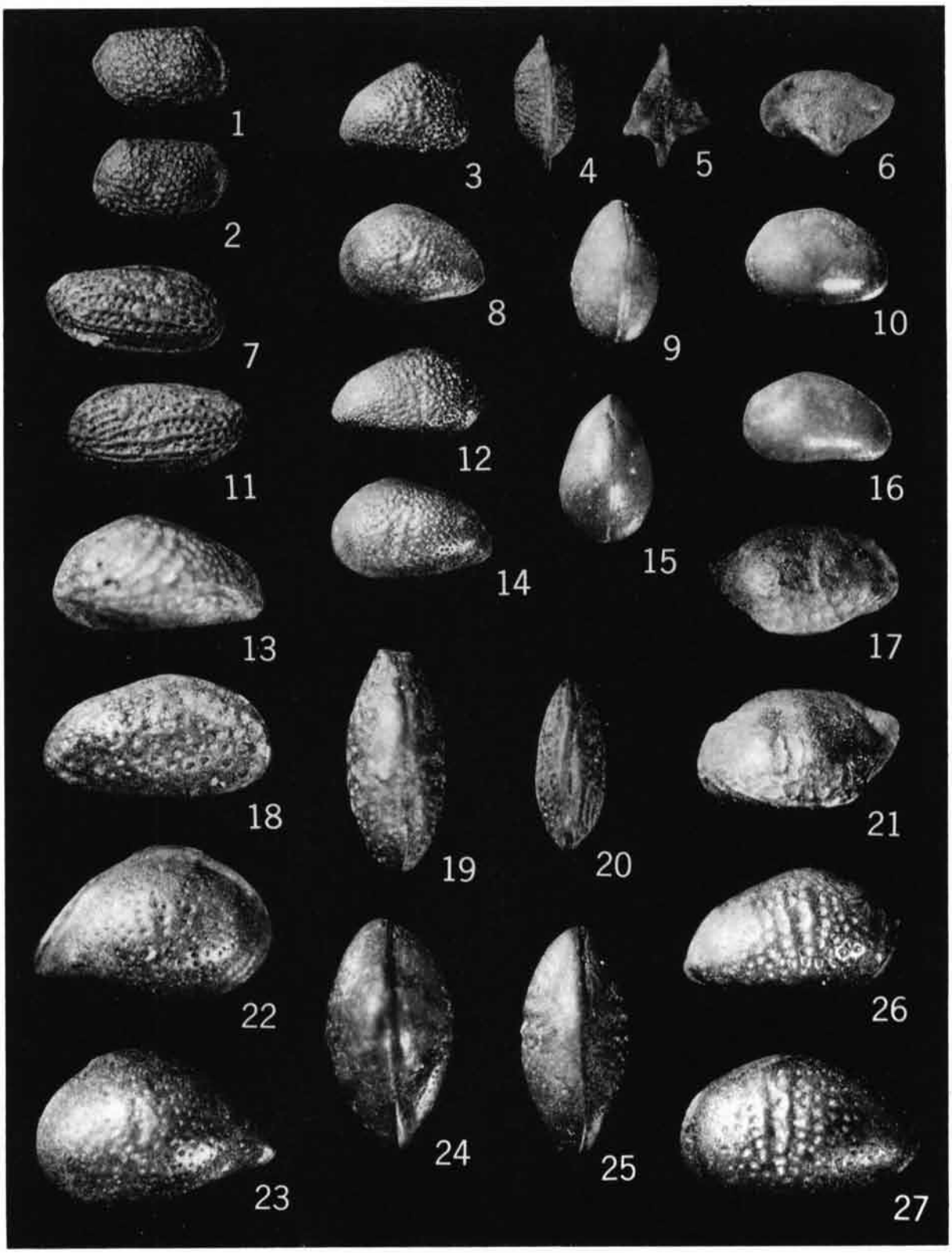
*7, 11, 20—Loxoconcha?* sp. cf. *L. seraphae* BROWN; *7,* exterior lateral view of right valve; *11,* exterior lateral view of left valve; *20,* dorsal view. ..... 17

*13—Haplocytheridea? fabaformis* (BERRY); exterior lateral view of left valve. ..... 16

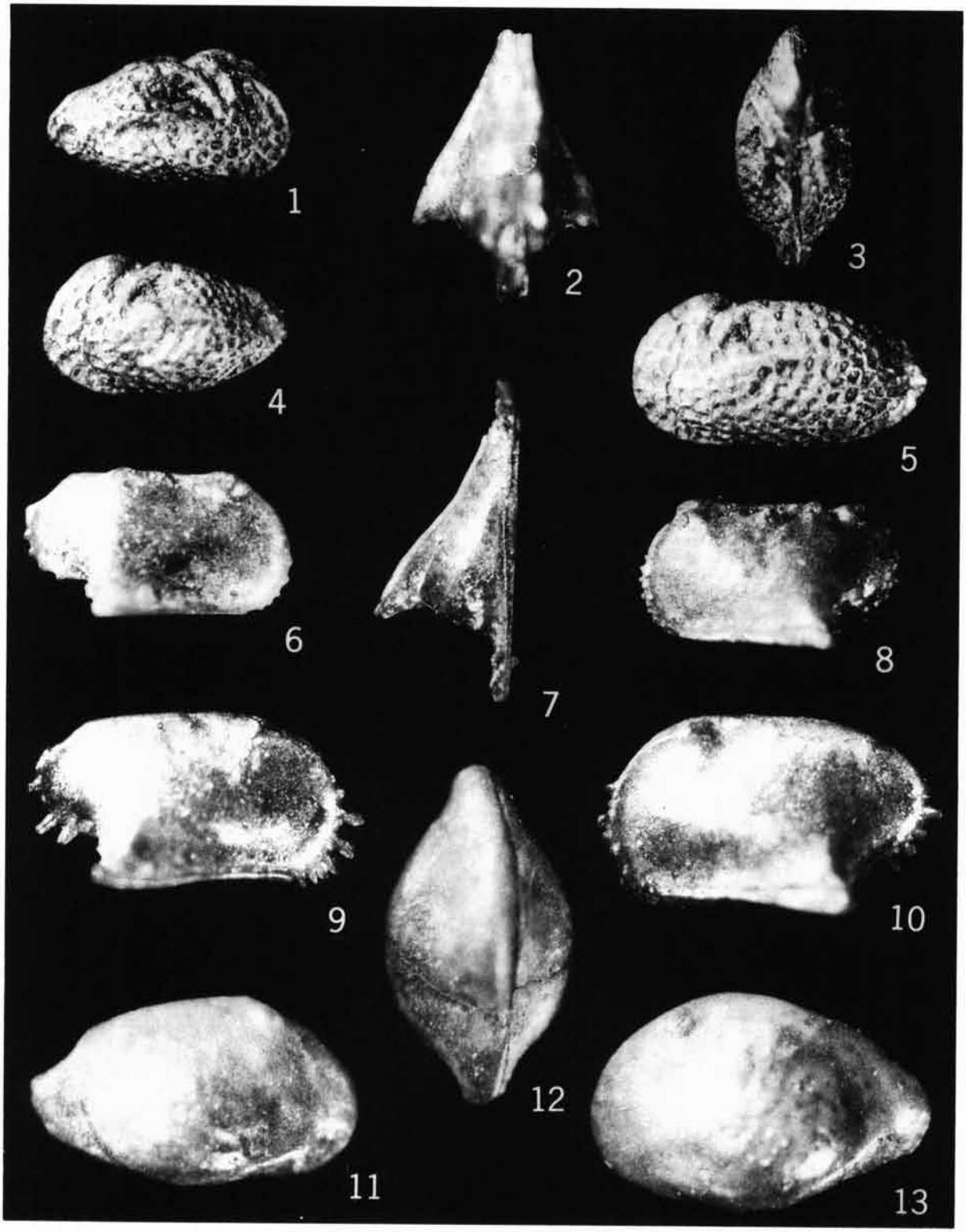
*18-19—Haplocytheridea councilli* BROWN; *18,* exterior lateral view of right valve; *19,* dorsal view. ..... 16

*17, 21—Cytheropteron castorensis* BUTLER & JONES; *17,* exterior lateral view of right valve; *21,* exterior lateral view of left valve. ..... 26

*22-27—Haplocytheridea? plummeri* (ALEXANDER); *22,* exterior lateral view of right valve of female; *23,* exterior lateral view of left valve of female; *24,* dorsal view of female; *25,* dorsal view of male; *26,* exterior lateral view of right valve of male; *27,* exterior lateral view of left valve of male. ..... 16




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas

tumid carapace with a compressed and produced, acute posteroventral angle and a compressed anterior is very distinctive and is easily distinguished from other species of this genus.

**BRACHYCYTHERE OVATA (Berry), 1925**

Plate 4, Figures 11-13; Text-Figure 6.

*Cythereis ovatus* BERRY, 1925, p. 484, fig. 15, (Monmouth Formation, New Jersey).

*Cytheropteron* sp. A, ISRAELSKY, 1929, p. 7, pl. 1A, figs. 1a-c, (Tokio Formation, Ozan Formation, Annona Chalk, Saratoga Chalk, Nacatoch Sand, and Arkadelphia Marl, Arkansas).

*Cythere ovata* (Berry), ALEXANDER, 1929, p. 87, pl. 7, figs. 10, 13, (Navarro Formation, Texas).

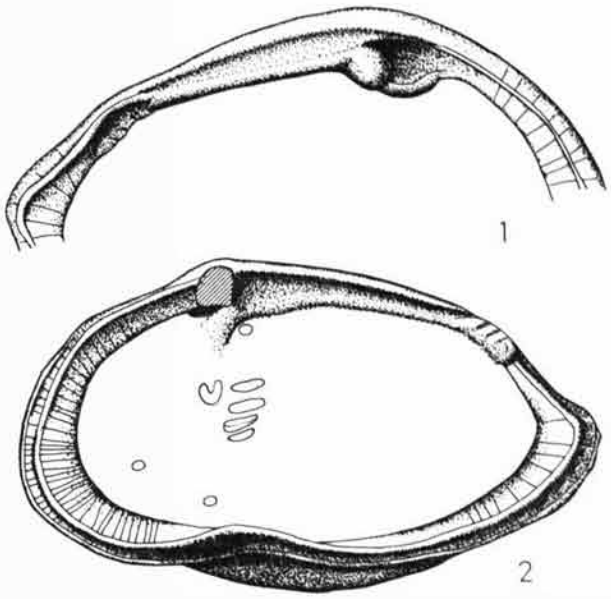
*Brachycythere ovata* (Berry), SCOTT, 1934, p. 1153; JENNINGS, 1936, p. 48, 50, pl. 6, figs. 16a-b, (Navesink Formation, New Jersey); VAN DEN BOLD, 1946, p. 108, pl. 13, figs. 9a-d; SKINNER, 1956, p. 190, pl. 2, figs. 3a-c, (Arkadelphia Marl, Arkansas); HOWE & LAURENCICH, 1958, p. 89.

*Dimensions.* Length of complete carapace 1.06 mm; height 0.65 mm; width 0.57 mm.

*Diagnosis.* Recognized by its large, subtriangular to ovate, smooth carapace with subdued alae that merges with the general swelling of the valves. Posterodorsal margin angles in right valve, venter flat. Valves strongly tumid when viewed dorsally.

*Description of Interior.* As seen in Text-Fig. 6, marginal area moderately wide; pronounced broad ventral sinuation near flare in ventrolateral ridge; selvage well developed as shelf overlooking narrow flange; straight, simple radial-pore canals closely spaced in anterior, spread apart in posterior. Flange continuous over hinge in left valve forming groove to receive dorsal ridge (homologous with selvage or flange) of right valve. Hinge hemiamphidont with crenulate posterior tooth. Muscle-scar pattern consists of four elongate adductor scars in vertical row with a deep heart-shaped antennal scar. Several other scars were noted whose function or homology could not be identified.

*Remarks.* Rare to common in all parts of the Marlbrook Marl. Similar to *Brachycythere sphenoides* (REUSS) but differentiated by its larger size and lack of a strongly developed alation or ventrolateral keel.




TEXT-FIG. 6. *Brachycythere ovata* (BERRY), 1925.—*1.* Interior view of partial left valve of adult showing the hinge with accommodation groove.—*2.* Interior view of right valve of adult showing the marginal features (anterior element of hinge was broken in specimen), including a hemiamphidont hinge, and muscle-scar pattern (×75).

