

A Systematic Revision of the  
Ostracode Species Described by  
Ulrich and Bassler and by Malkin  
from the Chesapeake Group in  
Maryland and Virginia

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 1128



# A Systematic Revision of the Ostracode Species Described by Ulrich and Bassler and by Malkin from the Chesapeake Group in Maryland and Virginia

By RICHARD M. FORESTER

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*Describes new ostracode genera and species  
and systematically updates those species  
previously described from the Calvert,  
Choptank, St. Marys, Eastover, and  
Yorktown Formations*



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# A SYSTEMATIC REVISION OF THE OSTRACODE SPECIES DESCRIBED BY ULRICH AND BASSLER AND BY MALKIN FROM THE CHESAPEAKE GROUP IN MARYLAND AND VIRGINIA

By RICHARD M. FORESTER

## ABSTRACT

Those ostracode species described by Ulrich and Bassler (1904) and Malkin (1953) from the Chesapeake Group of early Miocene to early Pleistocene age are treated systematically. Lectotypes are designated for all species which have syntypic suites and the lectotypes, holotypes, or hypotypes for all but two species are illustrated. A new genus *Otikocythere* is proposed, with *Cythere punctistriata* Ulrich and Bassler 1904 as the type species. A new species, *Hulingsina calvertensis*, is also proposed. All of the species are placed in an updated biostratigraphic framework.

## INTRODUCTION

Ulrich and Bassler (1904) and Malkin (1953) described ostracode species from the Chesapeake Group (lower Miocene to lower Pleistocene) of Maryland and Virginia. In ascending order, the Chesapeake Group consists of the Calvert, Choptank, St. Marys, Eastover, Yorktown, and Croatan Formations (Clark and Miller, 1906; Blackwelder and Ward, 1976; Ward and Blackwelder, in press). The Ulrich and Bassler work was particularly important to ostracode systematics because the forms proposed were the first ostracodes described from the North American upper Tertiary. The taxa formed a nucleus for subsequent ostracode systematic and biostratigraphic studies dealing with upper Tertiary, Quaternary, and modern sediments of the Atlantic and Gulf Coasts. The majority of these and, to a lesser extent, the Malkin species, were in need of detailed systematic revision.

In Ulrich and Bassler (1904), many sexual dimorphs and juvenile instars were proposed as distinct species. Conversely, the authors also combined several distinctive (by modern standards) species under a single binomen that are represented by syntypic suites. Both practices, particularly the latter, have led to instability in taxonomic nomenclature because more than one species can be, and often have been, selected as the representatives for a binomen. Furthermore, many subsequent studies have erroneously identified other

species as being conspecific with those from the formations of the Chesapeake Group. This has led to a compounding of some of the original problems, thus hampering the utility of these species for systematic and biostratigraphic studies. The seven new species described by Malkin (1953) are also represented by syntypic suites and some of the same problems exist.

The primary purpose of this study has been to examine all of the species described by Ulrich and Bassler (1904) and Malkin (1953) in order to (1) classify them taxonomically, (2) designate lectotypes for all syntypic suites, in keeping with Article 74 of the 1961 International Code of Zoological Nomenclature, and (3) provide adequate illustrations for the lectotypes and holotypes, thereby stabilizing the nomenclature of these ostracode species.

A few of Ulrich and Bassler's (1904) holotypes have been either lost or crushed. Where possible, these species are illustrated herein, using specimens that I feel are consistent with the original authors' concept. Hazel (1977; in press) has already illustrated a few of the Pliocene species in this category and these are not treated in this paper. I have attempted to preserve as many of the original trivial and varietal names as possible. However, this has occasionally meant synonymizing some commonly but erroneously used names. Synonymies are provided and a brief differential diagnosis is given for most species in order to indicate a few of the morphologic features I regard as particularly characteristic.

## ACKNOWLEDGMENTS

This study represents part of a research topic completed while the author was a National Research Council Postdoctoral Associate with the U.S. Geological Survey. I would especially like to thank Joseph E. Hazel who proposed this study and generously provided space and equipment. I would also like to thank

M. J. Mann and W. Brown of the U.S. National Museum for taking the scanning electron micrographs.

### PREVIOUS OSTRACODE WORK

Howe and others (1935) identified a number of Ulrich and Bassler (1904) species and described several new forms, mostly from Florida correlatives of the Chesapeake Group. McLean (1957; 1966) outlined the stratigraphic distribution of some of these ostracode species. Swain (1948) studied ostracodes from the sub-surface Chesapeake Group of the Maryland Eastern Shore. Hazel (1967) discussed some of these species in context with a study of the Holocene Hemicysteridae and Trachyleberididae of the North Atlantic, and also dealt with the biostratigraphy and systematics of the ostracodes from the Yorktown Formation (Hazel, 1971; 1977; in press). Swain (1974) treated several ostracode species from the Yorktown and St. Marys Formations. In addition to the study by Howe and others (1935), other important works in which the species of Ulrich and Bassler (1904) have been identified, or thought to have been identified, from other geographic areas are Edwards (1944), Puri (1954) and Swain (1968). In some cases these studies have helped to clarify the taxonomic confusion associated with the Ulrich and Bassler material; however, with the exception of the work by Sandberg (1964) on *Peratocytheridea subovata* (Ulrich and Bassler, 1904), none of the original material seems to have been studied in any detail.

### STRATIGRAPHIC SETTING

In 1904, Shattuck divided the Calvert, Choptank, and St. Marys Formations into 24 units that he called "zones." The Yorktown Formation, which crops out in nearby Virginia, was not treated by Shattuck; it is, however, normally included in the Chesapeake Group. Shattuck's divisions were based on a variety of criteria (lithology, occurrence or non-occurrence of fossil shells, and others) and, using today's terminology, the divisions are usually not valid lithostratigraphic or biostratigraphic units, but are only beds or groups of beds. His zones 1-15 make up the Calvert Formation, 16-20 the Choptank Formation, and 21-24 the St. Marys Formation. The Calvert Formation was further divided by Shattuck (1904) into the Fairhaven Diatomaceous Earth (zones 1-3) and the Plum Point Marl Members (zones 4-15). Zone 1 crops out at Lyons Creek on the west side of Chesapeake Bay (Deale 7½-minute quadrangle), and the other zones appear successively as one proceeds south along the bay. Gernant (1970), in a study of the Choptank Formation,

concluded that beds 16-20 were distinctive enough to be assigned member status and proposed the names Calvert Beach, Drum Cliff, St. Leonard, Boston Cliffs, and Conoy Members, respectively.

Blackwelder and Ward (1976) have utilized the informal designation of Little Cove Point unit for bed 21 of the St. Marys Formation, because it has a distinctive lithology and fauna. They have also proposed (Ward and Blackwelder, in press) the Eastover Formation to incorporate those sediments that were known as the "Virginia St. Marys." The Eastover Formation includes the Claremont Manor and Cobham Bay Members (also new names), that were once recognized as formations by Blackwelder and Ward (1976).

To facilitate discussion I will refer to the Little Cove Point unit, the St. Marys Formation (as restricted to beds 22-24), and the Claremont Manor and Cobham Bay Members of the Eastover Formation as units A, B, C, and D respectively. Work in progress suggests that these units represent important biostratigraphic and lithology units.

Gibson (1971) states that, on the basis of planktic foraminifers, "zone" 10 is referable to planktic zone N8 or N9 of Blow (1969). N8 is considered to be of latest early Miocene age and N9 is earliest middle Miocene (Berggren and Van Couvering, 1974). Well-preserved specimens of the foraminifer *Praeorbulina glomerosa circularis* (Blow, 1956) have been identified by me (and confirmed by T. G. Gibson, U.S. Geological Survey) from zone 12. This subspecies is indicative of an N9 age for zone 12. The lower Miocene-middle Miocene boundary, therefore, very probably falls in zone 10 or 11 of the Calvert Formation. It is not clear how much of the lower Miocene is represented by the lower Calvert. The similarity of the ostracode and mollusc faunas of the lower zones of the Calvert to zone 10 suggests that only the upper part of the lower Miocene is present. The middle Miocene-late Miocene boundary has been tentatively placed between units B and C. This is based on a K/Ar radiometric date of 12.5 m.y. on glauconite from the restricted St. Marys Formation (unit B), coupled with a faunal change in molluscs at that level (Blackwelder and Ward, 1976). Berggren and Van Couvering (1974), indicate that radiometrically the middle Miocene-upper Miocene boundary is at about 11.0 m.y. It is possible, however, that the faunally distinct unit C is also middle Miocene; it contains no diagnostic planktic organisms and no known radiometrically dateable minerals.

Hazel (1977; in press), using various lines of evidence, concluded that the basal beds of the Yorktown Formation are early Pliocene in age (N19 of Blow, 1969) and that the youngest beds legitimately assigned to the Yorktown are probably no younger

than the N20 zone. Paleontologic and radiometric data summarized by Hazel (1977; in press) and Blackwelder and Ward (1976) suggested that unit D (Cobham Bay Member of Eastover Formation) is of late, but not latest, Miocene age.

Most of the Ulrich and Bassler (1904) ostracode specimens came from "zone" 10 of the Calvert Formation at Plum Point on Chesapeake Bay. Other localities included Church Hill, Md. (Calvert Formation), Peachblossom Creek and Paw Paw Point, Md. (Choptank Formation), and outcrops on the James River in Virginia (Yorktown Formation). Malkin's (1953) material came from zones 4-6, 9, 10, 14, 19, 22 in Maryland and from the Yorktown Formation along the York and James Rivers, Va. The author has examined ostracode material from the above localities (except Church Hill and Paw Paw Point) and from numerous other localities which have ample comparative material. In the strictest sense exact original Ulrich and Bassler localities along Chesapeake Bay no longer exist due to erosion of the cliffs since 1904.

## PROCEDURES

When species from either the Ulrich and Bassler (1904) or the Malkin (1953) collections were represented by syntypes, lectotypes and occasionally paralectotypes have been designated and illustrated for each species. If a species is represented only by a holotype, it has been illustrated if it was extant in the collection (some are not). All illustrations are scanning electron micrographs of gold- or gold-palladium-coated specimens. The known stratigraphic range in the Maryland and Virginia region is given for each species and is based primarily upon studies in progress by Forester on the Miocene part of the Chesapeake Group and by Hazel (1971; 1977; in press) and Valentine (1971) for the younger deposits. When none of the original specimens exist, or where additional illustrations of non-type material were needed for clarification, samples from U.S. Geological Survey collections have been used. These hypotypes, where possible, were selected from topotype material, recognizing that true topotype material is no longer available, in most cases, due to the erosion of the cliffs along Chesapeake Bay.

All of the illustrated specimens and the remaining Ulrich and Bassler and Malkin specimens are deposited in the collections of the National Museum of Natural History.

## SYSTEMATIC PALEONTOLOGY

The left hand column of table 1 lists in alphabetical order, under their original generic assignments, the

species described by Ulrich and Bassler (1904) and Malkin (1953). The right hand column of the table gives my interpretation of the modern generic and species assignment. Each species is discussed in the following section under its updated binomen. Of the original 49 species-group taxa proposed, I feel that only 35 are valid.

The Ulrich and Bassler material has provided the type species for four previously described genera (*Henryhowella evax*, *Murrayina howei*, *Puriana rugipunctata*, and *Orionina vaughani*). One Ulrich and Bassler species, *Cythere punctistriata*, is made the type species of the new genus *Otikocythere*.

Table 2 is a generalized occurrence chart showing the distribution in the Chesapeake Group of the 35 valid taxa. See Hazel (1977) for a more detailed biostratigraphy for the Pliocene. A biostratigraphic treatment of the Miocene forms is in preparation by the author. Occurrence data are given for each species in the following section.

## SYSTEMATICS

**Class OSTRACODA Latreille, 1806**

**Order PODOCOPIDA G. W. Muller, 1894**

**Suborder PODOCOPA Sars, 1866**

**Superfamily CYTHERACEA Baird, 1850**

**Family CYTHERIDEIDAE Sars, 1925**

**Genus Cytheridea Bosquet, 1852**

*Type-species.*—*Cythere mulleri* Munster, 1830

***Cytheridea diagonalis* (Malkin, 1953)**

Plate 1, figures 3, 6

*Clithrocytheridea diagonalis* Malkin, 1953, p. 782, pl. 79, figs. 18, 19, 21, 22, 24.

Not *Clithrocytheridea diagonalis* Malkin. McLean, 1957, p. 74, pl. 8, figs. 1a, b.

*Diagnosis.*—Greatest length near the ventral margin and greatest height through central muscle scar region; posterior half of valve drawn out, posteroventral corner extending below ventral margin in females; normal pores (in punctae) irregularly distributed over valve surface; two prominent concentric rows of punctae that form two furrows along anterior margin of valve; larger than *Cytheridea virginensis* (Malkin, 1953).

*Lectotype.*—A female valve (Malkin, 1953, pl. 79; fig. 19), USNM 256018, from the Calvert Formation (locality MD 13-3 of Malkin, 1953) is herein designated the lectotype (pl. 1, fig. 6).