**BRACHYCYTHERE RHOMBOIDALIS (Berry), 1925**

Plate 5, Figures 16-18; Text-Figure 7.

*Cythere rhomboidalis* BERRY, 1925, p. 481, figs. 1, 2, (Monmouth Formation, Maryland); ALEXANDER, 1929, p. 86, pl. 7, figs. 1, 2, (Navarro Formation, Texas).

*Brachythere jerseyensis* JENNINGS, 1936, p. 48, pl. 6, figs. 14a,b, (*fide* SCHMIDT, 1948) (Navesink Formation, New Jersey).

*Brachycythere rhomboidalis* (Berry) ALEXANDER, 1933, p. 206; SCHMIDT, p. 414, pl. 62, figs. 8-10, (Monmouth Formation, Maryland, Delaware, and Virginia); BUTLER & JONES, 1957, p. 28, pl. 3, figs. 2a-b, (Marlbrook Marl, Saratoga Chalk, Nacatoch Sand, and Arkadelphia Marl, Louisiana); BROWN, 1957, p. 11, pl. 4, figs. 8-10, (Peedee Formation, North Carolina); HOWE & LAURENCICH, 1958, p. 90.

*Dimensions.* Length of adult specimen 0.84 mm; height 0.53 mm; width 0.44 mm.

*Diagnosis.* Distinguished by its intermediate size, subtriangular outline, punctate surface, and constrict-

## EXPLANATION OF PLATE 4

ALATACYTHERE, BRACHYCYTHERE, PTERYGOCYTHERE, VEENIA

(All illustrated forms are from the Marlbrook Marl, x55)

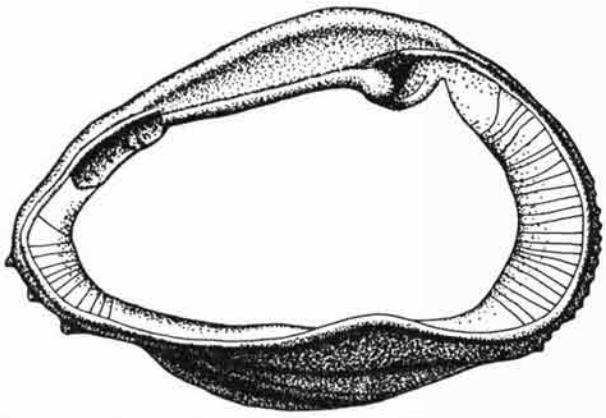
FIGURE — PAGE

*1,3-5—Veenia arachoides* (BERRY); *1,* exterior lateral view of right valve of female; *3,* dorsal view of female; *4,* exterior lateral view of left valve of female; *5,* exterior lateral view of left valve of male. ..... 24

*2,6,8—Alatacythere ponderosana* (ISRAELSKY); *2,* dorsal view; *6,* exterior lateral view of right valve; *8,* exterior lateral view of left valve. .... 21

*7,9,10—Pterygocythere saratogana* (ISRAELSKY); *7,* ventral view; *9,* exterior lateral view of right valve; *10,* exterior lateral view of left valve. .... 20

*11-13—Brachycythere ovata* (BERRY); *11,* exterior lateral view of right valve; *12,* dorsal view; *13,* exterior lateral view of left valve. ..... 19



TEXT-FIG. 7. *Brachycythere rhomboidalis* (BERRY), 1925. Interior view of left valve showing marginal features, including the hemiamphidont hinge and highly arched dorsum forming an accommodation groove (×95).

ed ventral keel. Flattened venter not as broad as some other species. Anterior compressed and broadly rounded; posterior compressed and denticulate. Left valve more rounded than right and overlaps it strongly dorsally.

*Description of Interior.* As seen in Text-Fig. 7, marginal area broad, especially in anterior with pronounced selvage; radial-pore canals straight, numerous in anterior and extreme posterior, becoming curved dorsally. Ventral sinuation abrupt. Flange very high over hemiamphidont hinge in left valve forming broad accommodation groove. Posterior hinge tooth particularly long and crenulate.

*Remarks.* Similar to *Brachycythere pietschkeri* SKINNER but highest anteriorly instead of in the middle. Distingiushed from *Brachycythere ovata* (BERRY) by its subtriangular lateral outline. *Brachycythere foraminosa* ALEXANDER closely resembles *B. rhomboidalis* and was reported by ALEXANDER (1934, p. 218) from the Eocene. He suggests that *B. foraminosa* is a descendant of *B. rhomboidalis* and states that *B. foraminosa* is distinguished by its smaller size, more strongly pitted valve surfaces, a straight, instead of gently convex ventral margin, and is distinctly higher in proportion to its length.

### Genus PTERYGOCYTHERE Hill, 1954

*Pterygocythere* HILL, 1954, p. 819.
*Type-species. Cypridina alata* BOSQUET, 1847, p. 19, pl. 4, figs. 1a-d.

*Diagnosis.* Recognized by its large, elongate-ovate to subtriangular, smooth carapace with well-developed ventrolateral alae. Internal features include a hemiamphidont hinge with an accommodation groove like *Brachycythere*. *U. Cret.-Eoc.*

*Remarks.* There may be some question about the validity of this genus as with *Alatacythere* (see *Remarks* under that genus). The significance of the accommodation groove and its relationship to the growth in alar structure is not yet known. Much study of the brachycytherids is still required before these taxa can be evaluated.

#### PTERYGOCYTHERE SARATOGANA (Israelsky), 1929

Plate 4, Figures 7, 9, 10; Text-Figure 8.

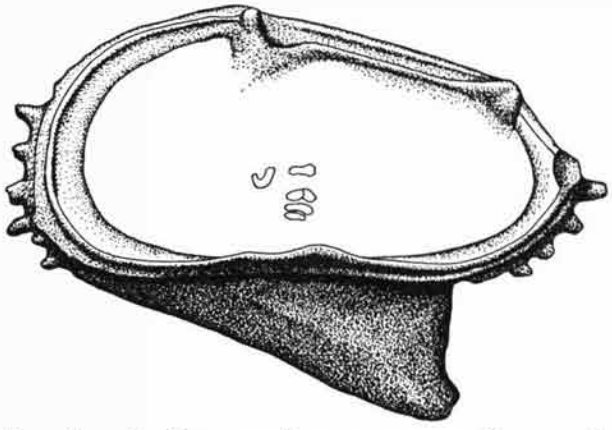
*Cytheropteron saratogana* ISRAELSKY, 1929, p. 10, pl. 2A, figs. 4a-c, (Saratoga Chalk, Arkansas).
*Cythere cornuta gulfensis* ALEXANDER, 1929, p. 85, pl. 8, figs. 1, 2, 6, (Austin Chalk and Navarro Formation, Texas).
*Brachycythere alata* ALEXANDER, 1933, p. 207, pl. 25, figs. 15a-b; pl. 27, fig. 18; JENNINGS, 1936, p. 46, pl. 6, figs. 11a-b, (Hornerstown and Navesink Formations, New Jersey).
*Pterygocythere gulfensis* HILL, 1954, p. 822, pl. 98, figs. 8a-b; pl. 100, figs. 6a-c.
*Pterygocythere saratogana* (Israelsky), BUTLER & JONES, 1957, p. 32, pl. 2, figs. 2a-b, (Ozan Formation, Annona Chalk, Marlbrook Marl, Saratoga Chalk, and Nacatoch Sand, Louisiana); HOWE & LAURENCICH, 1958, p. 484.

*Dimensions.* Length of complete carapace 1.02 mm; height 0.57 mm.

*Diagnosis.* Distinguished by its strong ventrolateral alae, large size, spiny anterior and posterior margins, and unornamented dorsum.

*Description of Interior.* As seen in Text-Fig. 8, marginal area moderately narrow with conspicuous selvage and no vestibule. Hinge ill-formed with poorly developed holo-hemiamphidont elements in the few specimens which could be examined. Muscle-scar pattern consists of four adductor scars in vertical row with a V-shaped antennal scar.

*Remarks.* Distinguished from *Alalatcythere ponderosana* (ISRAELSKY) by its large size, lack of dorsal ornamentation, and accommodation groove on the left valve. Spiny anterior differentiates it from *Ptery-*



TEXT-FIG. 8. *Pterygocythere saratogana* (ISRAELSKY), 1929. Interior view of right valve of penultimate instar (apparently no mature forms were found) showing incompletely formed amphidont hinge, the free marginal area, the muscle-scar pattern, and the ventral surface of a large ala (×80).

*gocythere alata* (BOSQUET). The form illustrated by SKINNER as *Alatacythere alata* (BOSQUET) is probably conspecific with the Marlbrook Marl form.

### Genus ALATACYTHERE Murray & Hussey, 1942

*Alatacythere* MURRAY & HUSSEY, 1942, p. 168.
*Type-species. Cythereis (Pterygocythereis?) alexanderi* HOWE & LAW, 1936, p. 42, pl. 4, fig. 23; pl. 5, fig. 5; (*non* MORROW, 1934, =*Alatacythere ivani* HOWE, 1951, p. 538, *nom. nov.*).

*Diagnosis.* Recognized by its elongate to subquadrate carapace that is arrowhead-shaped in dorsal view due to the distinct, thin backwardly directed alae. Surface smooth, spiny, or has short rounded ridges. Marginal area narrow. Hinge hemiamphidont, no accommodation groove. *U.Cret.-Oligo.*

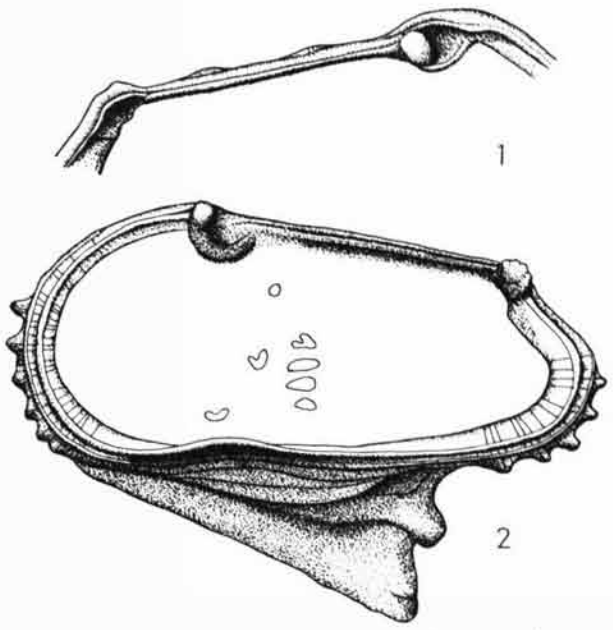
*Remarks.* The genus *Alatacythere* could be considered to be identical to *Pterygocythereis* in almost every respect except for the hinge. The hinge of *Alatacythere* is hemiamphidont, whereas the hinge of *Pterygocythereis* is holamphidont. The change in structure of the posterior tooth of the right valve appears to be an evolutionary sequence taking place in the Late Cretaceous (i.e., *P. nadeauae* HILL, 1954; Austin Chalk). The origin of *Alatacythere* some time in the late Middle Cretaceous is still uncertain. It may have developed from a strongly winged brachycytherid having crenulate terminal teeth in the right valve and a negligible accommodation groove in the left valve. Such a form has been described by HILL (1954) and identified as *Pterygocythereis thomasi*, which he considers to be identical to that form described by ISRAELSKY (1929) from the Marlbrook Marl and Annona Formations of Arkansas. HILL's form (1954, pl. 98, fig. 5a) shows such a crenulate amphidont (paramphidont) hinge. *P. thomasi* is considered to be identical to *Alatacythere ponderosana* ISRAELSKY 1929; however, specimens of this species found in the Marlbrook Marl during the present study possess a lobate to crenulate posterior tooth in the right valve with a smooth, small triangular anterior tooth. No specimens having a crenulate anterior tooth were found.

Several authors, as summarized in HILL (1954), have preferred in the past to abandon *Alatacythere* as a valid taxon. It is felt by the present authors that this concept represents a valid nomenclatural entity to express the earlier stages of pterygocythereidid evolution.

#### ALATACYTHERE PONDEROSANA (Israelsky), 1929

Plate 4, Figures 2, 6, 8; Text-Figure 9.

*Cytheropteron ponderosana* ISRAELSKY, 1929, p. 9, pl. 2A, figs. 1a-c, (Ozan Formation, Annona Chalk, and Marlbrook Marl, Arkansas).