*Measurements.*—The lectotype is 900  $\mu\text{m}$  (micrometers) in length and 500  $\mu\text{m}$  in height. The illustrated

TABLE 1.—A listing of all of the Ulrich and Bassler (1904) and Malkin (1953) ostracode species by their original designation and by their present (this report) designation

| Ulrich and Bassler (1904) or Malkin (1953) taxa              | Present assignment   |
|--|--|
| <i>Clithrocytheridea diagonalis</i> Malkin                   | <i>Cytheridea diagonalis</i> (Malkin).                     |
| <i>virginiensis</i> Malkin                                   | <i>virginiensis</i> (Malkin).                              |
| <i>Cythere burnsi</i> Ulrich and Bassler                     | <i>Pseudocytheretta burnsi</i> (Ulrich and Bassler).       |
| <i>calverti</i> Ulrich and Bassler                           | <i>Bensonocythere calverti</i> (Ulrich and Bassler).       |
| <i>clarkana</i> Ulrich and Bassler                           | <i>Echinocythereis clarkana</i> (Ulrich and Bassler).      |
| var. <i>miniscula</i> Ulrich and Bassler                     | <i>miniscula</i> (Ulrich and Bassler).                     |
| <i>dorsicornis</i> Ulrich and Bassler                        | <i>Murrayina martini</i> (Ulrich and Bassler).             |
| var. <i>bicornis</i> Ulrich and Bassler                      | <i>howei</i> (Ulrich and Bassler).                         |
| <i>evax</i> Ulrich and Bassler                               | <i>Henryhowella evax</i> (Ulrich and Bassler).             |
| var. <i>oblongula</i> Ulrich and Bassler                     | Do.  |
| <i>exanthemata</i> Ulrich and Bassler                        | <i>Actinocythereis exanthemata</i> (Ulrich and Bassler).   |
| <i>francisca</i> Ulrich and Bassler                          | <i>Otikocythere punctistriata</i> (Ulrich and Bassler).    |
| <i>inaequivalvis</i> Ulrich and Bassler                      | <i>Protocytheretta inaequivalvis</i> (Ulrich and Bassler). |
| <i>lienenklausi</i> Ulrich and Bassler                       | <i>Muellerina lienenklausi</i> (Ulrich and Bassler).       |
| <i>martini</i> Ulrich and Bassler                            | <i>Murrayina martini</i> (Ulrich and Bassler).             |
| <i>micula</i> Ulrich and Bassler                             | <i>Muellerina micula</i> (Ulrich and Bassler).             |
| <i>nitidula</i> Ulrich and Bassler                           | <i>Pseudocytheretta burnsi</i> (Ulrich and Bassler).       |
| var. <i>calvertensis</i> Ulrich and Bassler                  | Do.  |
| <i>paucipunctata</i> Ulrich and Bassler                      | Do.  |
| <i>planibasalis</i> Ulrich and Bassler                       | <i>Echinocythereis planibasalis</i> Ulrich and Bassler).   |
| <i>plebeia</i> Ulrich and Bassler                            | <i>Pseudocytheretta plebeia</i> (Ulrich and Bassler).      |
| var. <i>capax</i> Ulrich and Bassler                         | Do.  |
| var. <i>modica</i> Ulrich and Bassler                        | Do.  |
| <i>porcella</i> Ulrich and Bassler                           | Do.  |
| <i>producta</i> Ulrich and Bassler                           | <i>Murrayina howei</i> (Ulrich and Bassler).               |
| <i>punctistriata</i> Ulrich and Bassler                      | <i>Otikocythere punctistriata</i> (Ulrich and Bassler).    |
| <i>rugipunctata</i> Ulrich and Bassler                       | <i>Puriana rugipunctata</i> (Ulrich and Bassler).          |
| ? <i>shattucki</i> Ulrich and Bassler                        | <i>Microcytherura shattucki</i> (Ulrich and Bassler).      |
| <i>spiniplicata</i> Ulrich and Bassler                       | <i>Henryhowella evax</i> (Ulrich and Bassler).             |
| <i>subovalis</i> Ulrich and Bassler                          | <i>Cytheridea subovalis</i> (Ulrich and Bassler).          |
| <i>toumeyei</i> Ulrich and Bassler                           | <i>Pseudocytheretta burnsi</i> (Ulrich and Bassler).       |
| <i>vaughani</i> Ulrich and Bassler                           | <i>Orionina vaughani</i> (Ulrich and Bassler).             |
| <i>Cythereis alaris</i> Ulrich and Bassler                   | <i>Actinocythereis</i> sp. (Ulrich and Bassler).           |
| <i>cornuta</i> var. <i>americana</i> Ulrich and Bassler      | <i>Pterygocythereis americana</i> (Ulrich and Bassler).    |
| <i>Cytheridea</i> ? <i>chesapeakensis</i> Ulrich and Bassler | <i>Pseudocytheretta plebeia</i> (Ulrich and Bassler).      |
| <i>subovata</i> Ulrich and Bassler                           | <i>Peratocytheridea subovata</i> (Ulrich and Bassler).     |
| <i>Cytherideis ashermani</i> Ulrich and Bassler              | <i>Hulingsina ashermani</i> (Ulrich and Bassler).          |
| <i>echolsae</i> Malkin                                       | <i>rugipustulosa</i> (Edwards).                            |
| <i>cylindrica</i> Ulrich and Bassler                         | <i>cylindrica</i> (Ulrich and Bassler).                    |
| <i>longula</i> Ulrich and Bassler                            | <i>semicircularis</i> (Ulrich and Bassler).                |
| <i>semicircularis</i> Ulrich and Bassler                     | Do.  |
| <i>subaequalis</i> Ulrich and Bassler                        | <i>subaequalis</i> (Ulrich and Bassler).                   |
| <i>Cytheropteron nodosum</i> Ulrich and Bassler              | <i>Paracytheridea altila</i> (Edwards).                    |
| <i>Cytherura coryelli</i> Malkin                             | <i>Cytherura coryelli</i> Malkin.                          |
| <i>Eocytheropteron yorktownensis</i> Malkin                  | <i>Cytheropteron</i> ? <i>yorktownensis</i> (Malkin).      |
| <i>Hemicythere schmidtae</i> Malkin                          | <i>Thaerocythere schmidtae</i> (Malkin).                   |
| <i>Paracytheridea shattucki</i> var. <i>curta</i> Malkin     | <i>Microcytherura curta</i> (Malkin).                      |
| <i>similis</i> Malkin  | <i>similis</i> (Malkin).                                   |
| <i>Trachyleberis radiata</i> Malkin                          | <i>Murrayina radiata</i> (Malkin).                         |

paralectotype (pl. 1, fig. 3), USNM 256019, is 950  $\mu$ m in length and 460  $\mu$ m in height.

**Remarks.**—*Cytheridea diagonalis* (Malkin, 1953) exhibits strong sexual dimorphism, with the males being more elongate and lower than the females.

**Occurrence.**—Malkin (1953) reported this species from the Calvert and Choptank Formations. However, in our collections it occurs throughout the Calvert Formation, but is not present in the Choptank Formation. The specimens reported by Malkin (1953) from the Choptank Formation are all juveniles and their assign-

ment to *C. diagonalis* is questionable. As far as is known *Cytheridea diagonalis* is restricted to the Calvert Formation.

**Stratigraphic range.**—Lower to middle Miocene.

#### ***Cytheridea virginiensis* (Malkin, 1953)**

Plate 1, figure 7

*Haplocytheridea* sp. aff. *H. israelsky* (Stephenson). Swain, 1951, p. 20, pl. 1, figs. 15-17.

*Clithrocytheridea virginiensis* Malkin, 1953, p. 783, pl. 79, figs. 27, 28; McLean, 1957, p. 74, pl. 8, figs. 2a-g.



TABLE 2.—Stratigraphic distribution of the Ulrich and Bassler (1904) and Malkin (1953) ostracode species within the Maryland and Virginia Miocene and Pliocene formations  
[Leaders (—) indicate not found]

| Taxa  | Miocene      |                   |                    |                     |        |                    | Lower and Middle(?) Pliocene |                    |
|---|--------------|-------------------|--------------------|---------------------|--------|--------------------|------------------------------|--------------------|
|   | Lower (part) | Middle            |                    | Upper (part)        |        | Yorktown Formation |                              |                    |
|   |              | Calvert Formation | Choptank Formation | St. Marys Formation |        |                    |                              | Eastover Formation |
|   |              |                   |                    | Unit A              | Unit B |                    |                              |                    |
| <i>Actinocythereis exanthemata</i> ...          | X            | X                 | --                 | --                  | --     | --                 | --                           |                    |
| <i>Bensonocythere calverti</i> .....            | X            | --                | --                 | --                  | X      | X                  | X                            |                    |
| <i>Cytheridea diagonalis subovalis</i> .....    | X            | X                 | --                 | --                  | --     | --                 | --                           |                    |
| <i>virginiensis</i> .....                       | --           | --                | --                 | --                  | --     | --                 | X                            |                    |
| <i>Cytheropteron? yorktownensis</i> ..          | --           | --                | --                 | --                  | --     | --                 | X                            |                    |
| <i>Cytherura coryelli</i> .....                 | --           | X                 | --                 | X                   | --     | --                 | --                           |                    |
| <i>Echinocythereis clarkana miniscula</i> ..... | X            | --                | --                 | --                  | --     | --                 | --                           |                    |
| <i>planibasalis</i> .....                       | X            | X                 | --                 | --                  | X      | --                 | X                            |                    |
| <i>Henryhowella evax ashermanni</i> .....       | X            | X                 | X                  | X                   | X      | X                  | --                           |                    |
| <i>cylindrica</i> .....                         | X            | X                 | X                  | X                   | --     | --                 | --                           |                    |
| <i>rugipustulosa</i> .....                      | --           | --                | --                 | --                  | X      | X                  | X                            |                    |
| <i>semicircularis</i> .....                     | X            | X                 | X                  | X                   | X      | X                  | X                            |                    |
| <i>subaequalis</i> .....                        | X            | --                | --                 | --                  | --     | --                 | --                           |                    |
| <i>Microcytherura curta shattucki</i> .....     | --           | --                | --                 | --                  | --     | --                 | X                            |                    |
| <i>similis</i> .....                            | --           | X                 | --                 | --                  | --     | --                 | X                            |                    |
| <i>Muellerina lienenklausi micula</i> .....     | X            | X(?) <sup>1</sup> | --                 | --                  | --     | --                 | --                           |                    |
| <i>Murrayina howei martini</i> .....            | X            | --                | --                 | --                  | --     | --                 | --                           |                    |
| <i>radiata</i> .....                            | X            | X                 | --                 | --                  | --     | --                 | --                           |                    |
| <i>Orionina vaughani</i> .....                  | --           | --                | --                 | --                  | --     | --                 | X                            |                    |
| <i>Otikocythere punctistriata</i> .....         | X            | X                 | --                 | --                  | --     | --                 | --                           |                    |
| <i>Paracytheridea altila</i> .....              | --           | --                | --                 | --                  | X      | --                 | X                            |                    |
| <i>Peratocytheridea subovata</i> .....          | X            | X                 | --                 | X                   | --     | --                 | --                           |                    |
| <i>Protocytheretta inaequivalvis</i> ...        | X            | --                | --                 | --                  | --     | --                 | --                           |                    |
| <i>Pseudocytheretta burnsi plebeia</i> .....    | X            | X                 | X                  | X                   | --     | --                 | --                           |                    |
| <i>Pterygocythereis americana</i> .....         | X            | --                | --                 | --                  | --     | --                 | --                           |                    |
| <i>Puriana rugipunctata</i> .....               | --           | --                | --                 | --                  | X      | X                  | X                            |                    |
| <i>Thaerocythere schmidtae</i> .....            | --           | --                | --                 | --                  | X      | X                  | X                            |                    |

<sup>1</sup>Identification uncertain.

Not *Clithrocytheridea virginiensis* Malkin, 1953, p. 783, pl. 79, figs. 23, 25 (= *Cytheridea campwallacensis* Hazel, 1977).  
 ?*Haplocytheridea* sp. aff. *H. blanpedi* (Stephenson). Swain, 1968, p. 8, pl. 1, figs. 6a, b.  
*Cytheridea* sp. A Swain, 1974 (partim), p. 13, pl. 1, figs. 6, 7; not *Cytheridea* sp. A Swain, 1974, p. 13, pl. 1, fig. 8 (= *Peratocytheridea bradyi* (Stephenson, 1938)).  
*Cytheridea muelleri* (Munster) subspecies Swain, 1974, p. 14, pl. 1, fig. 5.  
*Cytheridea virginiensis* (Malkin). Hazel, 1977, p. 382, fig. g.

**Diagnosis.**—Greatest length about midvalve and greatest height just anterior of the central muscle scar

field; normal pores (in punctae) forming somewhat regular V-shaped patterns in medial area of the valve; three concentric rows of punctae forming concentric furrows along both the anterior and posterior ends of the valve; smaller than *Cytheridea diagonalis* (Malkin, 1953).

**Lectotype.**—A male left valve (Malkin, 1953, pl. 79, fig. 28), USNM 256020, from the Yorktown Formation (locality VA-10 of Malkin, 1953) is herein designated as the lectotype (pl. 1, fig. 7).

**Measurements.**—The lectotype is 770 μm in length and 420 μm in height.

**Remarks.**—*Cytheridea virginiensis* (Malkin, 1953) and a closely related species are illustrated in Hazel (1977; in press). Both species are morphologically similar except that *C. virginiensis* is always smaller and has a somewhat different punctae-normal pore pattern on the lateral surface of the valve. The larger species occurs in units C and D of the Eastover Formation (upper Miocene) and the lower (lower Pliocene) Yorktown Formation. *Cytheridea virginiensis* occurs throughout the Yorktown Formation and also occurs in upper Pliocene and lower Pleistocene units in the Atlantic Coastal Plain (Hazel, 1977).

**Stratigraphic range.**—Pliocene to lower Pleistocene.

**Cytheridea subovalis (Ulrich and Bassler, 1904)**

Plate 1, figures 1, 8

*Cythere subovalis* Ulrich and Bassler, 1904, p. 111, pl. 38, figs. 14, 15.

**Diagnosis.**—Subtriangular to oval valve outline; greatest length just below the midheight; greatest height just anterior of central muscle scar field; normal pores (in punctae) form a poorly defined V-shaped pattern on the medial area of the valve; three concentric rows of punctae form three furrows along the anterior margin of the valve, concentric furrows present but poorly defined at the posterior margin of the valve.

**Measurements.**—The holotype (pl. 1, fig. 8), USNM 35439, is 840 μm in length and 540 μm in height. The illustrated specimen (pl. 1, fig. 1), USNM 256021, is 850 μm long and 510 μm in height.

**Remarks.**—The species concept of *Cytheridea subovalis* (Ulrich and Bassler, 1904) is based upon a single poorly preserved valve (pl. 1, fig. 8). This specimen (the holotype) was collected at their Paw Paw Point locality near Leonardtown, Md., from the Choptank Formation. Due to the poor preservation, cogent placement of other specimens in this species is difficult. In my studies of the Choptank Formation no adult *Cytheridea* has yet been found. Specimens of a *Cytheridea* from the Calvert Formation at Plum Point (Bed 10) are similar in size and shape to the holotype of *C. subovalis* and are tentatively placed in this species.

One of these specimens is illustrated in plate 1, figure 1. This specimen and the others from the Plum Point locality form the material upon which the diagnosis of *C. subovalis* is based.

*Occurrence*.—Calvert (see remarks) and the Choptank Formations.

*Stratigraphic range*.—Lower to middle Miocene.

**Genus *Peratocytheridea* Hazel, in press**

*Type-species*.—*Cytheridea setipunctata* Brady, 1869.

***Peratocytheridea subovata* (Ulrich and Bassler, 1904)**

Plate 1, figure 4

*Cytheridea subovata* Ulrich and Bassler, 1904, p. 124, pl. 37, figs. 1-8.

Not *Haplocytheridea?* cf. *H.?* *subovata* (Ulrich and Bassler). Swain, 1951, p. 22, pl. 1, figs. 19, 20.