TEXT-FIG. 9. *Alatacythere ponderosana* (ISRAELSKY) 1929. —*1.* Partial view of the dorsal interior of the left valve showing the hinge.—*2.* Interior view of the right valve showing the amphidont hinge with lobate posterior tooth, narrow marginal area, muscle-scar pattern, and the plicate ventral surface of the ala (×100).

*Cythereis thomasi* ISRAELSKY, *nom. nov., in* ALEXANDER, 1933, p. 211, pl. 25, figs. 16a,b, (Annona Chalk, Texas); CALAHAN, 1939, p. 41, pl. 3, fig. 3; ALEXANDER, 1939, p. 66.
*Pterygocythereis thomasi* (Israelsky) HILL, 1954, p. 816, pl. 98, figs. 5a-c; pl. 99, figs. 2a-c, (Selma Chalk, Prairie Bluff Chalk, Ozan Formation, and Marlbrook Marl).
*Alatacythere ponderosana* (Israelsky), BUTLER & JONES, 1957, p. 29, pl. 2, figs. 4a-c, (Ozan Formation, Annona Chalk, Marlbrook Marl, Saratoga Chalk, and Arkadelphia Marl, Louisiana); HOWE & LAURENCICH, 1958, p. 42.

*Dimensions.* Length of complete carapace 0.88 mm; height 0.46 mm; width 0.59 mm.

*Diagnosis.* Distinguished by its "elongate-quadrate lateral outline, strong ventrolateral ala and prominent anterior and posterior dorsal projections" (BUTLER & JONES, 1957, p. 31).

*Description of Interior.* As seen in Text-Fig. 9, marginal area narrow with erratically spaced, simple, straight radial-pore canals; relatively strong selvage. Broad ventral sinuation merging with parallel ventral ridges along a slightly inflated venter. Hinge hemiamphidont, narrow, with small or thin elements; posterior tooth lobulate.

*Remarks.* Most common in the lower portion of the Marlbrook Marl.

### Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

### Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948

## Genus TRACHYLEBERIS Brady, 1898; emend. Harding & Sylvester-Bradley, 1953

*Trachyleberis* BRADY, 1898; emend. HARDING & SYLVESTER-BRADLEY, 1953.

*Type-species. Cythere scabrocuneata* BRADY, 1880, p. 103, pl. 17, figs. 5a-f; pl. 23, figs. 2a-c.

*Remarks.* This is presently a heterogeneous group containing many complex forms. The genus *Trachyleberis* is used as a convenient receiver for many species that are only distantly related. The species assigned to *Trachyleberis* in this report will probably be assigned by others to new genera in the future.

### TRACHYLEBERIS? COMMUNIS (Israelsky), 1929

Plate 5, Figures 13-15; Text-Figure 10.

*Cythereis communis* ISRAELSKY, 1929, p. 14, pl. 3A, figs. 8-13, (Ozan Formation, Annona Chalk, Marlbrook Marl, Saratoga Chalk, Nacatoch Sand, and Arkadelphia Marl, Arkansas): ALEXANDER, 1929, p. 101, pl. 9, fig. 18, (Navarro Formation, Texas); JENNINGS, 1936, p. 52, pl. 7, fig. 3, (Mt. Laurel Sand and Navesink Formation, New Jersey); SCHMIDT, 1948, p. 418, pl. 61, figs. 11-13, (Marshalltown and Mt. Laurel Formations, Delaware, Maryland, and Virginia); SKINNER, 1956, p. 196, pl. 3, figs. 7a-c, (Arkadelphia Marl, Arkansas); BUTLER & JONES, 1957, p. 35, pl. 3, fig. 6, (Annona Chalk, Marlbrook Marl, Saratoga Chalk, Nacatoch Sand, and Arkadelphia Marl, Louisiana).

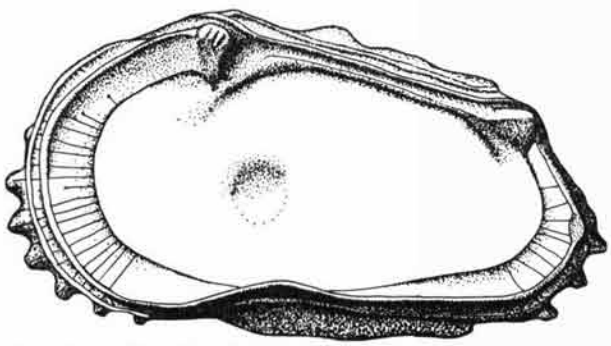
*Cythereis (Pterygocythereis)* cf. *C. (P.) communis* Israelsky, SWAIN, 1948, p. 419, pl. 61, figs. 11-13, (Cretaceous of Maryland).

*Trachyleberis communis* (Israelsky), BROWN, 1957, p. 14, pl. 3, figs. 10, 11, (Peedee Formation, North Carolina).

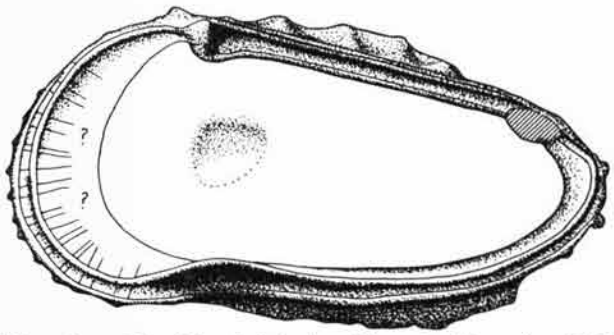
*Dimensions.* Length of adult carapace 0.79 mm; height 0.45 mm; width 0.39 mm.

*Diagnosis.* Distinguished by its spinose anteroventral and posterior margins, broad anterior marginal rim, smooth surface and three pronounced ridges.

*Description of Interior.* As seen in Text-Fig. 10, marginal area broad in terminal regions; fused duplicature (no vestibule); moderate selvage; radial-pore canals simple, straight, numerous in terminal regions, some do not carry to the outer margin. Ventral sinuation abrupt. Hinge amphidont, consisting of a slightly crenulate anterior tooth in right valve with a wedge-shaped, not visibly crenulate posterior tooth.



TEXT-FIG. 10. *Trachyleberis? communis* (ISRAELSKY), 1929. Interior view of right valve of adult showing the amphidont hinge, marginal area with radial- and false-pore canals (×100).




TEXT-FIG. 11. *Trachyleberis pidgeoni* (BERRY), 1925. Interior view of right valve of an adult male showing the amphidont hinge and marginal area (the posterior tooth was broken and the proximal ends of the radial-pore canals could not be seen (×105).

The selvage merges with the terminal hinge elements in the right valve, the flange seems to override the terminal elements extending the median groove and anteromedian socket, and is accompanied by a secondary, parallel flange above the main hinge elements.

*Remarks.* Very abundant in all parts of the Marlbrook Marl. This species has a wide distribution in other Upper Cretaceous formations. Because it is easily identified, it should be a useful Upper Cretaceous stratigraphic indicator.

### TRACHYLEBERIS PIDGEONI (Berry), 1925

Plate 5, Figures 1-3; Text-Figure 11.

**Cytheridea pidgeoni* BERRY, 1925, p. 485, figs. 7, 8, (Monmouth Formation, New Jersey); TRIEBEL, 1941, p. 341, pl. 10, fig. 113.

*Cythereis pidgeoni* (Berry), SCHMIDT, 1948, p. 421, pl. 62, figs. 2-6, (Monmouth Formation, Maryland, Delaware, and Virginia).

*"Archicythereis"* cf. *Cythereis pidgeoni* (Berry), SCHMIDT, 1948, p. 417, pl. 62, fig. 1.

*Trachyleberis pidgeoni* (Berry), BROWN, 1957, p. 14, pl. 7, figs. 26, 27, (Peedee Formation, North Carolina); *non* SWAIN, 1951, p. 36, pl. 6, fig. 1.

*Dimensions.* Length of female specimen 0.65 mm; height 0.40 mm; width 0.33 mm. Length of male specimen 0.75 mm; height 0.38 mm; width 0.29 mm.

*Diagnosis.* Distinguished by its large size, tapered outline, and surface ornamentation, consisting of bold, sharp horizontal and vertical ridges. Median ridge bifurcates near anterior.

*Description of Interior.* As seen in Text-Fig. 11, marginal area moderately wide in anterior, narrower in posterior, reflecting declivity of interior slope; selvage distinct, flange narrow; duplicature fused. Hinge holamphidont (?), fragile and very elongate in males. The posterior tooth was broken in all specimens examined.

*Remarks.* Rare to common in the upper portion of the Marlbrook Marl. This species is similar to *Cythereis huntensis* ALEXANDER. BROWN (1957) believes that a closer examination would show that they are sexual dimorphs.

## Genus CYTHEREIS Jones, 1849

*Cythereis* JONES, 1849, p. 14, 15; POKORNÝ, 1963, p. 1-59.
*Type-species. Cytherina ciliata* REUSS, 1846, p. 104, pl. 24, fig. 17. (=*Cytherina ornatissima* REUSS, 1846, p. 104, pl. 24, figs. 12, 13; SD by SUTTON & WILLIAMS, 1939, p. 562).

*Diagnosis.* Recognized by its moderately large, massive, subquadrangular to subrectangular carapace. Margins are nearly straight and converge toward the posterior. Left valve projects over the right valve at the front part of the hinge in the region of the post-ocular process. The anterior is broadly rounded and rimmed with marginal denticles. The posterior is triangular and rimmed. Surface texture is smooth, reticular, or spiny. A dorsal ridge, a post-subcentral tubercle median ridge, and a denticulate ventrolateral ridge are present. Hinge usually hemiamphoidont. Marginal area broad, no vestibule. *L. Cret.-Rec.*

### CYTHEREIS COSTATANA Israelsky, 1929

Plate 6, Figures 22, 26

*Cythereis costatana* ISRAELSKY, 1929, p. 16, pl. 3A, figs. 16a-c, (Saratoga Chalk, Nacatoch Sand, and Arkdelphia Marl, Arkansas); HOWE & LAURENCICH, 1958, p. 191.
*Cythereis pulchra* JENNINGS, 1936, p. 54, pl. 7, fig. 7, (Mt. Laurel and Navesink Formations, New Jersey).
*Cythereis costatana* Israelsky var. *angula* SCHMIDT, 1948, p. 420, pl. 61, figs. 17, 18, (Marshalltown and Mt. Laurel Formations, Maryland, Delaware, and Virginia).
*Platycythereis costatana* (Israelsky) var. *angula* BROWN, 1957, p. 15, pl. 6, figs. 22-25, (Peedee Formation, North Carolina).

*Dimensions.* Length of complete carapace 0.83 mm; height 0.43 mm.

*Diagnosis.* Distinguished by its subrectangular, compressed carapace with prominent, rounded ventrolateral ridge, subcentral tubercle, and dorsal ridge terminating at posterodorsum in prominent, elongate node. Anterior broadly rounded and rimmed, posterior with short caudal extension. Surface punctate but becomes reticular around the anterior rim. Marginal area broad.

*Remarks.* SCHMIDT (1948) included a subspecies within this species. In the present study this subspecies is considered to be only an intraspecific variant. The form described here is similar in ornamentation, but not in shape to *C.* sp. 306 illustrated by OERTLI (1958, pl. 8, fig. 180-182) from the upper Gargasian and lower Albian of France.

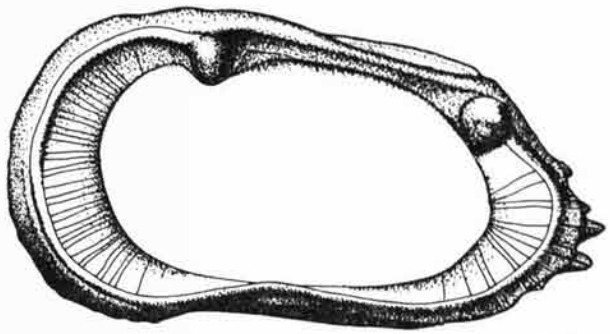
### CYTHEREIS HANNAI Israelsky, 1929

Plate 6, Figures 10, 13.

*Cythereis hannai* ISRAELSKY, 1929, p. 16, pl. 4A, figs. 1a-c, (Tokio and Brownstown Formations, Arkansas); ALEXANDER, 1939, p. 66, (Ozan Formation, Arkansas); HOWE & LAURENCICH, 1958, p. 200.