*Haplocytheridea subovata* (Ulrich and Bassler). Malkin, 1953, p. 782, pl. 79, figs. 15, 17; Sandberg, 1964, p. 359, pl. 1, figs. 1-9 (gives more complete synonymy).

*Diagnosis*.—Subovate valve outline; greatest length along midvalve and greatest height in central muscle scar area; finely punctate lateral surface with punctae containing the normal pores; posterior acute.

*Measurements*.—The illustrated paralectotype (pl. 1, fig. 4), USNM 648513, is 880  $\mu\text{m}$  in length and 480  $\mu\text{m}$  in height. The lectotype, USNM 35445, is 870  $\mu\text{m}$  in length and 490  $\mu\text{m}$  in height.

*Remarks*.—*Peratocytheridea subovata* (Ulrich and Bassler, 1904) comprises a complex group of sizes and morphologies. The lectotype and paralectotype (Sandberg, 1964, chose the lectotype from Ulrich and Bassler's syntype suite) are from bed 10 of the Calvert Formation at Plum Point, Md. The Calvert forms are generally small specimens ranging in size from 750 to 900  $\mu\text{m}$  in length, and the females are smaller than the males. In contrast, specimens from the Choptank Formation are usually within a range of from 920 to 1,200  $\mu\text{m}$  in length, the females again being smaller. Units A and B of the St. Marys Formation contain forms intermediate in size (ranging from 850 to 930  $\mu\text{m}$  between the Calvert and Choptank specimens. This size-time relationship has also been observed in correlative sediments in Florida (Sandberg, 1964).

Sandberg's (1964) illustrated adults were all from the Shoal River Formation of Florida. These specimens represent the large version of *P. subovata* (Ulrich and Bassler) common to the Choptank Formation. At present no obvious explanation can be advanced for these size differences.

*Occurrence*.—Ulrich and Bassler (1904) reported this species from the Calvert Formation. Malkin (1953) notes the occurrence of this species in both the Calvert

and Choptank Formations. I have found *Peratocytheridea subovata* occurring commonly in the Calvert, Choptank and units A and B of the St. Marys Formations.

*Stratigraphic range*.—Lower to middle Miocene.

**Family NEOCYTHERIDEIDAE Puri, 1957**

**Genus *Hulingsina* Puri, 1958**

*Type-species*.—*Hulingsina tuberculata* Puri, 1958.

***Hulingsina calvertensis* new species**

Plate 1, figures 2, 5

*Cytherideis ashermani* Ulrich and Bassler, 1904, p. 126, pl. 37, fig. 15.

*Cushmanidea fabula* (Howe and Dohm). Swain, 1974, p. 15, pl. 1, fig. 20; pl. 8, figs. 4a, b.

Not *Cytherideis ashermani* Ulrich and Bassler, 1904, p. 126, pl. 37, figs. 11-14, 16; Howe and others, 1935, p. 14, pl. 3, figs. 8-10; Malkin, 1953, p. 778, pl. 78, figs. 1-13; Puri, 1954, p. 286, pl. 9, figs. 4-8. (= *Hulingsina* spp., primarily *H. semicircularis* (Ulrich and Bassler, 1904)).

Not *Cushmanidea ashermani* (Ulrich and Bassler). McLean, 1957, p. 77, pl. 18, figs. 5a-f. (= *Hulingsina* sp.)

Not *Pontocythere ashermani* (Ulrich and Bassler). Swain, 1968, p. 10, pl. 2, figs. 1a-d. (= *Hulingsina* sp.)

Not *Pontocythere* (*Hulingsina*) *ashermani* (Ulrich and Bassler). Swain, 1974, p. 16, pl. 1, figs. 21, 24; pl. 2, figs. 1-3; pl. 9, figs. 12a, b. (= *Hulingsina* sp.)

*Diagnosis*.—Subquadrate shape; very oblique anterodorsal margin; predominantly smooth valves (particularly in the anterior); diagnostic punctae pattern in the posteromedial area of the valve where the pattern consists of five punctae forming an isosceles triangle that points toward the posterior, with three additional punctae located posterodorsally from the posterior-most point of the triangle.

*Etymology*.—The trivial name is after the Calvert Formation in which the holotype occurs.

*Holotype*.—A female left valve (pl. 1, fig. 2), USNM 256022, from "zone" 10 of the Calvert Formation, 0.5 miles north of Randle Cliffs, 10 feet above the water level on the west side of Chesapeake Bay, Calvert County, Md.

*Measurements*.—The holotype is 775  $\mu\text{m}$  in length and 375  $\mu\text{m}$  in height.

*Remarks*.—The syntype suite of four specimens (only one was illustrated by Ulrich and Bassler, 1904) for *Cytherideis ashermani* Ulrich and Bassler, 1904, represents three species. There are two poorly preserved juvenile specimens, which, in my opinion, represent *Hulingsina subaequalis* (Ulrich and Bassler, 1904). A third specimen, also poorly preserved, is conspecific with *H. semicircularis* (Ulrich and Bassler, 1904) (see discussion under that species). The fourth specimen represents a valid species that is a common

constituent of assemblages in the Miocene part of the Chesapeake Group. It was illustrated by Ulrich and Bassler (1904, plate 37, figure 15), and subsequently by Swain (1974), where it was erroneously classified under *Cushmanidea fabula* (Howe and Dohm, 1935) in Howe and graduate students (1935). There were other specimens illustrated by Ulrich and Bassler (1904), but these have apparently been lost.

I had originally planned to designate the specimen illustrated by Ulrich and Bassler (1904, pl. 37, fig. 15) as the lectotype of *Cytherideis ashermani* Ulrich and Bassler, and thereby conserve that trivial name. Unfortunately, the Ulrich and Bassler specimen was lost after the scanning electron micrograph shown on plate 1, figure 5 (this report) was taken. As noted above, the other specimens of the syntype suite were not illustrated and are either juveniles or clearly another described species (*Hulingsina semicircularis*). Furthermore, the trivial name *ashermani* has never been consistently used for any valid taxon occurring in the Chesapeake Group. In fact, the name *ashermani* has been used for several distinctive species of *Hulingsina* occurring in sediments ranging in age from early Miocene to Holocene. *Hulingsina ashermani* represents a group of species sharing a generally similar ornament rather than any one species.

In view of the situation outlined above, I feel that it is best to: (1) propose a new species that would include the lost specimen illustrated by Ulrich and Bassler as part of their *Cytherideis ashermani*, (2) designate as the lectotype of *C. ashermani* the unillustrated adult specimen from the syntype suite (this specimen is cataloged as USNM 35446), and (3) subjectively suppress *Cytherideis ashermani* by placing it in synonymy with *Hulingsina semicircularis*. This action is further warranted because the Ulrich and Bassler (1904) illustrations (pl. 37; figures 11-16) indicate that their concept of *Cytherideis ashermani* involved at least *Hulingsina calvertensis* and several poorly preserved specimens of *H. semicircularis*. If later workers disagree with this assessment that the lectotype of *Cytherideis ashermani* is synonymous with *Hulingsina semicircularis*, the trivial name *ashermani* can be revived.

**Occurrence.**—*Hulingsina calvertensis* occurs throughout the Miocene part of the Chesapeake Group.

**Stratigraphic range.**—Lower to upper Miocene.

***Hulingsina rugipustulosa* (Edwards, 1944)**

Plate 2, figure 1

*Cytherideis rugipustulosa* Edwards, 1944, p. 514, pl. 86, figs. 5-7.  
*Cytherideis echolsae* Malkin, 1953, p. 778, pl. 78, figs. 14-17.

?*Cushmanidea echolsae* (Malkin). McLean, 1957, p. 78, pl. 9, figs. 1a-c, 2a-d.

*Pontocythere rugipustulosa* (Edwards). Swain, 1968, p. 9, pl. 1, fig. 10.

*Hulingsina rugipustulosa* (Edwards). Valentine, 1971, pl. 3, figs. 17, 18, 21, 22, 25, 26, 29, 30.

*Pontocythere (Hulingsina) rugipustulosa* (Edwards). Swain, 1974, p. 17, pl. 1, fig. 18; pl. 2, figs. 4-7.

**Diagnosis.**—Distinguished by its generally small size, elongate subrectangular valve outline, rugose nature of the primary ornament (often leaving the appearance of the valve surface being wrinkled), and variation with respect to the presence of pustules along the carinae.

**Lectotype.**—A male right valve (Malkin, 1953, pl. 78, fig. 15), USNM 256023, from the Yorktown Formation (locality VA-12 of Malkin, 1953) is herein selected as the lectotype of *Cytherideis echolsae* Malkin, 1953 (pl. 2, fig. 1).

**Measurements.**—The lectotype is 650  $\mu\text{m}$  in length and 250  $\mu\text{m}$  in height.

**Remarks.**—*Hulingsina rugipustulosa* (Edwards, 1944) is typically represented by two morphologies (also see Valentine, 1971), a pustulose form described by Edwards (1944) as *Cytherideis rugipustulosa* and a nonpustulose form described by Malkin (1953) as *Cytherideis echolsae*. The carinae and normal pores of both forms seem identical in pattern. Occurrence data suggest that the nonpustulose form tends to be a more cryophilic form, whereas the pustulose form is more thermophilic. Both forms commonly occur in the same modern samples in the subtropical Carolinian Faunal Province, but only the nonpustulose form occurs north of Cape Hatteras in the mild temperate Virginian Province (J. E. Hazel, written commun., 1976).

**Occurrence.**—Malkin (1953) reported this species from the Yorktown Formation in Virginia. In my samples from the Chesapeake Group the nonpustulose form is found in units C and D of the Eastover Formation and in the Yorktown Formation.

**Stratigraphic range.**—Upper Miocene to Holocene.

***Hulingsina cylindrica* (Ulrich and Bassler, 1904)**

Plate 2, figure 2

*Cytheridea cylindrica* Ulrich and Bassler, 1904, p. 126, pl. 37, fig. 17.

**Diagnosis.**—Quadrate valve outline; sulcus along the line of the central muscle scar field; prominent reticulum.

**Measurements.**—The holotype (pl. 2, fig. 2), USNM 35447, is 890  $\mu\text{m}$  in length and 370  $\mu\text{m}$  in height.

**Remarks.**—*Hulingsina cylindrica* is similar to many other reticulate species of *Hulingsina*; however, it is

usually more coarsely reticulate, with a reticulum that covers the entire lateral surface, except for the medial dorsal part of the valve. The species, taken in a strict sense, may be confined to the Calvert Formation and represent a very rare component of the ostracode fauna. There is, however, a very similar but somewhat larger form in the Choptank and St. Marys Formations. The Choptank forms average 1,030  $\mu\text{m}$  in length; the St. Marys form averages 900  $\mu\text{m}$  in length. This younger form is probably conspecific with the Calvert form because an increase in size of several species from the Calvert to the Choptank Formations has been noted.

**Occurrence.**—Calvert Formation and probably the Choptank Formation, as well as units A and B of the St. Marys Formation.

**Stratigraphic range.**—Lower to middle Miocene.

***Hulingsina semicircularis* (Ulrich and Bassler, 1904)**

Plate 2, figure 5

*Cytherideis semicircularis* Ulrich and Bassler, 1904, p. 127, pl. 37, figs. 18–20.

*Cytherideis longula* Ulrich and Bassler, 1904, p. 128, pl. 37, figs. 21–27.

*Cytherideis ashermanni* Ulrich and Bassler, 1904, partim, p. 126, pl. 37, figs. 11–13; Howe and others, 1935, p. 14, pl. 3, figs. 8–10; Malkin, 1953, partim, p. 778, pl. 78, figs. 1–11, 13?; Puri, 1953, partim, p. 286, pl. 9, figs. 4, 5, 7, 8.

**Diagnosis.**—This species is distinguished by its somewhat semicircular valve outline, greatest length below midheight, greatest height (midvalve) behind the adductor muscle scar field, prominent large punctae containing normal pores.

**Lectotype.**—A female right valve, USNM 35449 a, is designated as the lectotype. This specimen is probably that illustrated by Ulrich and Bassler (1904) on plate 37, figure 18. The syntype series is from the Calvert Formation at Plum Point, Md.

**Measurement.**—The lectotype is 760  $\mu\text{m}$  in length and 350  $\mu\text{m}$  in height.

**Remarks.**—The specimens assigned to *Cytherideis semicircularis* by Ulrich and Bassler (1904) are all females (as has been noted by many authors). I believe the male of the species was described by Ulrich and Bassler as *Cytherideis longula* and therefore, synonymize the two species, retaining the trivial name *semicircularis*. A left valve, which is probably the specimen illustrated by Ulrich and Bassler (1904) on plate 37, figure 25, USNM 35448 a, is designated as the lectotype of *Hulingsina longula* (Ulrich and Bassler, 1904). The lectotype is illustrated herein on plate 2, figure 3 and a paralectotype is illustrated in plate 2, figure 4. The lectotype is 940  $\mu\text{m}$  in length and 380  $\mu\text{m}$  in height, while the illustrated paralectotype, USNM 35448 b, is 850  $\mu\text{m}$  in length and 330  $\mu\text{m}$  in height.

My concept is, however, that *H. semicircularis* (Ulrich and Bassler) is equivalent in part to *Cytherideis ashermanni* of some authors. The *C. ashermanni* syntype series represents three species (see discussion under *Hulingsina calvertensis*), and it is not clear what their concept of the species was. The *C. semicircularis* series contains only one species, in my opinion; at least for the females, Ulrich and Bassler's concept of them is clear. One of the specimens in the syntype series of *Cytherideis ashermanni*, herein designated the lectotype of that species, is placed in synonymy of *H. semicircularis*.

*Hulingsina semicircularis* is a common constituent of Calvert, Choptank and St. Marys (units A and B) assemblages, becoming somewhat rarer in the younger Miocene (Eastover Formation) sediments (units C and D). As with several other ostracode species occurring in both the Calvert and Choptank Formations, the mean size of the Choptank form is larger.

*Hulingsina semicircularis* (Ulrich and Bassler) is morphologically similar to *H. americana* (Cushman, 1906). Pleistocene and Holocene specimens of the latter species are readily distinguished from *H. semicircularis* by their narrower murae, prominent normal pores, and slight differences in valve outline. However, Pliocene specimens are morphologically somewhat gradational, exhibiting only slightly greater morphologic similarity with *H. americana*. My concept of *H. semicircularis* restricts the species to the Miocene; however, considerable difficulty is encountered in trying to classify some specimens from the lower part of the Yorktown Formation.

**Occurrence.**—Calvert, Choptank, and St. Marys and Eastover Formations.

**Stratigraphic range.**—Lower to upper Miocene.

***Hulingsina subaequalis* (Ulrich and Bassler, 1904)**

Plate 2, figure 6

*Cytherideis subaequalis* Ulrich and Bassler, 1904, p. 127, pl. 37, fig. 28; Malkin, 1953, partim, p. 779, pl. 78, fig. 18.

**Diagnosis.**—This species is distinguished by its quadrate shape; height approximately half the length; few, scattered punctae with normal pores.

**Measurements.**—The holotype USNM 35450 (female left valve, pl. 2, fig. 6), is 840  $\mu\text{m}$  in length and 420  $\mu\text{m}$  in height.

**Occurrence.**—Ulrich and Bassler (1904) reported this species from the Calvert Formation. Malkin (1953) reported it from the Calvert and Choptank Formations, but her illustrated specimens are all from the Calvert Formation. In my samples, *Hulingsina subaequalis* occurs in the Calvert below "zone" 11.

**Stratigraphic range.**—Lower Miocene.

**Family CYTHERURIDAE G. W. Muller, 1894**  
**Subfamily CYTHERURINAE G. W. Muller, 1894**

**Genus Cytherura Sars, 1866**

*Type-species.*—*Cytherura gibba* O. F. Muller, 1785.

***Cytherura coryelli* Malkin, 1953**

Plate 2, figure 8

*Cytherura coryelli* Malkin, 1953, p. 788, pl. 80, figs. 20, 21, 25.

*Diagnosis.*—Height to length ratio of 0.5 or greater, greatest height just posterior to the adductor muscle scar field; punctation that covers the entire valve surface and forms concentric rows along the dorsal and ventral margins; hingement consisting of an anterior socket, crenulate tooth, crenulate bar, and another crenulate tooth in the left valve.

*Lectotype.*—A female left valve (Malkin, 1953, pl. 80, fig. 25), USNM 256024, from the Choptank Formation (locality 14-5 of Malkin, 1953) is herein designated as the lectotype (pl. 2, fig. 8).

*Measurements.*—The lectotype is 450  $\mu$ m in length and 250  $\mu$ m in height.

*Occurrence.*—Malkin (1953) reported this species from the Choptank Formation. It also occurs in unit B of the St. Marys Formation in my collections, as well as in the Choptank Formation.

*Stratigraphic range.*—Middle Miocene.

**Subfamily CYTHEROPTERINAE Hanai, 1957**

**Genus Cytheropteron Sars, 1866**

*Type-species.*—*Cythere latissima* Norman, 1865

***Cytheropteron? yorktownensis* (Malkin, 1953)**

Plate 2, figure 7

*Eocytheropteron? species* Swain, 1951, p. 47, pl. 7, fig. 16.

*Eocytheropteron yorktownensis* Malkin, 1953, p. 780, pl. 79, figs. 1-4.

*Cytheropteron leonensis* Puri, 1954, p. 242, pl. 4, figs. 11, 12; figs. 6c, d.

*Cytheropteron yorktownensis* (Malkin). Swain, 1968, p. 13, pl. 4, figs. 7a-c, 11.

*Shattuckocythere yorktownensis* (Malkin). Swain, 1974, p. 22, pl. 3, figs. 9-12, 14, 15.

Not *Shattuckocythere yorktownensis* (Malkin).—Swain, 1974, p. 22, pl. 3, fig. 13; pl. 9, figs. 9a, b (= *Microcytherura similis* (Malkin)).

*Diagnosis.*—Small size; subtrapezoidal valve outline; in having the greatest height anterior to the adductor muscle scar field; ventral medial portion of the valve inflated and overhanging ventral valve margin; prominent ornamentation pattern consisting of a subdued reticulum with numerous fine punctae covering the solum of each fossa.

*Lectotype.*—A female left valve (Malkin, 1953, pl. 79, fig. 3), USNM 256025, (locality VA-4, of Malkin,

1953), is herein designated as the lectotype (pl. 2, fig. 7).

*Measurements.*—The lectotype is 390  $\mu$ m in length and 220  $\mu$ m in height.

*Remarks.*—*Cytheropteron? yorktownensis* (Malkin, 1953) is a very distinctive and common species in Pliocene sediments along the Atlantic Coastal Plain. It is probably sufficiently distinctive from the *Cytheropteron* to be placed in a new genus, although its familial assignment is uncertain at present. Swain (1974) assigned *C.? yorktownensis* to his new genus *Shattuckocythere*. However, *Shattuckocythere* is not a useful taxon because the type species selected by Swain (*Cythere? shattucki* Ulrich and Bassler, 1904) is a typical member of the genus *Microcytherura* Mueller, 1894.

*Occurrence.*—In the Chesapeake Group the species has been found only in the Yorktown Formation. It also occurs in Atlantic Coastal Plain deposits of early Pleistocene age.

*Stratigraphic range.*—Pliocene to lower Pleistocene.

**Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948**

**Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948**

**Tribe TRACHYLEBERIDINI Sylvester-Bradley, 1948**

**Genus Murrayina Puri, 1954**

*Type-species.*—*Murrayina howei* Puri, 1954.

*Remarks.*—The genus *Murrayina* is comprised of a group of reticulate Trachyleberidini closely related to *Actinocythereis*. The morphologic bounds of the species within this genus, for the most part, are poorly understood, particularly when populations are examined that are geographically or temporally disjunct from the type area of the species in question. *Murrayina* either consists of a few species with a great deal of morphologic variability or numerous species with little variability (or perhaps both). The genus has a known range of early Miocene to early Pleistocene and is recognized by its rectangular shape (i.e., *Actinocythereis*), its usually distinctive reticulum, and the presence of a denticular structure on the ventral inner margin of the right valve (also developed to varying degrees in *Actinocythereis*). The close relationship of *Murrayina* to *Actinocythereis* is exemplified by *Murrayina radiata* (Malkin, 1953), which has certain features that are practically intermediate between typical *Actinocythereis* and typical *Murrayina*.

The confusion associated with the morphologic definition of the various species of *Murrayina* is further compounded by the preservational states of *Murrayina*. In surface morphology, specimens may range from strongly reticulate to completely smooth; however, smooth exterior surfaces seem to be the

result of post-mortem processes. Diagenetic changes (the causes of which are poorly understood at present) seem to have progressively removed some or all of the reticulation, resulting in a smooth-valved specimen as an end product. I have observed specimens of several species of *Murrayina* in various states of alteration, with the reticulum "exfoliating" off the valve. *Murrayina* is in need of extensive morphologic study; this is beyond the scope of the present work.

***Murrayina howei* Puri, 1954**

Plate 3, figure 3

*Cythere producta* Ulrich and Bassler, 1904, p. 115, pl. 36, fig. 17; pl. 38, figs. 28-30.

*Cythere dorsicornis* Ulrich and Bassler, 1904, p. 113, pl. 36, fig. 13.

Not *Cythereis producta* Howe and others, 1935, p. 22, pl. 1, figs. 31, 32, 35-37; pl. 4, figs. 11, 12 (?= male of *Murrayina gunteri*).

Not *Murrayina howei* Puri, 1954, p. 255, pl. 12, figs. 9, 10; figures 8g, h; McLean, 1957, p. 85, pl. 10, figs. 4a-e.

**Diagnosis.**—Rectangular valve outline; very prominent reticulum, with narrow murae forming each fossa; broad smooth areas concentric with the anterior and posterior of the valve; large size.

**Lectotype.**—A male right valve, which is probably the specimen illustrated by Ulrich and Bassler (1904) on pl. 38, fig. 30, USNM 35433 a, is designated the lectotype (pl. 3, fig. 3). This specimen occurs at the Plum Point locality (Ulrich and Bassler, 1904) of the Calvert Formation.

**Measurements.**—The lectotype measures 980  $\mu\text{m}$  in length and 400  $\mu\text{m}$  in height.

**Remarks.**—*Murrayina howei* is very similar to *M. martini* (Ulrich and Bassler, 1904), but the former is larger and has polygonal fossae, whereas the fossae in *M. martini* are elliptical in outline and are relatively smaller.

The nomenclatural history of this species is quite complex. Ulrich and Bassler's *Cythere producta* is a junior homonym of *C. producta* Brady, 1866. Puri (1954) recognized this and renamed the species *Murrayina howei*, making it the type species of that genus. In my opinion, it is quite possible that the form identified by Puri (1954) and Howe and others (1935) as Ulrich and Bassler's *Cythere producta* may be the male of *Murrayina gunteri* (Howe and Chambers, 1935). Hazel (1967, p. 22) thought that *Murrayina gunteri* and *M. howei* were synonyms and therefore the former would have priority over Puri's (1954) name *M. howei*. However, work by the author on the genus *Murrayina* has led to the conclusion that *M. gunteri* is a distinct species and *M. howei* is retained for *Cythere producta* Ulrich and Bassler, 1904.

The juveniles of the species differ from the adults in shape and possess two prominent spines in the posterior of the valves. *Cythere dorsicornis* Ulrich and Bassler, 1904, is a typical juvenile of *M. howei* Puri, 1954. The holotype of *C. dorsicornis* Ulrich and Bassler, 1904, is illustrated in plate 3, figure 5 and is 670  $\mu\text{m}$  in length and 360  $\mu\text{m}$  in height.

**Occurrence.**—This species was reported from the Calvert Formation by Ulrich and Bassler (1904). It has been reported from younger sediments by other authors, but I believe that these reports represent other species. *Murrayina howei* occurs throughout the Calvert Formation in my collections, but has not been observed in younger units.

**Stratigraphic range.**—Lower to middle Miocene.

***Murrayina martini* (Ulrich and Bassler, 1904)**

Plate 3, figures 2, 4

*Cythere martini* Ulrich and Bassler, 1904, p. 112, pl. 36, figs. 11-15.  
*?Cythere dorsicornis* var. *bicornis* Ulrich and Bassler, 1904, p. 114, pl. 38, figs. 32, 33.

Not *Trachyleberis? martini* (Ulrich and Bassler). Swain, 1951, p. 29, pl. 3, figs. 8, 15; Malkin, 1953, p. 793, pl. 82, figs. 6-13.

Not *Murrayina martini* (Ulrich and Bassler). Puri, 1954, p. 256, pl. 12, figs. 8e, f, 11-13; McLean, 1957, p. 86, pl. 11, figs. 1a-c, 2a-b, 3a-d.

**Diagnosis.**—Valve outline quadrate; prominent reticulum with fairly wide murae and oval-shaped fossae; narrow smooth areas concentric to the anterior and posterior margins.

**Lectotype.**—A male right valve illustrated by Ulrich and Bassler (1904, pl. 36, fig. 13), USNM 35423 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype (pl. 3, fig. 2).

**Measurements.**—The lectotype is 710  $\mu\text{m}$  in length and 310  $\mu\text{m}$  in height. The illustrated paralectotype, USNM 35423 b, (pl. 3, fig. 4), a female left valve, is 710  $\mu\text{m}$  in length and 410  $\mu\text{m}$  in height.

**Remarks.**—Hazel (1967) deals with the complicated nomenclatural history of *Murrayina martini*. The majority of the species referred to *M. martini* by various authors represent several species of the genus *Muellerina* of the family Hemicytheridae.

*Murrayina martini* as defined herein has not been reported from sediments younger than the Choptank Formation. In fact, in my collections of Choptank sediments *M. martini* only occurs in "zones" 16 and 17 of the Choptank Formation. Morphologically similar forms, occurring in younger sediments, could easily be confused with *M. martini*; I regard them as being one or more undescribed species.

*Cythere dorsicornis* var. *bicornis* Ulrich and Bassler, 1904, like *C. dorsicornis sensu stricto*, represents a

*Murrayina* instar. The holotype USNM 35416, illustrated here (pl. 3, fig. 6; 430  $\mu\text{m}$  in length and 250  $\mu\text{m}$  in height), comes from the Choptank Formation at the "Paw Paw Point" locality of Ulrich and Bassler (1904). The reticulation is developed in a manner most similar to that seen in adults of *Murrayina martini* and therefore *M. bicornis* is placed in synonymy with *M. martini*.

**Occurrence.**—This species occurs commonly in collections from the Calvert and Choptank Formations.

**Stratigraphic range.**—Lower to middle Miocene.

***Murrayina radiata* (Malkin, 1953)**

Plate 3, figure 1

*Trachyleberis radiata* Malkin, 1953, p. 791, pl. 81, figs. 12, 13.

Not *Trachyleberis radiata* Malkin, 1953, p. 791, pl. 81, fig. 14 (= *Murrayina howei* (Ulrich and Bassler)).

**Diagnosis.**—Valve outline quadrate; prominent reticulum, with polygonal to irregularly shaped fossae; large carinae radiating from the central muscle node toward the posterior margin and medial ventral area, terminating in blunt denticles; prominent dorsal carina, which overhangs the dorsal margin; smooth area concentric to the anterior margin.

**Lectotype.**—A female right valve illustrated by Malkin (1953, pl. 81, fig. 12), USNM 256026, from the Kirkwood Formation of New Jersey (locality NJ-9 of Malkin, 1953) is designated the lectotype (pl. 3, fig. 1).

**Measurements.**—The lectotype is 780  $\mu\text{m}$  in length and 380  $\mu\text{m}$  in height.

**Remarks.**—*Murrayina radiata* exhibits a transitional morphology between *Actinocythereis* and *Murrayina* (see remarks above under *Murrayina*). This species is morphologically similar in reticulation pattern to the other species of *Murrayina* occurring in the Calvert Formation (compare pl. 3, figs. 1-4). These taxa differ from each other only in a few morphologic characteristics such as size or expression of a carina. *Murrayina* presumably originated in the Oligocene or early Miocene and thus the strong morphologic similarity of these lower to middle Miocene species (*M. radiata*, *M. howei*, and *M. martini*) may be because of the limited morphologic radiation from a common ancestor.

**Occurrence.**—Malkin (1953) reported this species from the Kirkwood and Calvert Formations. It represents a fairly rare component of the Calvert fauna.

**Stratigraphic range.**—Lower to middle Miocene.

**Genus *Actinocythereis* Puri, 1954**

**Type-species.**—*Cythere exanthemata* Ulrich and Bassler, 1904.

***Actinocythereis exanthemata* (Ulrich and Bassler, 1904)**

Plate 3, figures 7, 8

*Cythere exanthemata* Ulrich and Bassler, 1904, p. 117, pl. 36, figs. 1-3, 5.

Not *Cythere exanthemata* Ulrich and Bassler, 1904, p. 117, pl. 36, fig. 4 (= *Actinocythereis marylandica* (Howe and Hough, 1935)).