*Dimensions.* Length of complete carapace 0.62 mm; height 0.35 mm.

*Diagnosis.* Recognized by its coarsely punctate, gently tapering, subrectangular carapace with an unusually sharp caudal process. Dorsal and ventral margins essentially straight and convergent posteriorly; anterior broadly rounded, rimmed, and denticulate; posterior low, compressed, subtriangular, and extended, lower portion denticulate with four spines. A short ventrolateral ridge is terminated posteriorly by a smooth knob; a subdued dorsal nodose ridge terminates posteriorly as a smooth knob. The dorsal knob is closer to the posterior end than is the ventral knob. The subcentral tubercle is large, rounded and connected to a small knob behind it with a small ridge, which continues onward to the posterior terminal knob of the dorsal ridge.



TEXT-FIG. 12. *Cythereis* sp. A. Interior view of right valve of adult showing the massive marginal features, including the large teeth of the holamphidont hinge (×130).

*Remarks.* This species is rare in the Marlbrook Marl and has been found only in the Upper Cretaceous formations of Arkansas. Similar to *Cythereis dentonensis* ALEXANDER, but is smaller and more laterally compressed. It is very closely related to the form identified by SKINNER (1956, p. 195) as *C. ivii.*

### CYTHEREIS sp. A

Plate 5, Figures 4-6; Text-Figure 12.

*Dimensions.* Length of complete carapace 0.62 mm; height 0.34 mm; width 0.29 mm.

*Description.* Carapace subrectangular, tapering toward the posterior end. Dorsal and ventral margins straight or nearly so, converging toward posterior end; anterior end broadly rounded and rimmed; posterior end compressed, subtriangular, extended, and faintly rimmed, with four small spines. Subcentral tubercle large and elongate with a median ridge extending toward the posterior rim. Surface reticulate, coarser near the anterior end. Dorsal and ventral ridges parallel the median ridge; all are terminated and connected at their posterior ends by a faint raised line. Small eye tubercle present.

Marginal area wide, with robust selvage and holamphidont hinge. Radial-pore canals numerous, long,

closely spaced in anterior, fewer and more widely spaced in posterior. Ventral sinuation broad. Posterior and anterior teeth of right valve unusually high and pointed. Indistinct muscle-scar pattern in pit.

#### CYTHEREIS sp. B

Plate 6, Figures 4, 5, 9.

*Dimensions.* Length of complete carapace 0.54 mm; height 0.33 mm; width 0.25 mm.

*Description.* Carapace small, subtriangular, robust, highest anteriorly, with gross features. Dorsal margin generally straight, but undulatory; ventral margin straight; anterior end broadly rounded, faintly denticulate and rimmed, terminating abruptly at position of eye tubercle. Rim continues around venter to posterior end, becoming broad and finally terminating posterodorsally. Caudal extension small, compressed, and faintly denticulate. Surface finely reticular, with small eye tubercle present. Subcentral tubercle enlarged but not discrete, with a very small tubercle in front and a notched overriding median ridge extending across. Notch is immediately behind knob and very apparent when viewed dorsally. Dorsal and ventral ridges parallel the median ridge. Hinge not seen.

*Remarks.* All carapaces were complete and therefore the internal features could not be seen.

#### CYTHEREIS sp. C

Plate 6, Figures 12, 15.

*Dimensions.* Length of complete carapace 0.68 mm; height 0.32 mm.

*Material.* Five valves were found and examined.

*Description.* Carapace small, subrectangular and very compressed, with circumferential ridges. Dorsal and ventral margins straight and subparallel, tending to converge posteriorly, except where the dorsum joins broadly rounded and rimmed margin; caudal extension subtriangular, compressed, with six strong, posteriorly directed spines. Surface moderately punctate, with no median ridge present; eye tubercle prominent. A short ventrolateral ridge is terminated posteriorly by punctate enlargement; dorsal ridge terminates in a downturned, elongate juncture that is also punctate. Marginal area broad, with no vestibule. Hinge holamphidont.

*Remarks.* For the present, this specimen is being assigned to the genus *Cythereis;* however, it possesses some of the characteristics of the genus *Platycythereis* and may later be assigned to that genus. Species *C* was found only in the upper portion of the Marlbrook Marl.

Interiors of carapaces filled with calcareous matrix so that only the hinge and the marginal area could be seen.

### Genus VEENIA Butler & Jones, 1957

*Veenia* BUTLER & JONES, 1957, p. 43; HOWE & LAURENCICH, 1958, p. 510.

*Type-species. Cythereis ozanana* ISRAELSKY, 1929, p. 13, pl. 3A, figs. 1-3.

*Diagnosis.* Recognized by its robust, subtriangular carapace with three longitudinal ridges posterior to the subcentral tubercle. Surface smooth, punctate or reticulate. Anterior and posterior ends compressed; subcentral swelling pronounced. Prominent "hinge ear" on left valve. Marginal area broad; no vestibule; numerous radial-pore canals. Muscle-scar patterns trachyleberid. Hinge holamphidont. *U. Cret.-Rec.*

#### VEENIA ARACHOIDES (Berry), 1925

Plate 4, Figures 1, 3-5; Text-Figures 13, 14.

*Cythere arachoides* BERRY, 1925, p. 484, fig. 5, (Monmouth Formation, New Jersey); ALEXANDER, 1929, p. 84, (Cretaceous of Texas).

*?Cythereis ivii* ISRAELSKY, 1929, p. 15, pl. 3A, figs. 14a-c, (Saratoga Chalk and Arkadelphia Marl, Arkansas); ISRAELSKY, 1935, p. 485, pl. 3A, figs. 14a-c, (*non* SKINNER, 1956, p. 195, pl. 3, figs. 6a-f).

*Brachycythere arachoides* (Berry), SCHMIDT, 1948, p. 415, pl. 62, figs. 13-16, (Monmouth Formation, Maryland, Delaware, and Virginia); SWAIN, 1952, p. 81, pl. 9, fig. 22, (Peedee Formation, North Carolina).

*Cythere multipora* SKINNER, 1956, p. 90, pl. 2, figs. 4a-d, (Arkadelphia Marl, Arkansas).

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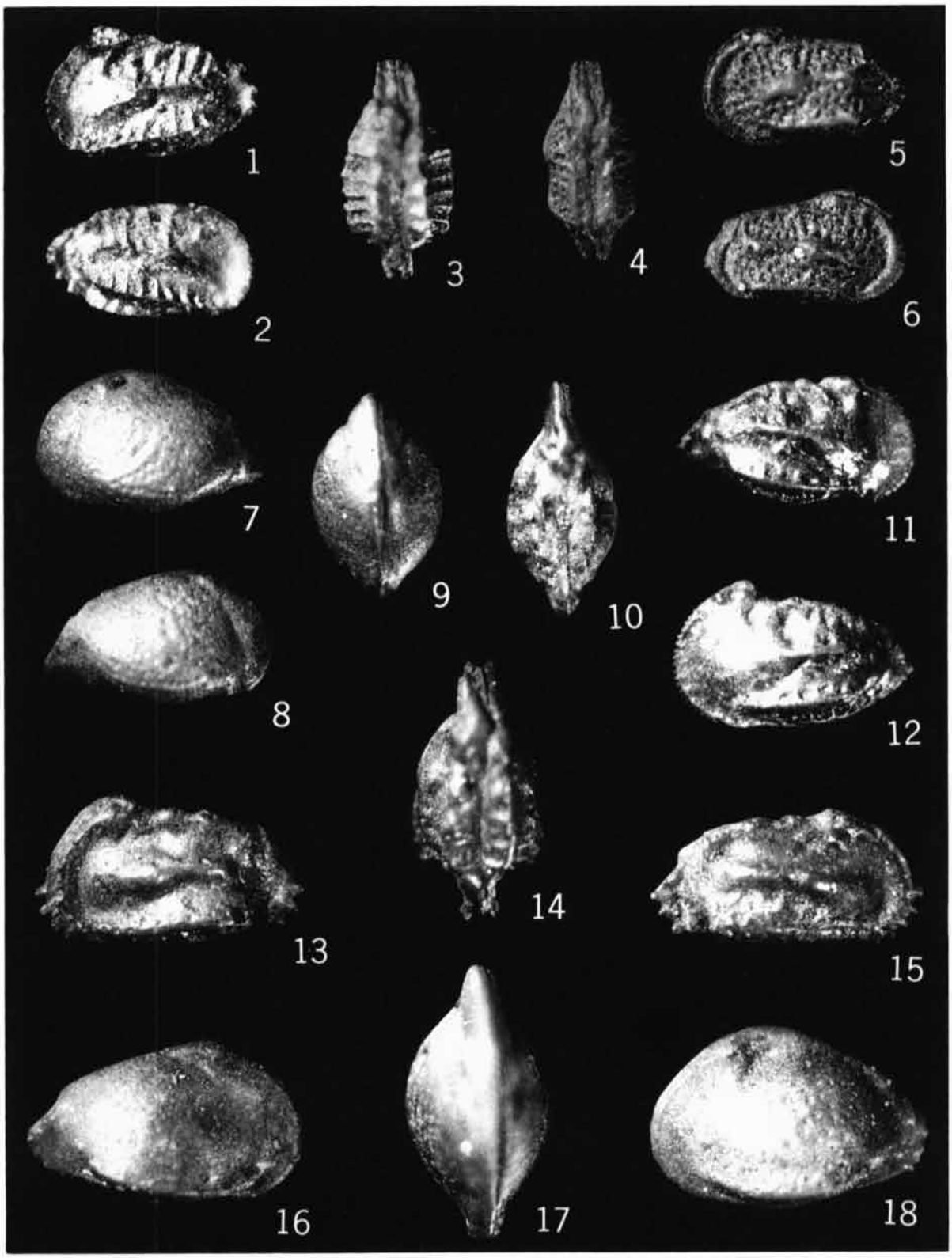
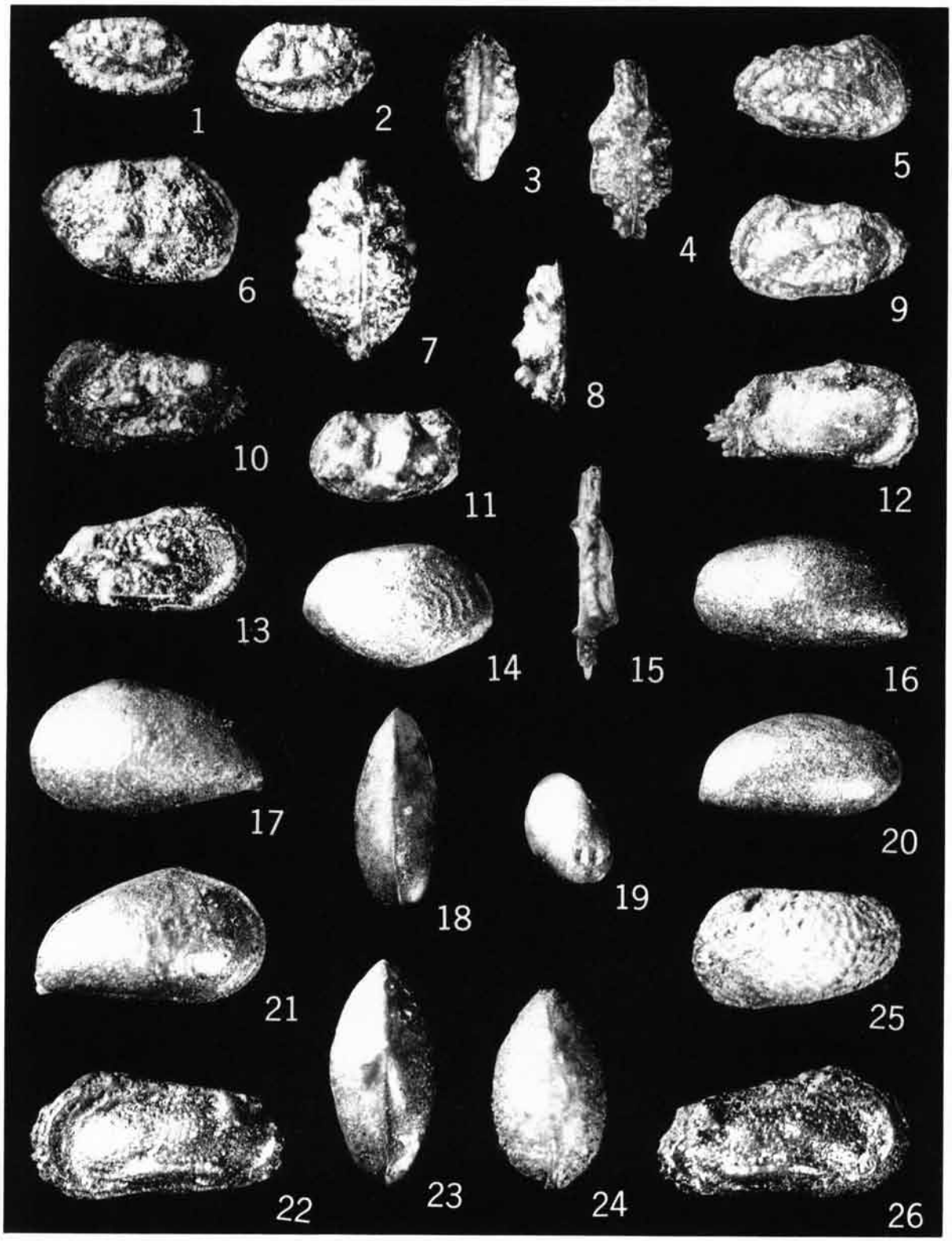
## EXPLANATION OF PLATE 5