Not *Trachyleberis exanthemata* (Ulrich and Bassler). Swain, 1951, p. 37, pl. 6, fig. 5; Malkin, 1953, p. 791, pl. 81, fig. 19.

*Trachyleberis exanthemata* (Ulrich and Bassler). Malkin, 1953, p. 791, pl. 81, fig. 19.

Not *Actinocythereis exanthemata* (Ulrich and Bassler). Puri, 1954, p. 252, pl. 13, figs. 6-13 (= *Actinocythereis* spp.); McLean, 1957, p. 82, pl. 10, figs. 1a-c (= *Actinocythereis* spp.); Swain, 1968, p. 14, pl. 2, figs. 5a-f, 12 (= *Actinocythereis capitonis* Hazel); Swain, 1974, p. 30, pl. 4, figs. 23, 24; pl. 5, figs. 1, 2; pl. 10, figs. 1a-g (= *Actinocythereis* spp.)

**Diagnosis.**—Distinctive arrangement of various surface spines: a posterodorsally oriented row of five spines occur along a weakly developed ridge located near the ventral margin; the two anterior-most of these clavate spines are located directly below the central muscle node, the posterior three are bullate in shape and positioned spines in the medial ventral area of the valve; the valve midline is marked by a longitudinal curved row of four spines, directly posterior of the central muscle node. The geometric relationship of these nine spines to each other is constant and unique for this species.

**Lectotype.**—A female left valve (Ulrich and Bassler, 1904, pl. 36, fig. 3), USNM 35419 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype (pl. 3, fig. 8).

**Measurements.**—The lectotype is 850  $\mu\text{m}$  in length and 400  $\mu\text{m}$  in height; the illustrated paralectotype, USNM 35419 b (pl. 3, fig. 7), is 800  $\mu\text{m}$  in length and 400  $\mu\text{m}$  in height.

**Remarks.**—*Actinocythereis exanthemata* is most frequently confused with the lower Miocene to Holocene species *A. marylandica* (Howe and Hough, 1935). *Actinocythereis marylandica* is a larger and more robust form that has a slightly different arrangement of the nine spines discussed above.

**Occurrence.**—*Actinocythereis exanthemata* occurs throughout the Calvert Formation and is also known from the lower part of the Choptank Formation ("zone" 17) in my collections.

**Stratigraphic range.**—Lower to middle Miocene.

***Actinocythereis alaris* (Ulrich and Bassler, 1904)**

Plate 4, figure 3

*Cythereis alaris* Ulrich and Bassler, 1904, p. 123, pl. 38, figs. 34, 35, 36.

**Measurements.**—The holotype, USNM 35451, is 730  $\mu\text{m}$  in length and 390  $\mu\text{m}$  in height.

*Remarks.*—*Cythereis alaris* Ulrich and Bassler, 1904 represents a rather early instar of a species of *Actinocythereis* from the Yorktown Formation. However, it cannot be specifically differentiated with certainty and therefore the binomen *Cythereis alaris* is considered to be *nomen dubium*.

**Genus Henryhowella Puri, 1957**

*Type-species.*—*Cythere evax* Ulrich and Bassler, 1904.

**Henryhowella evax (Ulrich and Bassler, 1904)**

Plate 4, figures 1, 2

*Cythere evax* Ulrich and Bassler, 1904, p. 119, pl. 36, figs. 6–8.  
*Cythere evax* var. *oblongula* Ulrich and Bassler, 1904, p. 119, pl. 36, figs. 9, 10.

*Cythere spiniplicata* Ulrich and Bassler, 1904, p. 120, pl. 38, fig. 18.

*Trachyleberis evax* (Ulrich and Bassler). Swain, 1951, p. 28, pl. 3, figs. 2, 3; Malkin, 1953, p. 792, pl. 82, figs. 4, 5.

?*Trachyleberis evax* (Ulrich and Bassler). Swain, 1951, p. 28, pl. 3, fig. 1.

Not *Echinocythereis evax* (Ulrich and Bassler). Puri, 1954, p. 260, pl. 12, fig. 1; fig. 9c.

Not *Howella evax* (Ulrich and Bassler). Puri, 1956, p. 275, pl. 35, figs. 1–8.

?*Henryhowella evax* (Ulrich and Bassler). Pooser, 1965, p. 59, pl. 19, fig. 1; pl. 20, figs. 2, 7, 9–13.

*Diagnosis.*—Large valve size; characteristic quadrate shape; three primary longitudinal carinae; numerous small bifurcating spines; development of a reticulum from the central muscle area of the valve to the valve anterior.

*Lectotype.*—A female left valve illustrated by Ulrich and Bassler (1904, pl. 36, fig. 7), USNM 35417 a, from the Calvert Formation, Plum Point, Md., is selected as the lectotype (pl. 4, fig. 2).

*Measurements.*—The lectotype is 770  $\mu\text{m}$  in length and 450  $\mu\text{m}$  in height.

*Remarks.*—*Henryhowella* species are usually morphologically quite similar to each other. Carapace size and minor details of the ornament appear to be important characteristics for differentiating the various species. The species identified by Puri (1954, 1956) from upper Miocene and Pliocene sediments as *Henryhowella evax* is smaller and has a slightly different shape than specimens from the Calvert Formation. *Cythere evax* var. *oblongula* Ulrich and Bassler, 1904 is the male of *Henryhowella evax*. A left valve (Ulrich and Bassler, 1904, pl. 36, fig. 10), USNM 35418 a, from the Calvert Formation, Plum Point, Md., is selected as the lectotype. The lectotype is 860  $\mu\text{m}$  in length and 450  $\mu\text{m}$  in height.

Only a fragment of the holotype of *Cythere spiniplicata* Ulrich and Bassler, 1904, USNM 35438, exists. The fragment is part of the valve just behind the cen-

tral muscle node. This fragment appears to be a *Henryhowella*, probably *H. evax*, and thus this species is synonymized under *H. evax*.

*Occurrence.*—Ulrich and Bassler (1904) reported this species from the Calvert Formation and from the Yorktown Formation; however, subsequent authors have not found the genus in the Yorktown Formation (Hazel, 1971). I have only found this species in the Calvert Formation. Pooser (1965) reports this species from the upper part (upper Oligocene) of the Cooper Formation in South Carolina.

*Stratigraphic range.*—Upper Oligocene to middle Miocene.

**Tribe PTERYGOCYHEREIDINI Puri, 1957**

**Genus Pterygocythereis Blake, 1933**

*Type-species.*—*Cythereis jonesii* Baird, 1850

**Pterygocythereis americana (Ulrich and Bassler, 1904)**

Plate 4, figure 4

*Cythereis cornuta* var. *americana* Ulrich and Bassler, 1904, p. 122, pl. 37, figs. 29–33.

Not *Cythereis* (*Pterygocythereis*) *cornuta* var. *americana* (Ulrich and Bassler). Howe and others, 1935, p. 26, pl. 2, figs. 19, 21–24; pl. 4, fig. 24.

?*Pterygocythereis cornuta americana* (Ulrich and Bassler, 1904). Puri, 1954, partim, p. 261, pl. 13, fig. 5.

*Pterygocythereis americana* (Ulrich and Bassler, 1904). Malkin, 1953, partim, p. 795, pl. 80, fig. 29.

Not *Pterygocythereis americana* (Ulrich and Bassler, 1904). McLean, 1957, p. 80, pl. 9, figs. 5a–d, 6a–e; Swain, 1974, p. 23, pl. 2, fig. 11; pl. 9, fig. 5; pl. 13, figs. 2a–c (= *Pterygocythereis inexpectata* Blake, 1933).

*Diagnosis.*—Distinguished by its quadrate valve outline, valve size, details of the dorsal crests, and the position and nature of the ala. The two dorsal crests are approximately equidimensional and generally non-plicated; ala parallels and overhangs the ventral margin and is usually wide enough that it is not plicated; ala is connected to the posteroventral area of the valve by a short, but prominent, posterodorsally oriented ridge.

*Lectotype.*—A female left valve (Ulrich and Bassler, 1904, pl. 37, fig. 31 (?)), USNM 35452 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype.

*Measurements.*—The lectotype (pl. 4, fig. 4) is 950  $\mu\text{m}$  in length and 530  $\mu\text{m}$  in height.

*Remarks.*—*Pterygocythereis americana* appears to represent an intermediate morphologic stage between *P. howei* Hill, 1954 (from the Oligocene) and *P. inexpectata* Blake, 1933, an upper Miocene to Holocene species. *Pterygocythereis howei* differs from *P. americana* in having dorsal crests of unequal length, where the posterior crest is longer than the anterior crest. The alae of *P. howei* are relatively thicker and



are located closer to the medial part of the valve (higher on the valve) than in *P. americana*. *Pterygocythereis americana* differs from *P. inexpectata* in having relatively thicker alae that are located more medially (higher) on the valve surface. The dorsal crests of both species are about the same length, although those in *P. americana* are relatively thicker than those in *P. inexpectata*. The valve outline of the *P. howei* to *P. inexpectata* sequence also changes by becoming progressively less quadrate and more rectangular, where *P. howei* has a greater height to length ratio than *P. inexpectata*.

The upper Miocene (unit D of the Eastover Formation), Pliocene, and Quaternary specimens of *P. inexpectata* are readily distinguished from Calvert specimens of *P. americana* (lower to middle Miocene) by the characteristics noted above. However, there are a number of intermediate forms occurring in units B and C of the St. Marys Formation (upper middle and upper Miocene) that could be placed in either species. These morphologically intermediate specimens are herein arbitrarily placed in *P. inexpectata*. As yet no *Pterygocythereis* species have been found in the Chop-tank Formation, thus providing a slight and somewhat arbitrary morphologic gap to subdivide the species.

**Occurrence.**—*Pterygocythereis americana* is confined to the Calvert Formation in our collections.

**Stratigraphic range.**—Lower to middle Miocene.

#### Tribe ECHINOCYHEREIDINI Hazel, 1967

##### Genus *Echinocythereis* Puri, 1954

**Type-species.**—*Cythereis garretti* Howe and McGuirt, 1935 (= *Echinocythereis margaritifera* (Brady, 1840)).

##### *Echinocythereis clarkana* (Ulrich and Bassler, 1904)

Plate 4, figure 5

*Cythere clarkana* Ulrich and Bassler, 1904, p. 98, pl. 35, figs. 1-3, 5, 7-10.

Not *Cythere clarkana* Ulrich and Bassler, 1904, p. 98, pl. 35, figs. 4, 6 (= *Echinocythereis miniscula* (Ulrich and Bassler, 1904)).

?*Leguminocythereis? clarkana* (Ulrich and Bassler). Swain, 1951, p. 43, pl. 6, fig. 18.

Not *Trachyleberis clarkana* (Ulrich and Bassler). Malkin, 1953, p. 792, pl. 82, figs. 1-3 (= *Echinocythereis planibasalis* (Ulrich and Bassler, 1904)).

Not *Echinocythereis? clarkana* (Ulrich and Bassler). Swain, 1974, p. 32, pl. 5, figs. 13-15 (figs. 13, 14 = juvenile *Murrayina macleani* Swain, 1974; fig. 15 = *Echinocythereis planibasalis* (Ulrich and Bassler, 1904)).

**Diagnosis.**—Large size; valve outline, quadrate; prominent reticulum with small spines along the murae; greatest length is midvalve; greatest height is anterior to the central muscle field.

**Lectotype.**—A male left valve (Ulrich and Bassler, 1904, pl. 35, fig. 5), USNM 35413 a, from the Calvert

Formation, Plum Point, Md., is selected as the lectotype.

**Measurement.**—The lectotype is 1,200  $\mu\text{m}$  in length and 640  $\mu\text{m}$  in height.

**Occurrence.**—*Echinocythereis clarkana* occurs in the Calvert Formation, below bed 12.

**Stratigraphic range.**—Upper Oligocene to lower Miocene.

##### *Echinocythereis miniscula* (Ulrich and Bassler, 1904)

Plate 4, figure 8

*Cythere clarkana* var. *miniscula* Ulrich and Bassler, 1904, p. 99, pl. 35, figs. 11-14.

*Cythere clarkana* Ulrich and Bassler, 1904, partim, p. 98, pl. 35, figs. 4, 6.

**Diagnosis.**—Small; valve outline quadrate to ovate; greatest length just ventral of midvalve; greatest height anterior of central muscle scar field; prominent reticulum (with generally thicker murae than *E. clarkana*) with spinelets along the murae.

**Lectotype.**—A female left valve (Ulrich and Bassler, 1904, pl. 35, fig. 14), USNM 35414 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype.

**Measurements.**—The lectotype is 900  $\mu\text{m}$  in length and 550  $\mu\text{m}$  in height.

**Remarks.**—Ulrich and Bassler, 1904, designated *E. miniscula* as a variety of *E. clarkana*, because of its smaller size. The syntype suite of *E. miniscula* contains three juvenile and one adult valves. Presumably Ulrich and Bassler's concept of *E. miniscula* was based primarily upon the three juveniles; however, the specimen they illustrated on plate 35, figure 14 is an adult female left valve. Material collected from various Calvert localities reveals that there is a polymodal distribution in size of *Echinocythereis* populations. One female mode is centered around about 937  $\mu\text{m}$  in length; the adult female selected as the lectotype of *E. miniscula* falls in this class. A second female mode is centered around 1,025  $\mu\text{m}$  in length, while the two male modes are centered around 1,062  $\mu\text{m}$  and 1,225  $\mu\text{m}$  in length. I have interpreted the smaller male and female modes as being *E. miniscula* and the larger two male and female modes as being *E. clarkana*. At present, size appears to be the only means of consistently distinguishing the two forms from each other. The two size groupings may represent two closely related species differing primarily in size, or they may be the same species exhibiting two sizes. The latter might result from seasonal breeding, wherein one size represents fall-winter population and the other a spring-summer population. Males and females of *E. clarkana* and *E. miniscula* occur commonly in the same samples, and both have the same stratigraphic range.

It is impossible to be certain whether or not there is one or two species in this case; I have elected to conserve both names and recognize two species at this time.

**Occurrence.**—*Echinocythereis miniscula* (Ulrich and Bassler, 1904) occurs in the pre-“zone” 12 units of the Calvert Formation in our collections.

**Stratigraphic range.**—Lower Miocene.

***Echinocythereis planibasalis* (Ulrich and Bassler, 1904)**

Plate 4, figure 7

*Cythere planibasalis* Ulrich and Bassler, 1904, p. 99, pl. 38, figs. 1-3.