BRACHYCYTHERE, CYTHEREIS, TRACHYLEBERIS, VEENIA

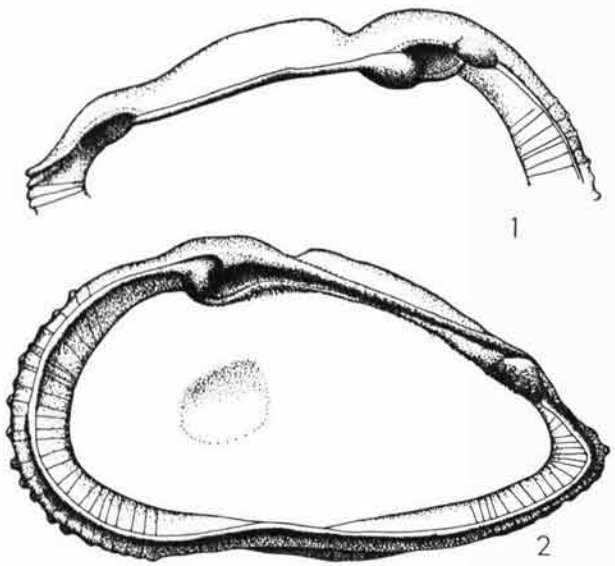
(All illustrated forms are from the Marlbrook Marl, x50)




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas




BENSON & TATRO — Ostracoda of the Marlbrook Marl, Arkansas




TEXT-FIG. 13. *Veenia arachoides* (BERRY), 1925.—*1.* Partial view of dorsal interior of left valve showing hinge with enlargement of proximal end of selvage in anterodorsum.—*2.* Interior view of right valve of adult showing holamphidont hinge and marginal area (×110).

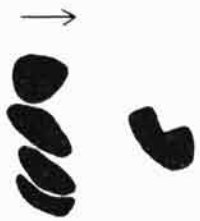
*Velarocythere arachoides* (Berry), BROWN, 1957, p. 22, pl. 5, figs. 16-18, (Peedee Formation, North Carolina).
*non Cythereis ivii* (Israelsky) SKINNER, 1956, p. 95, pl. 3, figs. 6a-f.
*Veenia arachoides* (Berry), BUTLER & JONES, 1957, p. 46, pl. 5, fig. 4, (Marlbrook Marl and Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 510.

*Dimensions.* Length of adult female 0.72 mm; height 0.42 mm; width 0.36 mm. Length of adult male 0.91 mm; height 0.47 mm; width 0.43 mm.

*Diagnosis.* Distinguished by its coarsely reticulate surface with two sulci above the subcentral swelling and behind to below the eye tubercle. These sulci are separated by a short, downward-pointing dorsal ridge. Strong ventrolateral swelling; short median ridge extends posteriorly from the region of the subcentral swelling and dies out in the reticulation.

*Description of Interior.* Marginal area moderate in width; ventral sinuation slight; duplicature fused, no vestibule; radial-pore canals straight, simple, moderately spaced, concentrated in terminal areas. Hinge holamphidont with smooth subtriangular posterior tooth, pointed anterior tooth (in right valve); an enlarged segment of the selvage anterior to the anterior socket of the left valve in some forms. Muscle-scar pattern (Text-Fig. 14) in shallow pit consisting of vertical row of four adductor scars and heart-shaped antennal scar.

*Remarks.* Common in the upper portions of the Marlbrook Marl. Differentiated from the type-species *Veenia ozanana* (ISRAELSKY) by its much coarser reticular surface.



TEXT-FIG. 14. *Veenia arachoides* (BERRY), 1925. Muscle-scar pattern of left valve (×280).

## EXPLANATION OF PLATE 6

AMPHICYTHERURA, NEOCYTHERE, CYTHEREIS, ECHINOCYTHEREIS, HAPLOCYTHERIDEA, KRITHE, ORTHONOTACYTHERE

(All illustrated forms are from the Marlbrook Marl, x50)

FIGURE — PAGE

*1-3—Amphicytherura dubia* (ISRAELSKY); *1,* exterior lateral view of right valve; *2,* exterior lateral view of left valve; *3,* dorsal view. ..... 27

*4,5,9—Cythereis* sp. B: *4,* dorsal view; *5,* exterior lateral view of right valve; *9,* exterior lateral view of left valve. ..... 23

*6,7—Orthonotacythere hannai* (ISRAELSKY); *6,* exterior lateral view of right valve, *7,* dorsal view. ..... 27

*8,11—Orthonotacythere polita* ALEXANDER; *8,* dorsal view; *11,* exterior lateral view of left valve. .... 27

*10,13—Cythereis hannai* ISRAELSKY: *10,* exterior lateral view of left valve; *13,* exterior lateral view of right valve. ..... 23

*14—Neocythere (Neocythere)? psedoconcentrica* BUTLER & JONES; exterior lateral view of right valve. ..... 28

FIGURE — PAGE

*12,15—Cythereis* sp. C; *12,* exterior lateral view of right valve; *15,* dorsal view. ..... 24

*16,18-20—Krithe swaini* BENSON & TATRO, n. sp.; *16,* exterior lateral view of left valve; *18,* dorsal view; *19,* posterior view; *20,* exterior lateral view of right valve. ..... 17

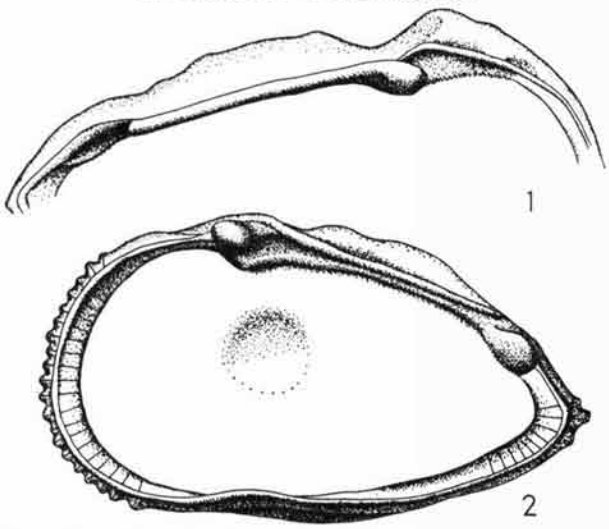
*17,21,23—Haplocytheridea monmouthensis* (BERRY); *17,* exterior lateral view of left valve; *21,* exterior lateral view of right valve; *23,* dorsal view. ..... 16

*22,26—Cythereis costatana* ISRAELSKY; *22,* exterior lateral view of left valve; *26,* exterior lateral view of right valve. ..... 23

*24-25—Echinocythereis bartoni* (ISRAELSKY); *24,* dorsal view; *25,* exterior lateral view of left valve. ..... 26

**VEENIA OZANANA (Israelsky), 1929**

Plate 5, Figures 10-12; Text-Figure 15.




TEXT-FIG. 15. *Veenia ozanana* (ISRAELSKY), 1929.—*1.* Partial view of dorsal interior of left valve showing the hinge.—2. Interior view of right valve showing the holamphidont hinge and narrow marginal area (×110).

*Cythereis ozanana* ISRAELSKY, 1929, p. 13, pl. 3A, figs. 1-3, (Ozan Formation, Annona Chalk, and Marlbrook Marl, Arkansas); ALEXANDER, 1933, p. 212; LOETTERLE, 1937, p. 64, pl. 11, fig. 6, (Fort Hays Limestone, Kansas); ALEXANDER, 1939, p. 66, (Ozan Formation, Annona Chalk, and Brownstown Formation, Arkansas); VAN DEN BOLD, 1946, p. 98, pl. 6, figs. 12a-c, (Cretaceous, British Honduras).

*Cythereis ponderosana* ISRAELSKY, 1929, p. 13, pl. 3A, figs. 5-8; ALEXANDER, 1929, p. 83, pl. 6, fig. 3, (Taylor Formation and Austin Chalk, Texas).

*Veenia ozanana* (Israelsky), BUTLER & JONES, 1957, p. 44, pl. 3, figs. 4a-e, (Annona Chalk and Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 512.

*Dimensions.* Length of complete adult carapace 0.73 mm; height 0.45 mm; width 0.34 mm.

*Diagnosis.* Recognized by its "smooth compressed anterior surface, broadly rounded anterior margin and median pointed posterior" (BUTLER & JONES, 1957, p. 44).

*Description of Interior.* Marginal area moderately wide in most forms, narrow in some; ventral sinuation slight; duplicature fused, no vestibule. Radial-pore canals, simple, moderately spaced. Hinge holamphidont with simple terminal teeth. Muscle-scar pattern not visible. Interior body cavity deep, with subcentral pit separated from larger posterior cavity by low arcuate ridge.

*Remarks.* Common in the lower portion of the Marlbrook Marl. Differentiated from *Veenia arachoides* (BERRY) by its smooth surface and broadly rounded and laterally compressed anterior. Similar to *Veenia parallelopora* (ALEXANDER), but lacks the small pits between ribs; a prominent downturned dorsal rib separates the two dorsal sulci.

## Genus ECHINOCYTHEREIS Puri, 1953

*Echinocythereis* PURI, 1953, p. 259-260; BENSON & COLEMAN, 1963, p. 46.

*Type-species. Cythereis garretti* HOWE & M'GUIRT, *in* HOWE & OTHERS, 1935, p. 20, pl. 3, figs. 17-19; pl. 4, figs. 5, 15.

**ECHINOCYTHEREIS BARTONI (Israelsky), 1929**

Plate 6, Figures 24-25.

*Cythereis bartoni* ISRAELSKY, 1929, p. 17, pl. 3A, figs. 1a,b, (Saratoga Chalk, Arkansas).

*Echinocythereis bartoni* (Israelsky), HOWE & LAURENCICH, 1958, p. 323.

*Dimensions.* Length of complete carapace 0.58 mm; height 0.32 mm; width 0.34 mm.

*Diagnosis.* Distinguished by its tumid, subrectangular carapace, sulcus behind the eye tubercle, and reticulate surface with spines at the intersections of the reticulations.

*Remarks. Echinocythereis bartoni* was found rarely in the upper portion of the Marlbrook Marl.

## Family CYTHERURIDAE Müller, 1894

## Genus CYTHEROPTERON Sars, 1866

*Cytheropteron* SARS, 1866, p. 79; VAN MORKHOVEN, 1963, p. 382-385.

*Type-species. Cythere latissima* NORMAN, 1865, p. 19, pl. 6, figs. 5-8.

*Diagnosis.* Recognized by its elongate or ovate carapace with a posterior caudal process and a usually distinct, but possibly blunted ventral ala. Surface smooth, or pitted; sometimes reticulated. Duplicature fairly broad, with small anterior vestibule; radial-pore canals few, simple, or bifurcating; hinge antimerodont, with projecting terminal cusps and a curved differentially loculated groove in between in right valve. Adductor muscle scar consists of a vertical row of four with a divided or V-shaped antennal in front. *U. Jur.-Rec.*

**CYTHEROPTERON CASTORENSIS Butler & Jones, 1957**

Plate 3, Figures 17, 21.

*Cytheropteron castorensis* BUTLER & JONES, 1957, p. 20, pl. 5, figs. 5a,b, (Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 297.

*Dimensions.* Length of complete carapace 0.69 mm; height 0.38 mm; width 0.39 mm.

*Diagnosis.* Recognized by its subovate carapace, upturned caudal process, obliquely rounded anterior end, and foreshortened, rounded and reticulated alae.

*Remarks. Cytheropteron castorensis* was found rarely throughout the entire vertical extent of the Marlbrook Marl. "This species most closely resembles *Cytheropteron latissimum* (NORMAN), which has a more pronounced caudal process and lack of strong alar reticulations" (BUTLER & JONES, 1957, p. 21).

**CYTHEROPTERON HARRISI Skinner, 1956**

Plate 3, Figures 5-6.

*Cytheropteron harrisi* SKINNER, 1956, p. 201, pl. 4, fig. 7, (Arkadelphia Marl, Arkansas); BUTLER & JONES, 1957, p. 19, pl. 1,

fig. 4, (Saratoga Chalk and Arkadelphia Marl, Louisiana); HOWE & LAURENCICH, 1958, p. 301.

*Dimensions.* Length of carapace 0.40 mm; height 0.22 mm.

*Diagnosis.* Distinguished by its small carapace, and relatively large ventrolateral ala bearing a median furrow.

*Remarks.* Very rare, found in the upper and lower portions of the Marlbrook Marl. Differentiated from *Cytheropteron castorensis* by its small size, large and furrowed ventrolateral ala, and lack of alar reticulations.

### Genus ORTHONOTACYTHERE Alexander, 1933

*Orthonotacythere* ALEXANDER, 1933, p. 199; VAN MORKHOVEN, 1963, p. 361-364.

*Type-species. ?Cytheridea hannai* ISRAELSKY, 1929, p. 12, pl. 2A, fig. 10.

*Diagnosis.* Recognized by its large, ovate to subquadrate carapace. Surface pitted or reticulated with about six large tubercles or costae and a sulcus. Dorsum straight; venter broadly convex; anterior obliquely rounded; caudal process small and high above mid-line. Hinge antimerodont to entomodont; fused duplicature; radial-pore canals few, straight, and simple. Nontuberculate forms are classified in a separate subgenus from the nominotypical and similar species. *Cret.-L. Tertiary.*

*Remarks.* Both of the species of *Orthonotacythere* found in the Marlbrook Marl, i.e., *O. hannai* and *O. polita,* are characterized by the presence of eight or nine strong tubercles that constitute the most conspicuous aspect of the surface ornament. As pointed out by KAYE (1963), *Orthonotacythere* can be divided into two groups (not including those species set aside as the subgenus *Acrocythere* by NEALE, 1960, and elevated to generic status by MALZ, 1961). Forms of the one group, of Early Cretaceous age or older, are primarily costate and reticulate; whereas the second group, of Late Cretaceous or younger age, are primarily tuberculate.

The classification of this genus has posed a problem that was beyond the scope of the present study. We have arbitrarily placed it in the Cytheruridae, as was done in the Treatise (MOORE, 1961, p. Q296), rather than in the Loxoconchinae as proposed by NEALE (1960, p. 211), or in the Progonocytheridae as proposed by MALZ (1961). The latter placement seems most likely, but we could not see the hinge well enough to establish whether it was entomodont or simply antimerodont.

#### ORTHONOTACYTHERE (ORTHONOTACYTHERE) HANNAI (Israelsky), 1929

Plate 6, Figures 6-7.

*Cytheridea? hannai* ISRAELSKY, 1929, p. 12, pl. 2A, figs. 10a-b, (Ozan Formation, Arkansas); ISRAELSKY, 1935, p. 482, pl. 2A, figs. 10a-b.

*Cytheropteron hannai* (Israelsky) ALEXANDER, 1929, p. 105, pl. 9, fig. 16, (Navarro Formation, Texas).

*Orthonotacythere hannai* (Israelsky), ALEXANDER, 1933, p. 200, pl. 25, figs. 1a-c; pl. 26, figs. 6a,b; pl. 27, figs. 14a,b; ALEXANDER, 1939, p. 66; SKINNER, 1956, p. 202, pl. 4, figs. 9a,b, (Arkadelphia Marl, Arkansas); BUTLER & JONES, 1957, p. 21, pl. 4, fig. 2, (Marlbrook Marl and Saratoga Chalk, Louisiana); BROWN, 1957, p. 24, pl. 6, figs. 3-5, (Peedee and Black Creek Formations, North Carolina); HOWE & LAURENCICH, 1958, p. 436.

*Dimensions.* Length of complete carapace 0.63 mm; height 0.36 mm; width 0.36 mm.

*Diagnosis.* Distinguished by its tumid carapace with eight to nine spinose tubercles and a reticular to finely spinose surface.

*Remarks.* Similar to a Paleocene species, *Orthonotacythere cristata* ALEXANDER, in shape of carapace, ornamentation, and arrangement of tubercles. The tubercles on *O. cristata* are more strongly elevated (Alexander, 1934, p. 65).

#### ORTHONOTACYTHERE (ORTHONOTACYTHERE) POLITA Alexander, 1934

Plate 6, Figures 8, 11.

*Orthonotacythere polita* ALEXANDER, 1934, p. 66, pl. 8, fig. 7, (Taylor Formation, Texas).

*Dimensions.* Length of complete carapace 0.55 mm.

*Diagnosis.* Recognized by its eight strong tubercles, smooth surface, prominent vertical median sulcus, and bladelike ventrolateral keel.

*Remarks.* This species is very rare and was found only in the lower portion of the Marlbrook Marl. Differentiated from *Orthonotacythere hannai* by its smaller size, prominent median sulcus, smooth surface, bladelike ventrolateral keel, and laterally compressed sides.

### Family SCHIZOCYTHERIDAE Howe, 1961

### Genus AMPHICYTHERURA Butler & Jones, 1957

*Amphicytherura* BUTLER & JONES, 1957, p. 41; VAN MORKHOVEN, 1963, p. 358-360.

*Type-species. Cytherura? dubia* ISRAELSKY, 1929, p. 5, pl. 4A, fig. 6.

*Diagnosis.* Recognized by its small, robust, subquadrate carapace. Dorsum straight, venter broadly arched; anterior end broadly and obliquely rounded; posterior end compressed with small caudal process. Eye tubercle prominent. Ornamentation consists of a prominent median ridge, a thickened, high dorsal ridge, and a ventrolateral ridge, which tends to extend beyond the ventral margin. Schizodont to amphidont hinge well developed. *U. Cret.-L. Paleocene.*

*Remarks.* BUTLER & JONES (1957) placed this genus in the subfamily Trachyleberidinae because of its strong amphidont hinge. Its present placement in the cytherurids may be questionable.

**AMPHICYTHERURA DUBIA (Israelsky), 1929**

Plate 6, Figures 1-3.

*Cytherura dubia* ISRAELSKY, 1929, p. 6, pl. 4A, fig. 6, (Saratoga Chalk, Arkansas).

*Eucytherura chelodon* (Marsson), ALEXANDER, 1936, p. 692, pl. 93, figs. 6, 12, (Ozan Formation and Annona Chalk, Arkansas); ALEXANDER, 1939, p. 66.

*Cythereis curta* JENNINGS, 1936, p. 52, pl. 7, figs. 4a,b, (Navesink Formation, New Jersey); BROWN, 1957, p. 25, pl. 6, figs. 20, 21, (Peedee Formation, North Carolina).

*Amphicytherura dubia* (Israelsky), BUTLER & JONES, 1957, p. 42, pl. 5, figs. 1a-d, (Saratoga Chalk, Louisiana); HOWE & LAURENCICH, 1958, p. 47.

*Dimensions.* Length of adult specimen 0.45 mm; height 0.26 mm; width 0.23 mm.

*Diagnosis.* Distinguished by its strongly ridged carapace. Median ridge prominent, with subdued cross ridges on both sides. Ventrolateral ridge long, curved, and nodulose. Dorsal ridge weakest and least irregular. Hinge variable from schizodont to holamphidont (VAN MORKHOVEN, 1963, p. 359).

*Remarks. Amphicytherura dubia* was found only in the upper portion of the Marlbrook Marl, where it was very rare. It is similar to *Amphicytherura limbergensis* HOWE & LAURENCICH, but is differentiated by its smaller size, straight dorsum and laterally compressed sides.

## Family PROGONOCYTHERIDAE Sylvester-Bradley, 1948

## Subfamily PROGONOCYTHERINAE Sylvester-Bradley, 1948

## Genus NEOCYTHERE Mertens, 1956

*Neocythere* MERTENS, 1956, p. 205; KAYE, 1963, p. 274.

*Type-species. Neocythere vanveeni* MERTENS, 1956, p. 205, pl. 12, figs. 72-78; pl. 14, figs. 100-102.

### Subgenus NEOCYTHERE Mertens, 1956

*Neocythere (Neocythere)* MERTENS, 1956, p. 205; KAYE, 1963, p. 276.

*Diagnosis.* Nominotypical subgenus of *Neocythere* s.l. with forms having inflated ventrally tumid carapace; hinge of right valve with crenulate teeth, intermediate locellate groove deepened at anterior end to form circular socket; left valve with accommodation groove above median element (after KAYE, 1956). *Cret.*

**NEOCYTHERE (NEOCYTHERE)? PSEUDOCONCENTRICA Butler & Jones, 1957**

Plate 6, Figure 14.

*"Cythere" pseudoconcentrica* BUTLER & JONES, 1957, p. 18, pl. 5, figs. 3a-c, (Ozan Formation, Annona Chalk, Marlbrook Marl, and Saratoga Chalk, Louisiana).

*Dimensions.* Length of complete carapace 0.58 mm; height 0.38 mm.

*Diagnosis.* Recognized by its delicate concentric surface ornamentation.

*Remarks. Neocythere (Neocythere)? pseudoconcentrica* is rare in the Marlbrook Marl. The hingement was poorly preserved in the few single-valved specimens available for study. In their original description BUTLER & JONES, 1957 described the hinge as consisting of ". . . crenulate sockets connected by a thin raised bar above which is a deep accommodation groove; right valve dentition consists of terminal crenulate cusps connected with a thin groove. . . ." No mention was made of an anterior socket present in the right valve; however, as MERTEN's (1956) work was apparently unknown to these authors at that time. It is possible this feature could have been overlooked in poorly preserved specimens. Immature stages were not described and it is possible that a protogenic hinge was seen. We have not examined the type-specimens and cannot make this judgment. The importance of this detail only became evident after the publication of KAYE's (1963) work as our paper was going to press.

We have assigned *pseudoconcentrica* to the subgenus *Neocythere* on the basis of the presence of the accommodation groove in the left valve which is not present (KAYE, 1963, p. 278) in the subgenus *Physocythere.*

According to BUTLER & JONES the species *pseudoconcentrica* differs from *Neocythere concentrica* (REUSS) in being more delicately sculptured, lacking an eye spot and having greater dimensions.

## REFERENCES


ADAMS, J. K., 1960, *Note on Lower Tertiary and Upper Cretaceous Ostracoda from New Jersey*: Jour. Paleontology, v. 34, p. 371-372.

ALBRITTON, C. C., and others, 1941, *Geology of Dallas County, Texas*: Field and Lab., Dallas, v. 10, no. 1, 1134 p.

ALEXANDER, D. I., 1927, *The stratigraphic range of the Cretaceous ostracod* Bairdia subdeltoidea *and its allies*: Jour. Paleontology, v. 1, p. 29-33, 1 pl.

———, 1929, *Ostracoda of the Cretaceous of North Texas*: Texas Univ. Bull. 2907, 137 p.

———, 1932, *New names for two species of Cretaceous Ostracoda*: Jour. Paleontology, v. 6, p. 101.

———, 1932b, *Sexual dimorphism in fossil Ostracoda*: Am. Mid. Naturalist, v. 13, no. 5, p. 302-311, pl. 28.

———, 1933, *Shell structure of the genus* Cytheropteron, *and species from the Cretaceous of Texas*: Jour. Paleontology, v. 7, p. 181-214, pl. 25-27.

———, 1934a, *Ostracoda of the genera* Monoceratina *and* Orthonotacythere *from the Cretaceous of Texas:* Jour. Paleontology, v. 8, p. 57-67, pl. 8.

———, 1934b, *Ostracoda of the Midway (Eocene) of Texas*: Same, v. 8, p. 216, 237, pl. 32-35.