*Buntonia? planibasalis* (Ulrich and Bassler). Swain, 1951, p. 39, pl. 3, figs. 4, 5.

*Trachyleberis clarkana* (Ulrich and Bassler). Malkin, 1953, p. 792, pl. 82, figs. 1-3.

*Echinocythereis clarkana* (Ulrich and Bassler). McLean, 1957, p. 84, pl. 10, figs. 3a-c.

*Echinocythereis planibasalis* (Ulrich and Bassler). Hazel, 1967, p. 37, pl. 6, figs. 4, 5, 8.

*Echinocythereis? clarkana* (Ulrich and Bassler). Swain, 1974, p. 32, pl. 5, fig. 15.

Not *Echinocythereis? clarkana* (Ulrich and Bassler). Swain, 1974, p. 32, pl. 5, figs. 13, 14 (= juvenile *Murrayina macleani* Swain, 1974).

**Diagnosis.**—Valve outline ovoid; massive reticulum; greatest length about midvalve; greatest height just anterior of central muscle scar field; prominent ventral carinae with numerous stubby spines on the males.

**Measurements.**—The holotype, a male right valve, USNM 35428, is 1,020  $\mu\text{m}$  in length and 570  $\mu\text{m}$  in height.

**Remarks.**—*Echinocythereis planibasalis* (Ulrich and Bassler, 1904) was originally described from the Yorktown Formation. In the present collections I have assigned individuals from the Calvert, Choptank, and Eastover Formations to *E. planibasalis*. The Miocene forms (particularly those from the Calvert Formation) are somewhat smaller than their Pliocene and younger counterparts; Miocene males, for example, will usually fall in the 950 to 1,000  $\mu\text{m}$  length size class. There does appear to be a general size increase through time. Other than size, however, the Miocene individuals seem nearly identical with the Pliocene and younger forms.

The males of *E. planibasalis* have a characteristic ventral rib with numerous blunt spines that is lacking in the females. The females often have a “braided” sequence of murae in the same area of the valve.

**Occurrence.**—Ulrich and Bassler (1904) found this species in the Yorktown Formation. I have found this species in the Calvert, Choptank, and Eastover (unit C) Formations. Hazel (1967) and Valentine (1971) report this species from modern sediments.

**Stratigraphic range.**—Lower Miocene to Holocene.

**Tribe CYTHERETTINI Triebel, 1952**

**Genus *Pseudocytheretta* Cushman, 1906**

**Type-species.**—*Pseudocytheretta edwardsi* Cushman, 1906.

***Pseudocytheretta burnsi* (Ulrich and Bassler, 1904)**

Plate 4, figure 6; Plate 5, figures 2, 3, 6, 7, 8.

*Cythere burnsi* Ulrich and Bassler, 1904, p. 103, pl. 36, figs. 35-39. Not *Cythere burnsi* Ulrich and Bassler, 1904, p. 105, pl. 38, fig. 34 (= *Pseudocytheretta* n. sp.).

*Cythere paucipunctata* Ulrich and Bassler, 1904, p. 105, pl. 38, figs. 7-9.

*Cythere nitidula* Ulrich and Bassler, 1904, p. 107, pl. 36, figs. 21-23. *Cythere nitidula* var. *calvertensis* Ulrich and Bassler, 1904, p. 108, pl. 36, fig. 24.

*Cythere toumeyii* Ulrich and Bassler, 1904, p. 105, pl. 38, figs. 5, 6. *Cytheretta burnsi* (Ulrich and Bassler). Howe and others, 1935,

p. 33, pl. 2, figs. 12-14, 17, 20; pl. 4, figs. 14, 21; Malkin, 1953, p. 789, pl. 81, figs. 7, 8, 10, 11; Puri, 1954, p. 282, pl. 7, figs. 1, 2.

**Diagnosis.**—Extreme asymmetry between the valves; small “tab” like extension of the valve margin in the posterodorsal corner of the left valve; fine to coarse punctation posterior of the central muscle scar field that is ovate in outline; greatest length along the medial portion of the valve.

**Lectotype.**—A male left valve (Ulrich and Bassler, 1904, pl. 36, fig. 37 (?)), USNM 35411 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype (pl. 4, fig. 6).

**Measurements.**—The lectotype is 1,130  $\mu\text{m}$  in length and 570  $\mu\text{m}$  in height.

**Remarks.**—*Pseudocytheretta burnsi* has a complicated nomenclatural history. Like other species of the genus, *P. burnsi* exhibits extreme asymmetry between the valves (compare pl. 4, fig. 6 with pl. 5, fig. 3). This feature, coupled with strong sexual dimorphism and normal individual variation in size, results in populations of valves represented by numerous sizes and shapes. These factors are compounded when the instar sequence is considered. Ulrich and Bassler (1904) did not recognize these features and proposed several species based on juveniles as well as one based on an adult (*P. paucipunctata*). *Pseudocytheretta paucipunctata* (Ulrich and Bassler) differs from *P. burnsi* primarily in the nature of the punctae; *P. paucipunctata* has a large ovate punctae as opposed to small fine punctae.

The holotype, USNM 35427, of *Pseudocytheretta paucipunctata* (Ulrich & Bassler, 1904) is illustrated in plate 5, figure 6. This specimen is a female left valve that is 1,050  $\mu\text{m}$  in length and 580  $\mu\text{m}$  in height. The remaining species herein synonymized under *Pseudocytheretta burnsi* (Ulrich and Bassler, 1904) are all juveniles. A left valve, which is probably the specimen illustrated by Ulrich and Bassler (1904) in plate 36, figure 21, is herein designated the lectotype of

*Pseudocytheretta nitidula* (Ulrich and Bassler, 1904). This specimen, USNM 35425 a, was collected from the Plum Point locality of Ulrich and Bassler (1904), in the Calvert Formation. It is illustrated in plate 5, figure 2 and is 860  $\mu\text{m}$  in length and 460  $\mu\text{m}$  in height.

A left valve (Ulrich and Bassler, 1904, pl. 36, fig. 24), USNM 35426 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype of *Pseudocytheretta calvertensis* (Ulrich and Bassler, 1904). The lectotype (pl. 5, fig. 8) is 780  $\mu\text{m}$  in length and 410  $\mu\text{m}$  in height. The lectotype is one of two specimens in the syntype suite; the other (Ulrich and Bassler, 1904, pl. 36, fig. 25) is a juvenile of *Pseudocytheretta plebeia* (Ulrich and Bassler, 1904).

A right valve (Ulrich and Bassler, 1904, pl. 38, fig. 5), USNM 35440, from the Peachblossom Creek locality in the Choptank Formation, is selected as the lectotype of *Pseudocytheretta toumeyii* (Ulrich and Bassler, 1904). The lectotype (pl. 5, fig. 7) is 600  $\mu\text{m}$  in length and 320  $\mu\text{m}$  in height. The *P. toumeyii* syntype suite originally contained juveniles of two species of *Pseudocytheretta*. One of the species is from the Yorktown Formation and the other is from the Choptank Formation. The specimen from the Yorktown Formation is lost and was probably conspecific with *Pseudocytheretta burnsi sensu* McLean (1957), Swain (1974), and Hazel (1971). However, the Yorktown species does not appear to be conspecific with *P. burnsi* (Ulrich and Bassler, 1904), as noted above.

*Pseudocytheretta burnsi* is known from the Calvert, Choptank, and St. Marys (units A and B) Formations. I do not believe that the specimens reported from the Pliocene (Swain, 1974) are conspecific with *P. burnsi*. The younger forms possess a punctation that covers the whole valve and are much more equivalved (and thus more symmetrical) than *P. burnsi*.

**Occurrence.**—*Pseudocytheretta burnsi* (Ulrich and Bassler, 1904) occurs in the Calvert, Choptank, and St. Marys (units A and B) Formations in my collections.

**Stratigraphic range.**—Lower to middle Miocene.

***Pseudocytheretta plebeia* (Ulrich and Bassler, 1904)**

Plate 5, figures 1, 4, 5; Plate 6, figures 5, 6, 7

*Cythere plebeia* Ulrich and Bassler, 1904, p. 102, pl. 35, figs. 20–29.  
*Cythere plebeia* var. *capax* Ulrich and Bassler, 1904, p. 103, pl. 35, figs. 30–33.

*Cythere plebeia* var. *modica* Ulrich and Bassler, 1904, p. 103, pl. 35, figs. 18, 19.

*Cytheridea? chesapeakeensis* Ulrich and Bassler, 1904, p. 125, pl. 37, fig. 9.

*Cythere porcella* Ulrich and Bassler, 1904, p. 106, pl. 36, figs. 26–33.  
Not *Cytheretta porcella* (Ulrich and Bassler). Swain, 1951, p. 45, pl. 4, fig. 7; Swain, 1974, p. 24, pl. 2, figs. 19, 20.

Not *Cytheretta?* sp. aff. *C. plebeia* (Ulrich and Bassler). Swain, 1951, p. 45, pl. 6, fig. 17. (= *Pseudocytheretta* n. sp.)

*Cytheretta paucipunctata* (Ulrich and Bassler). Puri, 1952, p. 204, pl. 39, figs. 1, 2, text figs. 3, 4.

Not *Cytheretta ulrichi* Puri, 1952, p. 204, pl. 39, fig. 3, text figs. 5–7 (= *Pseudocytheretta burnsi* (Ulrich and Bassler, 1904); McLean, 1957, p. 92, pl. 12, figs. 3a–d.

*Cytheretta plebeia* (Ulrich and Bassler). Malkin, 1953, p. 790, pl. 81, figs. 1–6, 9.

**Diagnosis.**—Valves asymmetrical; left valve ovoid in outline; right valve with a medial portion of the valve overhanging the ventral margin; dorsal margin of right valve arched; the few punctae are generally circular in outline.

**Lectotype.**—A male left valve (Ulrich and Bassler, 1904, pl. 35), USNM 35429 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype.

**Measurement.**—The lectotype (pl. 5, fig. 4) is 1,025  $\mu\text{m}$  in length and 550  $\mu\text{m}$  in height.

**Remarks.**—*Pseudocytheretta plebeia* (Ulrich and Bassler, 1904), like *P. burnsi*, has a complicated nomenclatural history. Puri (1952) pointed out that *Cythere (Bairdia) plebeia* was used in 1859 by Jones and proposed the new name *Cytheretta ulrichi* for *P. plebeia*. Puri (1954) later realized that the name *Pseudocytheretta porcella* (Ulrich and Bassler, 1904) was available and advised that his name *P. ulrichi* be dropped. Swain (1974) followed this suggestion and used *P. porcella* for a species of *Pseudocytheretta* from the Yorktown Formation. Sohn (1960) has provided the nomenclatural history of *Bairdia plebeia*, which was originally described by Reuss (1854) and subsequently transferred to *Cythere (Bairdia) plebeia* by Jones (1859). Vine (1884) transferred the species from the genus *Cythere* back to the genus *Bairdia*. Therefore, *Cythere plebeia* (Ulrich and Bassler, 1904) is not a homonym of *Cythere (Bairdia) plebeia*, and the trivial name is valid.

Ulrich and Bassler (1904) described two variants of *P. plebeia* and two juvenile species that are all synonymous with *P. plebeia*. The species ascribed to *P. porcella* by Swain (1974) differs from *P. plebeia* by having greater valve symmetry in the right valve.

A right valve, which is probably the specimen illustrated by Ulrich and Bassler, 1904, pl. 35, fig. 32, USNM 35430 a, from the Plum Point locality (Ulrich and Bassler, 1904) of the Calvert Formation is designated as the lectotype of *Pseudocytheretta capax* (Ulrich and Bassler, 1904). The lectotype (pl. 5, fig. 5) is 990  $\mu\text{m}$  in length and 530  $\mu\text{m}$  in height. As noted by Ulrich and Bassler (1904) this form is a variety of *P. plebeia*, although in my opinion it may be more of a preservational variant than a biologic one.

A left valve (Ulrich and Bassler, 1904, pl. 35, fig. 18), USNM 35431 a, from the Calvert Formation at Plum Point, MD., is selected as the lectotype of *Pseudocytheretta modica* (Ulrich and Bassler, 1904). The lectotype (pl. 6, fig. 5) is 900  $\mu\text{m}$  in length and 500  $\mu\text{m}$  in height and is a typical specimen of *P. plebeia*. The

distinctions made by Ulrich and Bassler, based on ornamentation or valve shape, are gradational within the population of *P. plebeia*. The remark made by Ulrich and Bassler, about having only left valves of *P. modica*, is curious because one of their syntype specimens is a carapace.

*Cytheridea? chesapeakensis* Ulrich and Bassler, 1904, is a well-preserved, very ornate, juvenile of *Pseudocytheretta plebeia* (Ulrich and Bassler). The holotype, USNM 35444, is 770  $\mu\text{m}$  in length and 410  $\mu\text{m}$  in height and is illustrated in pl. 6, fig. 7.

A left valve (Ulrich and Bassler, 1904, pl. 36, fig. 27), USNM 35432 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype of *Pseudocytheretta porcella* (Ulrich and Bassler, 1904). The lectotype (pl. 6, fig. 6) is 770  $\mu\text{m}$  in length and 420  $\mu\text{m}$  in height. *P. porcella* is a poorly preserved, weakly ornamented juvenile of *P. plebeia* (Ulrich and Bassler, 1904).

**Occurrence.**—*Pseudocytheretta plebeia* occurs throughout the Calvert Formation in our collections.

**Stratigraphic range.**—Lower to middle Miocene.

**Genus Protocytheretta Puri, 1958**

**Type-species.**—*Cythere daniana* Brady, 1869.

**Protocytheretta inaequalvis (Ulrich and Bassler, 1904)**

Plate 6, figure 8

*Cythere inaequalvis* Ulrich and Bassler, 1904, p. 101, pl. 35, figs. 15, 16.

Not *Cythere inaequalvis* Ulrich and Bassler, 1904, p. 101, pl. 35, fig. 17 (= *Pseudocytheretta burnsi* (Ulrich and Bassler, 1904)).

?*Cytheretta inaequalvis* (Ulrich and Bassler). Puri, 1954, p. 284, pl. 8, fig. 9.

**Diagnosis.**—Strong valve asymmetry; prominent sinuous ventral margin; distinct caudal process; two prominent carinae, one paralleling the dorsal margin and the other running anterior-posterior through the medial part of the valve.

**Lectotype.**—A right valve (Ulrich and Bassler, 1904, pl. 35, fig. 16), USNM 35421 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype (pl. 6, fig. 8).

**Measurements.**—The lectotype is 1,125  $\mu\text{m}$  in length and 480  $\mu\text{m}$  in height.

**Remarks.**—*Protocytheretta inaequalvis* is extremely rare in the Chesapeake Group sediments. The only known specimens are those illustrated by Ulrich and Bassler (1904).

**Occurrence.**—*Protocytheretta inaequalvis* was reported from the Calvert Formation by Ulrich and Bassler (1904) at their Plum Point locality. It does not occur in our collections.

**Stratigraphic range.**—Lower Miocene.

**Family HEMICYTHERIDAE Puri, 1953**

**Subfamily HEMICYTHERINAE Puri, 1953**

**Tribe AURLINI Puri, 1973**

**Genus Otikocythere New Genus**

**Type-species.**—*Cythere punctistriata* Ulrich and Bassler, 1904.

**Etymology.**—*Otikos* (Greek), of ears, in reference to the somewhat ear-shaped outline.

**Diagnosis.**—Low height to length ratio; valves compressed; anterior margin rounded; prominent caudal process; valve surface smooth to reticulate; holamphidont hinge; central muscle scar pattern with three frontal scars linearly arranged, split dorsal and dorsomedian adductor scars and two complete (unsplit) ventral and ventromedian adductor scars.

**Comparisons.**—*Otikocythere* is very similar to both *Aurila* and *Heterocythereis*, undoubtedly reflecting their close relationship. *Otikocythere* differs from *Heterocythereis* in possessing a prominent caudal process and in having an aurilid-shaped right valve. *Otikocythere* differs from *Aurila* in having an unsplit ventromedial adductor muscle scar and a "cauditid"-shaped left valve.

**Remarks.**—Three species can be presently assigned to *Otikocythere* with confidence; they are *Cythere punctistriata* Ulrich and Bassler, 1904, *Hemicythere dalli* Howe and Brown, 1935, and *Hemicythere red-bayensis* Howe and Brown, 1935. These taxa all occur in Miocene sediments in the Atlantic Coastal Plain or Florida. *Aurila petricola* Hartmann, 1974, described from the southwestern coast of Africa, may also belong to *Otikocythere*, despite its disjunct geographic and temporal position from the other species. However, I have not examined specimens of that species.

**Stratigraphic range.**—Lower to upper Miocene; Holocene(?).

**Otikocythere punctistriata (Ulrich and Bassler, 1904)**

Plate 6, figures 1-4; Plate 7, figure 5

*Cythere punctistriata* Ulrich and Bassler, 1904, p. 108, pl. 38, figs. 22-24.

*Cythere francisca* Ulrich and Bassler, 1904, p. 110, pl. 38, figs. 19, 20.

*Hemicythere punctistriata* (Ulrich and Bassler). Malkin, 1953, p. 796, pl. 82, fig. 15.

**Diagnosis.**—Large; reticulum weakly to strongly developed in the medial to posterior portion of the valve; greatest length ventral of valve midline; greatest height at anterior cardinal angle; crescent shape of a medioanterior depression on the valve.

**Paratype.**—A female left valve (Ulrich and Bassler, 1904, pl. 38, fig. 24), USNM 35435, from the Calvert

Formation at Church Hill, Md., is illustrated (pl. 6, fig. 3), being the only whole specimen remaining in the type suite. The holotype, USNM 35434, is partially destroyed, with only the anterior and posterior part of the valve remaining.

*Measurements.*—The paratype is 600  $\mu\text{m}$  in length and 310  $\mu\text{m}$  in height.

*Remarks.*—Ulrich and Bassler (1904) designated a specimen of *O. punctistriata* from their Peachblossom Creek locality in the Choptank Formation as the holotype. *Otikocythere punctistriata* occurs abundantly in some parts of the Choptank Formation, but rarely throughout the formation as a whole. Based upon the study collections, the Choptank specimens always are typified by the specimens illustrated on pl. 6, figs. 1, 2, 4 (USNM 256029, 256030, 256031). The Choptank form, however, appears to represent an end member of a morphologic cline starting in the Calvert Formation.

*Otikocythere punctistriata* is currently known from two localities in the Calvert Formation: (1) from the Ulrich and Bassler locality at Church Hill, Md., and (2) from well cuttings near Denton, Md. Specimens from the latter locality exhibit a continuous gradation from a completely smooth form (similar to the slightly larger *O. dalli* (Howe and Brown)) to an ornate version represented by the specimen illustrated on pl. 6, fig. 3 (the paratype). Each step of this gradation basically involves the addition of more reticulæ starting in the posterior of the valve and progressing toward the anterior. The only morphologic gap occurs between specimens from the upper Calvert Formation and the lower Choptank Formation, as illustrated on pl. 6 (compare figs. 3 and 4). I currently regard the entire sequence as a gradually changing population of a single species (including specimens from both the Calvert and Choptank Formations).

The smooth specimens of *Otikocythere punctistriata* from the well cuttings near Denton, Md., are quite similar to *O. dalli* (Howe and Brown), differing from *O. dalli* primarily in its slightly smaller size. Howe and Brown (*in* Howe and graduate students, 1935) noted that their *H. dalli* varies morphologically from a smooth version to a slightly ornate version, where their more ornate ribbed specimens are regarded as a separate species, *O. redbayensis*. The size differences do not appear to be significant and may simply represent geographic variation. Thus *O. dalli* (Howe and Brown) may be a junior synonym of *O. punctistriata* (Ulrich and Bassler).

*Otikocythere punctistriata* differs from *O. redbayensis* (Howe and Brown) in its larger size, somewhat different shape and in details of the ornament. *O. redbayensis* occurs in upper Miocene

sediments in Florida (Red Bay Formation of Puri and Vernon, 1964) and in the eastern shore of Chesapeake Bay.

*Otikocythere punctistriata* generally occurs abundantly along the present edges of the depositional basins for the Choptank and Calvert Formations. It appears to become very rare to nonexistent towards the center of those basins. Thus, I would surmise that *O. punctistriata* favors shallow marine to possibly polyhaline conditions. *Aurila petricola* Hartmann, 1974 was also collected from a near shore locality.

Ulrich and Bassler (1904) proposed *Cythere francisca* based upon a single specimen, USNM 35420, the holotype. This specimen has been lost; however, from Ulrich and Bassler's (1904) description, illustrations, and locality data, this species seems to be a juvenile of *Otikocythere punctistriata* (Ulrich and Bassler, 1904). A juvenile of *O. punctistriata* from the Choptank Formation at Peachblossom Creek, is illustrated (pl. 7, fig. 5, USNM 256032) for comparison purposes.

*Occurrence.*—*Otikocythere punctistriata* occurs in the Calvert and Choptank Formations.

*Stratigraphic range.*—Lower to middle Miocene.

**Subfamily THAEROCYTHERINAE Hazel, 1967**

**Tribe THAEROCYTHERINI Hazel, 1967**

**Genus *Thaerocythere* Hazel, 1967**

*Type-species.*—*Cythereis crenulata* Sars, 1865.

***Thaerocythere schmidtae* (Malkin, 1953)**

Plate 7, figure 8

*Trachyleberis?* cf. *T. reesei* (Swain). Swain, 1951, p. 30, pl. 3, fig. 13.

*Hemicythere schmidtae* Malkin, 1953, p. 796, pl. 82, figs. 19-23.

*Hemicythere schmidtae* Malkin. McLean, 1957, p. 92, pl. 12, figs. 2a-d.

*Thaerocythere schmidtae* (Malkin). Swain, 1974, p. 40, pl. 6, fig. 19; pl. 7, figs. 9-15; pl. 9, figs. 1a-d.

*Lectotype.*—A female left valve (Malkin, 1953, pl. 82, fig. 2), USNM 256033, from the Yorktown Formation (locality VA-9 of Malkin (1953)), is selected as the lectotype (pl. 7, fig. 8).

*Measurements.*—The lectotype is 700  $\mu\text{m}$  in length and 410  $\mu\text{m}$  in height.

*Remarks.*—*Thaerocythere schmidtae* occurs frequently in upper Miocene (Eastover Formation, units C and D), Pliocene, and lower Pleistocene sediments in North Carolina, Virginia, and Maryland, but it has not been found in equivalent age sediments in Florida. On this basis it would appear to be a temperate species, as is the type, *Thaerocythere crenulata* (Sars, 1865) (see Hazel, 1967). Hazel (1977; *in press*) illustrated and discussed this taxon.

**Occurrence.**—*Thaerocythere schmidtæ* occurs in the Eastover (units C and D) and Yorktown Formations in my collections.

**Stratigraphic range.**—Upper Miocene to lower Pleistocene.

**Genus Puriana Coryell and Fields, 1937**

**Type-species.**—*Favella puella* Coryell and Fields, 1937 (= *Puriana rugipunctata* var. *gatumensis* Coryell and Fields, 1937).

***Puriana rugipunctata* (Ulrich and Bassler, 1904)**

*Cythere rugipunctata* Ulrich and Bassler, 1904, p. 118, pl. 38, figs. 16, 17.

*Cythereis rugipunctata* (Ulrich and Bassler). Howe and others, 1935, p. 23, pl. 1, figs. 18, 20–22; pl. 4, figs. 22, 23.

*Trachylebereis? rugipunctata* (Ulrich and Bassler). Swain, 1951, p. 38, pl. 6, fig. 8.

*Favella rugipunctata* (Ulrich and Bassler). Malkin, 1953, p. 797, pl. 82, fig. 24.

*Puriana rugipunctata* (Ulrich and Bassler). McLean, 1957, p. 89, pl. 11, figs. 5a–d.

?*Puriana rugipunctata* (Ulrich and Bassler). Swain, 1968, p. 18, pl. 5, figs. 8a–c; pl. 7, fig. 4; text figs. 16, 17.

*Puriana rugipunctata* (Ulrich and Bassler). Swain, 1974, p. 41, pl. 7, figs. 19, 20.

**Remarks.**—The holotype of *P. rugipunctata* (Ulrich and Bassler, 1904), USNM 35436, has been crushed and most of the fragments are lost. At present, only two small fragments of the holotype are left. Hazel (1977; in press) has illustrated this species and discusses some of the problems associated with it.

**Occurrence.**—*Puriana rugipunctata* occurs in the Eastover (units C and D) Formation, and is common in Pliocene to Holocene deposits along the Atlantic Coast.

**Stratigraphic range.**—Upper Miocene to Holocene.

**Subfamily COQUIMBINAE Ohmert, 1968**

**Genus Muellerina Bassiouni, 1965**

**Type-species.**—*Cythere latimarginata* Speyer, 1863.

***Muellerina lienenklausi* (Ulrich and Bassler, 1904)**

Plate 7, figure 4

*Cythere lienenklausi* Ulrich and Bassler, 1904, p. 114, pl. 38, fig. 31.

Not *Orionina lienenklausi* (Ulrich and Bassler). Puri, 1954, p. 254, pl. 12, fig. 14; text fig. 8d (= *Neocaudites* sp.).

Not *Muellerina lienenklausi* (Ulrich and Bassler). Swain, 1968, p. 16, pl. 3, figs. 2a–h, 3a–b, 4a–b; text fig. 15 (= *Muellerina* spp.).

Not *Muellerina micula* (Ulrich and Bassler). Swain, 1974, p. 38, pl. 7, figs. 1–8 (= *Muellerina* spp.).

**Diagnosis.**—Small; rectangular valve outline; well-developed reticulum; details of fossae arrangement characteristic, such as the anterior-most (ventral to

dorsal) row of fossae consisting of two small rounded fossae, one dorsal to the other, followed dorsally by two other rounded fossae, one anterior to the other; these in turn are followed dorsally by two more fossae, with one fossa dorsal to the other and sometimes fused to form one elongate fossa; prominent carina extends subparallel to the valve margin, originating at the anterodorsal corner and proceeding to the postero-dorsal corner. These carina become slightly broader just posterior of the ventral concavity and contain five to six small fossae (relationship of these fossae to one another are characteristic); the carina splits and encircles several more fossae in the posteroventral region of the valve.

**Measurements.**—The holotype, USNM 35422, from the Calvert Formation at Plum Point, Md., is 590  $\mu$ m in length and 290  $\mu$ m in height. The illustrated specimen, a female right valve, USNM 256034, from the type locality, is 620  $\mu$ m in length and 330  $\mu$ m in height.

**Remarks.**—The holotype, a male left valve, is crushed. However, the specimen is still sufficiently intact to use it as a means of recognizing complete specimens from the type locality at Plum Point, bed 10, of the Calvert Formation. There are only two species of *Muellerina* known from Bed 10. One of these species appears to be the adult of *Cythere micula* Ulrich and Bassler, 1904 and is illustrated on pl. 7, fig. 2. The other species is morphologically identical with the holotype of *M. lienenklausi*. The two species are easily distinguished from one another by several characteristics, such as arrangement of the anterior-most row of fossae, where *M. micula* has a row of several circular fossae, one dorsal to the other.

Hazel (1967) discusses the nomenclatural confusion associated with various Neogene species of *Muellerina*. Most of these species of *Muellerina* have been identified as *Murrayina martini* (Ulrich and Bassler, 1904), even though *Murrayina* and *Muellerina* are in different families. Hazel (1967) argued that what was identified as *Murrayina martini* by many authors should be referred to *Muellerina lienenklausi*. Subsequently, Hazel (in press) and the author (in studies in progress) have recognized numerous species of *Muellerina* in the Chesapeake Group sediments. Thus, what at one time was regarded as a single species is now believed to be several. Swain (1974) also discusses this problem and argues that the holotype of *Muellerina lienenklausi* is too badly damaged to be recognized. He believes that the juveniles in the *M. micula* syntype collection are more representative of what was referred to in the past as *Murrayina martini*. In my opinion, most of the *Muellerina* species referred to *Murrayina martini* by various authors are conspecific with *Muellerina* species from post-Miocene deposits. The *Muellerina micula*

syntype slide contains two species of *Muellerina*, a juvenile of *M. lienenklausi* (Ulrich and Bassler, 1904), and the specimen selected as the lectotype of *M. micula* (Ulrich and Bassler, 1904). The latter specimen is believed to be the juvenile of the specimen illustrated on plate 7, figure 2. Many of the specimens illustrated by Swain (1968; 1974) as *Muellerina micula* and *Muellerina lienenklausi* are *M. ohmerti* Hazel, 1977.

The majority of *Muellerina* species are superficially quite similar to each other. However, each can be readily distinguished by fossae pattern, size, and valve outline. When the fossae patterns of numerous *Muellerina* species have been studied, distinctive species groups can be recognized, and some of these complexes can be traced from the Calvert Formation at least into the Pliocene.