———, 1936, *Ostracoda of the genera* Eucythere, Cytherura, Eucytherura, *and* Loxoconcha *from the Cretaceous of Texas*: Same, v. 10, p. 689-694, pl. 93.

———, 1939, *Common and significant species of Foraminifera and Ostracoda of the Brownstown, Ozan, and Annona formations of southwestern Arkansas*: Shreveport Geol. Soc. Guidebook, Fourteenth Ann. Field Trip, p. 64-67.

——— & ALEXANDER, C. W., 1933, *Reversal of valve size and hinge structure in a species of the genus* Cytheridea: Am. Mid. Naturalist, v. 14, no. 3, p. 280-283.

APOSTOLESCU, V., 1955, *Un nouveau genre d'ostracode du Cenomanien de Dordogne:* Dordoniella strangulata *n. gen., n. sp.*: Cahiers géologiques, no. 33, p. 329, 330.

BAIRD, W., 1838, *The natural history of British Entomostraca*: Mag. Zool. Bot., v. 2, p. 132-143.

———, 1845, *Arrangement of the British Entomostraca with a list of species, particularly noticing those which have as yet been discovered within the bounds of the club*: Berwickshire Nat. Club (History) Proc., (1842-1849), p. 145-148.

———, 1850, *The natural history of the British Entomostraca*: The Ray Society (London), 364 p.

BENSON, R. H., & COLEMAN, G. L., 1963, *Recent marine ostracodes from the eastern Gulf of Mexico*: Univ. Kansas Paleont. Contr., Arthropoda, art. 2, p. 1-52.

BERRY, E. W., 1925, *The Upper Cretaceous Ostracoda from Maryland*: Am. Jour. Sci., v. 209, p. 481-487, fig. 1-15.

———, 1933, Cytheridea brightseatensis *Berry, a new name for* C. truncata *Berry*: Jour. Paleontology, v. 7, p. 112.

BOLD VAN DEN, W. A., 1946, *Contribution to the study of Ostracoda with special reference to the Tertiary and Cretaceous microfauna of the Caribbean region*: J. H. De Bussey (Amsterdam), 167 p., 18 pl.

———, 1950, *A checklist of Cuban Ostracoda*: Jour. Paleontology, v. 24, p. 107-109.

BONNEMA, J. H., 1941, *Ostracoden aus der Kreide des Untergrundes der nordöstlichen Niederlanden*: Natuurhist Maandblad, v. 28, p. 8-10, 21-24, 26-29, 40-43, 56-60, 70-72, pl. 5-7.

BOSQUET, J., 1847, *Description des Entomostracés fossiles de la Craie de Maestricht*: Soc. Roy. Sci. Liège, Mém., v. 4, p. 353-378, pl. 1-4.

———, 1852, *Entomostracés fossiles des terrains tertiares de la France et de la Belgique*: Acad. Roy. Sci. Belgique, Mém., v. 24, p. 37-41.

———, 1855, *Review of Les Crustacés fossiles du terrain Crétacé de Limburg:* Neues Jahrb. f. Mineralogie, Geognosie, Geologie, u. Petrefakten-Kunde, p. 125-128 (publ. 1854).

BRADY, G. S., 1866, *On new or imperfectly known species of marine Ostracoda*: Trans. Zool. Soc. London, v. 5, pt. 5, p. 359-393.

———, 1880, *Report on the Ostracoda dredged by the* H. M. S. Challenger *during the years 1873-1876*: Rept. Sci. Results Voyage of *H. M. S. Challenger* (London), Zoology, v. 1, pt. 3, p. 1-184.

———, 1898, *On new or imperfectly known species of Ostracoda, chiefly from New Zaland:* Zool. Soc. London, Trans., v. 12, p. 429-452.

———, CROSSKEY, H. W. & ROBERTSON, D., 1874, *A monograph of the post-Tertiary Entomostraca of Scotland including species from England and Ireland*: Palaeontographical Soc., London, v. 2, p. 1-229, pl. 1-16.

———, & NORMAN, A. M., 1889, *A monograph of the marine and freshwater Ostracoda of the North Atlantic and of northwestern Europe. Section 1, Podocopa:* Sci. Trans. Royal Dublin Soc., ser. 2, v. 4, p. 63-270.

BROWN, P. M., 1957, *Upper Cretaceous Ostracoda from North Carolina*: North Carolina Dept. Conserv. and Devel., Div. Min. Res. Bull. 70, 28 p., 7 pl.

———, 1958, *Well logs from the coastal plain of North Carolina:* Same, Bull. 72, 68 p., 8 pl.

BUTLER, E. A. & JONES, D. E., 1957, *Cretaceous ostracodes of Prothro and Rayburns salt domes, Bienville Parish, Louisiana*: Louisiana Geol. Survey, Geol. Bull. 32, 49 p., 6 pls.

CALAHAN, L. W., 1939, *Diagnostic fossils of the Ark-La-Tex area*: Shreveport Geol. Soc., Guidebook, Fourteenth Ann. Field Trip, p. 36-56, pl. 1-9.

CARTER, C. S., 1931, *Additions to the list of fossil microfauna of the White-Chalk of Lincolnshire:* Lincolnshire Nat. Union, Louth, Trans. for 1930, p. 175-176.

CONRAD, T. A., 1858, *Observations on a group of Cretaceous fossil shells found in Tippah County, Mississippi:* Acad. Nat. Sci. Philadelphia, Jour., ser. 2, v. 3, 1855-58, p. 335.

CORYELL, H. N., SAMPLE, C. H., & JENNINGS, P. H., 1933, Bairdoppilata, *a new genus of Ostracoda, with two new species*: Am. Mus. Novitates, no. 777, p. 1-5.

DANE, C. H., 1929, *Upper Cretaceous formations of southwestern Arkansas*: Arkansas Geol. Survey, Bull. 1, 215 p., 4 fig., 29 pl. (incl. map).

DUPPER, W., 1952, *Über das Cenoman in niedersächsischen Bergland und seine Mikrofossilien*: Paläont. Zeitschr. (Stuttgart), v. 26, p. 49-111.

GALEEVA, M. N., 1955, *Cretaceous ostracod succession of Mongolian Peoples Republic*: Government Sci. Tech. Data, p. 65, pl. 15.

GAUGER, D. J., 1953, *Microfauna of the Hillard*; *in* PETERSON, GAUGER, & LANKFORD: *Microfauna of the Upper Cretaceous of northeastern Utah and southwestern Wyoming*: Utah Geol. Min. Survey, Bull. n. 47, p. 51-90, pl. 4-11; Ostracoda p. 87-90, pl. 11.

GREKOFF, N., 1951, *Quelques Ostracodes nouveaux Senonian Superior du Cameroun:* Inst. Franç. du Pétrole, Revue, v. 6, p. 53-59.

HANAI, T., 1957, *Studies on the Ostracoda from Japan, III. Subfamilies Cytherurinae* G. W. MÜLLER (emend. G. O. SARS, *1925*) *and Cytheropterinae new subfamily:* Jour. of the Faculty of Sci., Univ. of Tokyo, Sec. II, v. 11, pt. 1, p. 11-26.

HARDING, J. P. & SYLVESTER-BRADLEY, P. C., 1953, *The ostracod genus Trachyleberis*: Brit. Mus. (Nat. Hist.) Bull., Zool., v. 2, p. 1-15.

HILL, B. L., 1954, *Reclassification of winged* Cythereis *and winged* Brachycythere: Jour. Paleontology, v. 28, p. 804-826, pl. 97-100.

HILL, W., 1900, *Microscopical structure and mineral ingredients of the Gault and Red Chalk, in* JUKES-BROWNE, A. J., Geol. Survey United Kingdom, Mem., *Cretaceous*, v. 1, p. 189, 33-476.

———, 1903, *Lower and Middle Chalk of England*; *in* JUKES-BROWNE, A. J., Same, v. 2, p. 230-511.

———, 1904, *Upper Chalk of England*; *in* JUKES-BROWNE, A. J., Same, v. 3, p. 229-496.

HIRON, S. D., JR., 1958, *History of terminology and correlations of the basal Cretaceous formations of the Carolinas*: Bull., Div. of Geol., South Carolina, v. 2, no. 11-12, p. 77-87.

HOWE, H. V., 1934, *The ostracode genus Cytherelloidea in the Gulf Coast Tertiary*: Jour. Paleontology, v. 8, p. 29-34, pl. 5.

———, 1951, *New name for the genotype of* Alatacythere (*Ostracoda*): Same, v. 25, p. 538.

———, 1955, *Handbook of ostracod taxonomy:* Louisiana State Univ. Studies, no. 1, 389 p.

———, & GARRETT, J. B., 1934, *Louisiana Sabine Eocene Ostracoda*: Louisiana Dept. Conserv., Geol. Bull. 5, p. 1-65, pl. 1-6.

———, & CHAMBERS, J., 1935, *Louisiana Jackson Eocene Ostracoda*: Louisiana Dept. Conserv., Geol. Bull. 7, p. 1-96, pl. 1-6.

——— & LAURENCICH, LAURA, 1958, *Introduction to the study of Cretaceous Ostracoda:* Louisiana State Univ. Press, (Baton Rouge), 536 p.

———, *et. al.*, 1935, *Ostracoda of the* Arca *zone of the Choctawhatchee Miocene of Florida*: Florida Dept. Cons., Geol. Bull. 13, p. 1-47.

ISRAELSKY, M. C., 1929, *Upper Cretaceous Ostracoda of Arkansas*: Arkansas Geol. Surv., Bull. 2, 29 p., 4 pls.

———, 1931, *Upper Cretaceous Ostracoda* (*revised*): Same, p. 475-496.

———, 1931, Cythereis thomasi ISRAELSKY, *new name*: Jour. Paleontology, v. 7, p. 211.

———, 1935, *Appendix to* SPOONER, W. C., *Oil and Gas Geology of the Gulf Coastal Plain in Arkansas*: Ark. Geol. Surv. Bull. 2, p. 477-489.

JENNINGS, P. H., 1936, *A microfauna from the Monmouth and basal Rancocas groups of New Jersey*: Bull. Am. Paleontology, v. 23, no. 78, p. 161-234, pls. 1-7.

JONES, T. R., (1848), 1857, *A monograph of the Entomostraca of the Cretaceous formations of England*: Palaeontograph. Soc. (London), 40 p.

———, (1856), 1857, *A monograph of the Tertiary Entomostraca of England*: Same, 68 p.

———, & HINDE, G. J., 1890, *A supplementary monograph of the Cretaceous Entomostraca of England and Ireland*: Same, v. 43, p. i-viii, 1-10, pl. 1-4.

KAYE, P., 1963, *The ostracod genus* Neocythere *in the Speeton Clay*: Palaeontology, v. 6, p. 274-281.

———, 1963, *The ostracod species* Orthonotacythere inversa (*Cornuel*) *and its allies in the Speeton Clay of Yorkshire*: Same, v. 6, p. 430-439.

———, 1963, *The interpretation of the Mesozoic ostracod genera of the family Cytherideidae* SARS, *1925*: Revue de Micropaléontologie, v. 6, p. 23-40.

KLINE, V. H., 1934, *Clay County fossils, Midway Foraminifera and Ostracoda*: Mississippi Geol. Survey, Bull. 53, p. 1-98; Ostracoda, p. 64-71.

KOLLMANN, K., 1960, *Cytherideinae und Schulerideinae (n. subfam. Ostracoda) aus dem Neogen des Ostl. Oesterreich:* Mitt. Geol. Gesell. Wien, v. 51, p. 89-196.

LAURENCICH, LAURA, 1957, Stillina, *A new genus of Cretaceous Ostracoda*: Jour. Paleontology, v. 31, p. 455-457.

LOETTERLE, G. J., 1937, *The micropaleontology of the Niobrara formation in Kansas, Nebraska, and South Dakota:* Nebraska Geol. Survey, ser. 2, Bull. 12, 73 p., 11 pl.

LOZO, FRANK E., 1943, *Bearing of Foraminifera and Ostracoda on Lower Cretaceous Fredericksburg-Washita boundary of North Texas*: Am. Assoc. Petrol. Geol., Bull., v. 27, p. 1060-1080, 10 fig.

LYUBIMOVA, P. S., 1956, *Ostrakody melovykh otlozhenii vostochnoi chasti Mongolskoi Narodnoi Respubliki i ikh znachenie dlya stratigrafii*: Vsesoyuz. Neft. Nauch.-Issled. Geol.-Razv. Inst. (VNIGRI), Trudy vyp. 93, 174 p., 25 pl. [Ostracodes of Cretaceous formations of eastern part of Mongolian National Republic and their importance to stratigraphy.]

MALZ, H., 1961, *Erörterung der taxonomischen Fassung der Progonocytherinae* (*Ostracoda*): Senckenbergiana, v. 42, p. 175-179.

MARSSON, T., 1880, *Die Cirripedien und Ostracoden der Weissen Schreibkreide der Insel Rügen:* Naturw. Ver.

von Neuvorpommern und Rügen, Greifswald, Mitteilungen, 1880, p. 1-50, 2 pls.

MARTIN, J. L., 1939, *Claiborne Eocene species of the ostracode genus Cytheropteron*: Jour. Paleontology, v. 13, no. 2, p. 176-182, pl. 22.

MERTENS, ERWIN, 1956, *Zur Grenzziehung Alb/Cenoman in Nordwestdeutschland mit Hilfe von Ostracoden:* Geol. Jahrb., Bd. 72, p. 173-230.

MOORE, R. C., *Introduction to Historical Geology*: McGraw-Hill Book Co., New York, 1958, 656 p.

MOREHEAD, M. B., 1959, *Some Cretaceous Foraminifera and Ostracoda from Kingston, North Carolina*: North Carolina Acad. Sci. Proc., *in* Elisha Mitchell Sci. Soc. Jour., v. 75, no. 2, p. 69 (Nov. 1959, abstract).

MORKHOVEN, F. P. C. M. VAN, 1958, *On the validity of the ostracod genera* Glyptobairdia *and* Bairdoppilata: Jour. Paleontology, v. 32, p. 366-368.

———, 1962, 1963, *Post-Paleozoic Ostracoda: Their morphology, taxonomy and economic use:* Elsevier Publ. Co., v. 1 and 2.

MORROW, A. L., 1934, *Foraminifera and Ostracoda from the Upper Cretaceous of Kansas*: Jour. Paleontology, v. 8, no. 2, p. 186-205, pls. 29-31.

MÜLLER, G. W., 1894, *Die Ostracoden des Golfes von Neapel und der angrenzenden Meeres Abschnitte:* Fauna und Flora von Neapel, v. 21, (Berlin), 404 p.

———, 1912, *Ostracoda*: *in* Das Tierreich, v. 31, 434 p.

MÜLLER, O. F., 1785, *Entomostraca seu Insecta Testacea, quae in aquis Daniae et Norvegiae reperit, descripsit et iconibus illustravit:* Lipsiae et Mavniae, 135 p.

MURRAY, G. E. JR., & BUSSEY, K. M., 1942, *Some Tertiary Ostracoda of the genera Alatacythere and Brachycythere*: Jour. Paleontology, v. 16, no. 2, p. 164-182, pls. 27-28.

M'COY, F., 1844, *A synopsis of the characters of the Carboniferous Limestone fossils of Ireland*: Dublin Univ. Press, 207 p.

NEALE, J. W., 1960, *Marine Lower Cretaceous Ostracoda from Yorkshire, England*: Micropaleontology, v. 6, p. 203-224.

———, 1962, *Berriasian-Hauterivian Ostracoda from the Speeton Clay (L. Cretaceous) of Speeton, Yorkshire, England*: Same, v. 8, p. 425-484.

———, & KILENYI, T. I., 1961, *New species of* Mandelstamia (*Ostracoda*) *from the English Mesozoic*: Palaeontology, v. 2, p. 439-449.

NORMAN, A. M., 1865, *Reports on deep-sea dredgings off the coast of Northumberland and Durham*: Nat. Hist. Soc., Northumberland and Durham, Trans., v. 1, p. 12-29.

OERTLI, H. J., 1958, *Les Ostracodes de l'Aptien—Albien d'Apt*: Inst. Franç. Pétrole, Rev., v. 13, n. 11, p. 1499-1537.

———, 1959, Euryitycythere *und* Parexophthalmocythere, *Zwei neue Ostracoden-Gattungen aus der Unterkreide Westeuropas*: Pal. Zeitschr., v. 23, n. 4, p. 241-246.

POKORNÝ, VLADIMIR, 1963, *Revision of* Cythereis ornatissima (*Reuss, 1846*) (*Ostracoda, Crustacea*): Rozpravy Československe Akad., v. 73, p. 1-59.

———, 1963, *Karsteneis gen. n. (Ostracoda, Crustacea) from the Upper Cretaceous of Bohemia*: Casopsis pro Mineral. a. Geol., v. 1, n. 8, p. 39-44.

PURI, H. S., 1953, *Contributions to the study of the Miocene of the Florida Panhandle: Part 3, Ostracoda*: Florida Geol. Survey, Bull. 36, p. 215-345.

———, 1957, *Notes on the ostracode subfamily Cytherideidinae, Puri, 1952*: Jour. Washington Acad. Sci., v. 47, p. 306-308.

REUSS, A. E., 1846, *Die Versteinerungen der böhmischen Kreideformation:* (Schweizerbrat, Stuttgart), Abt. II, p. 1-148, pls. 14-51.

———, 1854, *Beiträge zur Charakteristik der Kreideschichten in den Ostalpen, besonders in Gosauthale und am Wolfangsee:* K. Akad. Wiss. Wien, math, naturw. Cl., Denkschr., Bd. 7, p. 1-56, pls. 1-31.

ROEMER, F. A., 1840, *Die Versteinerungen des Norddeutschen Kreidegebirges*: Hannover, 145 p.

ROTH, R., 1928, *Monoceratina: A new genus of Ostracoda from the Pennsylvanian of Oklahoma*: Jour. Paleontology, v. 2, p. 15-19.

SARS, G. O., (1885), 1866, *Oversigt af norges marine ostracoder:* Norske Vidensk. Akad. Forh. (Christiania, Oslo), v. 16, 130 p.

———, 1888, *Nye bidrag til kundshaben om middlehavets invertebratfauna 4. Ostracoda Mediterranea*: Arch. Math. Naturv., v. 12, p. 173-324.

———, 1922-1928, *An account of the Crustacea of Norway, Ostracoda*: Bergen Mus. (Oslo), v. 9, 277 p.

SCHMIDT, RUTH A., 1948, *Ostracoda from the Upper Cretaceous and Lower Eocene of Maryland, Delaware, and Virginia*: Jour. Paleontology, v. 22, p. 389-431, pls. 61-64.

SCOTT, GAYLE, 1934, *Age of the Midway group*: Geol. Soc. America, Bull., v. 45, p. 1153.

SEXTON, J. V., 1951, *The ostracode genus* Cytherelloidea *in North America*: Same, v. 25, p. 808-816, pls. 115-117.

SHARAPOVA, E., 1937, *The stratigraphy of Mesozoic deposits of the Emba Region on the base of Ostracoda*: Leningrad: Vsesoiuznyi neftyanoi nauchne-issledovatelskii geologorazvedochnyi institut, Trudy, Series A. Fascicle 106, p. 69-84 (Russian), 84-86 (English), pls. 1, 2.

SKINNER, HUBERT C., 1956, *Ostracoda from the basal Arkadelphia Marl exposures near Hope, Arkansas*: Sixth Ann. Meeting Gulf Coast Assoc. Geol. Soc., p. 179-204, 4 pls.

STEPHENSON, M. B., 1936, *Shell structure of the Ostracoda genus Cytheridea:* Jour. Paleontology, v. 10, p. 695-703, pl. 94, text-fig. 1, 2.

———, 1937, *Middle Tertiary Ostracoda of the genus* Cytheridea: Same, v. 11, p. 145-159, pls. 26, 27.

———, 1944, *New Ostracoda from subsurface Middle Tertiary strata of Texas:* Same, v. 18, p. 156-161.

———, 1946, *Weches Eocene Ostracoda from Smithville, Texas*: Same, v. 20, p. 297-344, pls. 42-45.

SULC, JAROSLOW, 1932, *Contribution to our knowledge of the Ostracoda of the Cretaceous formation of Bohemia*: Inst. Géol. Paléont. Univ. Charles, Prague, Tr., p. 3-8.

SUTTON, A. H. & WILLIAMS, J. R., 1939, *Ostracoda from the Weches formation at Smithville, Texas*: Jour. Paleontology, v. 13, p. 561-574, pls. 63-64.

SWAIN, F. M., *in* ANDERSON, *et al.*, 1948, *Cretaceous and Tertiary subsurface geology. Ostracoda from the Hammond Well*: Maryland Dept. Geol., Mines, Water Resources, Bull. 2, p. 187-213, pls. 12-14.

———, 1951, *Ostracoda from wells in North Carolina. Part 1, Cenozoic Ostracoda*: U. S. Geol. Survey Prof. Paper no. 234-A, 58 p., 7 pls.

———, 1952, *Ostracoda from wells in North Carolina. Part 1, Mesozoic Ostracoda*: U. S. Geol. Survey Prof. Paper no. 234-B, p. 59-93, pls. 8-9.

SYLVESTER-BRADLEY, P. C., 1948, *The ostracode genus* Cythereis: Jour. Paleontology, v. 22, p. 792-797.

———, 1950, *The shell of the ostracode genus* Bairdia: Ann & Mag. Nat. Hist., ser. 12, v. 3, no. 33, p. 751-756.

TRIEBEL, ERIC, 1938, *Ostracoden-Untersuchungen,* Protocythere *und* Exophthalmocythere, *zwei neue Ostracoden-Gattungen aus des deutschen Kreide*: Senckenbergiana, v. 20, n. 1-2, p. 131-200.

———, 1938a, 1. *Die Ostracoden der deutschen Kreide*: 2. *Die* Cytheridea *Arten der Unteren Kreide*: Same, v. 20, n. 6, p. 425-501.

———, 1940, *Die Ostracoden der Deutschen Kreide. III Cytherideinae und Cytherinae aus der Unteren Kreide.* Same, v. 20, p. 471-501, pls. 1-6.

———, 1941, *Zur Morphologie und Oekologie der fossilen Oostracoden. Mit Beschreibung einiger neuer Gattungen und Arten*: Same, Bd. 23, p. 294-400, 15 pls.

ULRICH, E. O., 1901, *Eocene*, Md. Geol. Survey, p. 120.

———, & BASSLER, R. S., 1923, *American Silurian formations*: *Paleozoic Ostracoda; their morphology, classification, and occurrence*: Maryland Geol. Survey, Silurian Volume, p. 273-391.

WEINGEIST, LEO, 1949, *The ostracode genus Eucytherura and its species from the Cretaceous and Tertiary of the Gulf Coast*: Jour. Paleontology, v. 23, p. 364-379.

## APPENDIX

Collecting Locality 2 is located in Sec. 29 and 32, T. 11 S., R. 27 W., about 1¼ miles north of Saratoga, Arkansas on Arkansas State Highway 355. Eighteen samples from this location were obtained from the sample collection of the University of Kansas. The Marlbrook is 215 feet thick here and is bounded above by the Saratoga Chalk and below by the Annona Chalk.

| Sample Number | Distance above Base |
|---|---|
| 606 | 211 feet |
| 742 | 206 feet |
| 621 | 200 feet |
| 620 | 189 feet |
| 604 | 158 feet |
| 603 | 146 feet |
| 87 | 136 feet |
| 619 | 122 feet |
| 618 | 104 feet |
| 615 | 93 feet |
| 599 | 75 feet |
| 601 | 74 feet |
| 600 | 64 feet |
| 613 | 30 feet |
| 612 | 22 feet |
| 609 | 8 feet |
| 608 | 2 feet |

Collecting Locality 3 is located in Sec. 8, T. 11 S., R. 25 W., 3.3 miles north of Washington, Hempstead County on Arkansas State Highway 4. Only the Upper 30 feet of the Marlbrook is exposed here.

| Sample Number | Distance from Top |
|---|---|
| 1 | 1 foot |
| 2 | 10 feet |
| 3 | 20 feet |
| 4 | 30 feet |

Collecting Locality 4 is located on Arkansas State Highway 26 immediately below the intersection of Arkansas State Highways 26 and 51, which is 7 miles west of the town of Arkadelphia in Clark County. The Marlbrook Marl is about 40 feet thick at this location.

| Sample Number | Distance from Top |
|---|---|
| 5 | 1 foot |
| 6 | 15 feet |
| 7 | 25 feet |
| 8 | 1 foot above base |