**Occurrence.**—I have found *Muellerina lienenklausi* in bed 10 and older beds within the Calvert Formation.

**Stratigraphic range.**—Lower Miocene.

***Muellerina micula* (Ulrich and Bassler, 1904)**

Plate 7, figures 2, 3

*Cythere micula* Ulrich and Bassler, 1904, p. 116, pl. 36, figs. 19, 20.  
Not *Cythere micula* Ulrich and Bassler, 1904, p. 116, pl. 36, fig. 18  
(= *Muellerina lienenklausi* (Ulrich and Bassler, 1904)).

*Trachyleberis martini* (Ulrich and Bassler). Malkin, 1953, p. 793, pl. 82, figs. 9, 13.

Not *Muellerina micula* (Ulrich and Bassler). Swain, 1974, p. 38, pl. 7, figs. 1-8 (= *Muellerina* spp.).

**Diagnosis.**—Large; strong reticulum; details of the fossae pattern characteristic, such as a continuous anterior-most row of round fossae subparallel to the anterior margin; murae thin relative to *M. lienenklausi*; ventral carinae are subparallel to ventral margin terminating just posterior of ventral concavity.

**Lectotype.**—A juvenile left valve illustrated by Ulrich and Bassler, 1904, plate 36, figure 20, USNM 35424 a, from the Calvert Formation at Plum Point, Md., is selected as the lectotype.

**Measurements.**—The lectotype (pl. 7, fig. 3) is 500  $\mu$ m in length and 270  $\mu$ m in height. The illustrated specimen (pl. 7, fig. 2), a female left valve, USNM 256035, is 640  $\mu$ m in length and 350  $\mu$ m in height.

**Remarks.**—*Muellerina micula* was represented by a syntypic suite of three valves. The specimen illustrated on plate 36, figure 19 of Ulrich and Bassler (1904) has been destroyed and lost except for a small fragment. Ulrich and Bassler (1904) note that the specimen illustrated in figure 18 is smaller than normal, suggesting that it was not what they regarded as typical. The latter specimen, in my opinion, is a juvenile of *Muellerina lienenklausi*, and is not con-

specific with the specimen illustrated in figure 20. The specimen illustrated in figure 20 and chosen here as the lectotype of *M. micula*, appears to be a juvenile conspecific with the specimen illustrated herein on plate 7, figure 2. The latter specimen is representative of the dominant *Muellerina* species in the Calvert Formation and is regarded by the author as *M. micula*. The *Muellerina micula* ornament pattern varies, often due to the merging of two or more fossae or the degree of expression of the carinae. However, this variation never overlaps with the ornamentation pattern seen in *M. lienenklausi*, although the two species are apparently closely related.

There is an undescribed species of *Muellerina* occurring in the Choptank Formation that is morphologically disjunct from *M. micula*, but very similar to it.

**Occurrence.**—Ulrich and Bassler (1904) reported this species from the Calvert and Yorktown Formations. The Yorktown occurrence represents another species of *Muellerina*. *Mullereina micula* occurs throughout the Calvert Formation in our collections.

**Stratigraphic range.**—Lower to middle Miocene.

**Subfamily ORIONININAE Puri, 1973**

**Genus Orionina Puri, 1954**

**Type-species.**—*Cythere vaughani* Ulrich and Bassler, 1904.

***Orionina vaughani* (Ulrich and Bassler, 1904)**

*Cythere vaughani* Ulrich and Bassler, 1904, p. 109, pl. 38, figs. 25-27.

*Cythereis vaughani* (Ulrich and Bassler). Howe and others, 1935, p. 25, pl. 3, figs. 24-26; pl. 4, fig. 13.

?*Trachyleberis vaughani* (Ulrich and Bassler). Swain, 1951, p. 37, pl. 6, figs. 6, 7.

*Trachyleberis vaughani* (Ulrich and Bassler). Malkin, 1953, p. 794, pl. 82, fig. 14.

*Orionina vaughani* (Ulrich and Bassler). Puri, 1954, p. 254, pl. 12, fig. 16; McLean, 1957, p. 88, pl. 11, figs. 6a-b; Swain, 1968, p. 21, pl. 4, figs. 4a-e; text fig. 19; Swain, 1974, p. 39, pl. 7, fig. 17; pl. 12, figs. 2a-h.

**Remarks.**—Ulrich and Bassler's (1904) holotype, USNM 35442, the only deposited specimen, is lost. However, Hazel (in press) has recently treated this species and the reader is referred to that study.

**Occurrence.**—*Orionina vaughani* occurs commonly in Pliocene to Holocene sediments in the Atlantic coastal plain and Florida.

**Stratigraphic range.**—Pliocene to Holocene.

**Subfamily CAMPYLOCYTHERINAE Puri, 1960**

**Tribe LEGUMINOCYTHERINI Howe, 1961**

**Genus Bensonocythere Hazel, 1967**

**Type-species.**—*Leguminocythereis whitei* Swain, 1951.

**Bensonocythere calverti (Ulrich and Bassler, 1904)**

Plate 7, figure 6

*Cythere calverti* Ulrich and Bassler, 1904, p. 100, pl. 38, figs. 11-13.

**Diagnosis.**—Large; prominent reticulum; absence of carinae; rectangular valve outline.

**Measurements.**—The holotype, USNM 35412, from the Calvert Formation at Plum Point, Md., is 800  $\mu\text{m}$  in length and 430  $\mu\text{m}$  in height.

**Remarks.**—*Bensonocythere calverti* is an extremely rare component of the Chesapeake Group sediments. As with several other ostracodes in these sediments, *B. calverti* increases in overall size through time so that the Yorktown Formation individuals are larger but otherwise morphologically similar to those from the Calvert Formation.

**Occurrence.**—*Bensonocythere calverti* occurs in the Calvert, Eastover (units C and D), and Yorktown Formations in our collections.

**Stratigraphic range.**—Lower Miocene to Lower Pliocene.

**Family PARACYTHERIDEIDAE Puri, 1957****Genus Paracytheridea G. W. Muller, 1894**

**Type-species.**—*Paracytheridea depressa* G. W. Muller, 1894.

**Paracytheridea altia Edwards, 1944**

Plate 7, figure 7

*Cytheropteron nodosum* Ulrich and Bassler, 1904, p. 129, pl. 38, figs. 37-40.

Not *Cytheropteron nodosum* Brady, 1868, p. 448, pl. 34, figs. 31-34.

*Paracytheridea nodosum* (Ulrich and Bassler). Howe and others, 1935, p. 37, pl. 3, fig. 7; Swain, 1951, p. 51, pl. 3, figs. 19-22.

*Paracytheridea altia* Edwards, 1944, p. 512, pl. 85, figs. 20, 21; Swain, 1974, p. 20, pl. 1, fig. 17.

*Paracytheridea vandenboldi* Puri, 1953, p. 751 (new name); Malkin, 1953, p. 780, pl. 79, fig. 5; Puri, 1954, p. 238, pl. 3, fig. 7; text figs. 5a, b; McLean, 1957, p. 75, pl. 8, figs. 4a-b.

?*Paracytheridea* cf. *P. vandenboldi* Puri. Swain, 1968, p. 11, pl. 2, figs. 4a, b.

**Measurements.**—The holotype (*C. nodosum* Ulrich and Bassler, 1904), USNM 35443, is 650  $\mu\text{m}$  in length and 300  $\mu\text{m}$  in height.

**Remarks.**—*Cytheropteron nodosum* Ulrich and Bassler, 1904 is a junior homonym of *C. nodosum* Brady, 1868. Puri (1953) recognized this and renamed the species *Paracytheridea vandenboldi*. However, van den Bold (1968) has shown that *P. altia* Edwards, 1944 is conspecific with *P. nodosum* (Ulrich and Bassler) and therefore is the valid name for the species.

**Occurrence.**—Ulrich and Bassler (1904) found this species in the Yorktown Formation (see also Hazel, 1971); Edwards (1944) reported it in the Duplin Marl of

South Carolina. The species occurs in the Eastover (unit C) and Yorktown Formations in our collections. It has also been reported from Pleistocene and modern sediments (Valentine, 1971).

**Stratigraphic range.**—Upper Miocene to Holocene.

**Genus Microcytherura G. W. Mueller, 1894**

**Type-species.**—*Microcytherura nigrescens* G. W. Muller, 1894.

**Microcytherura shattucki (Ulrich and Bassler, 1904)**

Plate 7, figure 1

*Cythere(?) shattucki* Ulrich and Bassler, 1904, p. 121, pl. 38, fig. 10. Not *Paracytheridea shattucki* (Ulrich and Bassler). Malkin, 1953, p. 780, pl. 79, figs. 6-9. (? = *Microcytherura* n. sp.)

Not *Shattuckocythere shattucki* (Ulrich and Bassler). Swain, 1974, p. 21, pl. 1, fig. 14; pl. 8, fig. 9 (? = *Microcytherura similis* (Malkin, 1953)).

**Diagnosis.**—Triangular to subtriangular valve shape with a broad anterior and a surface ornamentation consisting of a weak reticulum superimposed on a finely punctate surface; punctae are very numerous and small, densely distributed in each solum.

**Measurements.**—The illustrated specimen, USNM 256036, (pl. 7, fig. 1) is 600  $\mu\text{m}$  in length and 300  $\mu\text{m}$  in height.

**Remarks.**—The anterior half of the holotype of *Microcytherura shattucki*, USNM 35437, is all that remains intact; the posterior portion of the valve consists of several fragments. The type locality of this species is at Ulrich and Bassler's Paw Paw Point, in the Choptank Formation. Based on our collections, only one species of *Microcytherura* occurs in the Choptank Formation, and this appears to be conspecific with the holotype. It also conforms to Ulrich and Bassler's description and illustration of *M. shattucki*. The illustrated specimen (pl. 7, fig. 1) comes from bed 17 of the Choptank Formation at Scientist's Cliffs on the Western Shore of Chesapeake Bay.

Swain (1974) selected this species as the type of his genus *Shattuckocythere*. In my opinion, this species is congeneric with the type species of *Microcytherura* (*M. nigrescens* G. W. Mueller, 1894). The diagnostic criteria given by Swain (1974) for *Shattuckocythere* do not differentiate it from *Microcytherura* except in the type of hingement, which Swain describes as being antimerodont (*Microcytherura* being hemimerodont). All of Swain's (1974) *Shattuckocythere* species have a hemimerodont hinge except for the species *Eocytheropteron? yorktownensis* Malkin, 1953 which he also places in *Shattuckocythere* and which has an antimerodont hinge. I do not consider *Eocytheropteron? yorktownensis* to be a *Microcytherura*.



**Occurrence.**—*Microcytherura shattucki* occurs only in the Choptank Formation in our collections.

**Stratigraphic range.**—Middle Miocene.

***Microcytherura curta* (Malkin, 1953)**

Plate 7, figure 10

*Paracytheridea shattucki curta* Malkin, 1953, p. 791, pl. 79, figs. 10-12.

**Diagnosis.**—Trapezoidal right valve in the female, subtrapezoidal left valve in the female, and both valves in the male; a subdued reticulum superimposed over fine punctation that tends to occupy the entire solum.

**Lectotype.**—A male left valve illustrated by Malkin (1953, pl. 79, fig. 11), USNM 256037, from the Yorktown Formation (Malkin, 1953, locality VA-10) is selected as the lectotype.

**Measurements.**—The lectotype (pl. 7, fig. 10) is 600  $\mu\text{m}$  in length and 300  $\mu\text{m}$  in height.

**Remarks.**—Malkin (1953) originally proposed *Microcytherura curta* as a subspecies of *M. shattucki*. However, *M. curta* differs from *M. shattucki* in having fewer and larger punctae and a different valve outline. Further, the two species are not known from the same or even adjacent stratigraphic horizons. *Microcytherura curta*, however, does appear to be closely related to *M. similis*, based upon general morphologic similarity.

**Occurrence.**—*Microcytherura curta* occurs only in the Yorktown Formation in our collections.

**Stratigraphic range.**—Pliocene.

***Microcytherura similis* (Malkin, 1953)**

Plate 7, figure 9

*Paracytheridea similis* Malkin, 1953, p. 781, pl. 79, figs. 13, 14.

?*Shattuckocythere similis* (Malkin). Swain, 1974, p. 22, pl. 9, fig. 14.  
Not *Shattuckocythere similis* (Malkin). Swain, 1974, p. 22, pl. 1, fig. 19a (= *Microcytherura curta* (Malkin, 1953)).

*Shattuckocythere shattucki* (Ulrich and Bassler). Swain, 1974, p. 21, pl. 1, fig. 14; pl. 8, fig. 9.

*Shattuckocythere yorktownensis* (Malkin). Swain, 1974, p. 22, pl. 3, fig. 13; pl. 9, figs. 9a, b.

**Diagnosis.**—Subtrapezoidal valve outline; subdued reticulum with wide murae; prominent punctae usually located mainly along the edge of the murae in the solum.

**Lectotype.**—A female right valve illustrated by Malkin (1953, pl. 79, fig. 13), USNM 256038, is selected as the lectotype. This specimen is from the Yorktown Formation (Malkin, 1953, locality VA-10).

**Measurements.**—The lectotype is 550  $\mu\text{m}$  in length and 280  $\mu\text{m}$  in height.

**Occurrence.**—*Microcytherura similis* occurs commonly in the Pliocene and lower Pleistocene formations in the Atlantic Coastal Plain (Hazel, 1977).

**Stratigraphic range.**—Pliocene to lower Pleistocene.

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| <i>howei, Murrayina</i> .....         | 3, 4, 5, 9, 10, 11; pl. 3 |
| <i>Pterogocythereis</i> .....         | 12                        |
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| <i>calvertensis</i> .....             | 1, 6, 7, 8; pl. 1         |
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| <i>rugipustulosa</i> .....            | 4, 7; pl. 2               |
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| Kirkwood Formation, N. J. ....            | 11; pl. 3 |

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| <i>Trachyleberis</i> .....                  | 10, 19                    |
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| <i>shattucki</i> .....                      | 4, 5, 20, 21; pl. 7       |
| <i>similis</i> .....                        | 4, 5, 9, 20, 21; pl. 7    |
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| <i>bicornis</i> .....                       | pl. 3                     |
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| <i>macleani</i> .....                       | 13                        |
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| <i>curta</i> .....                                | 4, 21                                 |
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| <i>porcella, Cythere</i> .....                    | 4, 15                                 |
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| <i>calvertensis</i> .....                         | 15; pl. 5                             |
| <i>capax</i> .....                                | pl. 5                                 |
| <i>chesapeakeensis</i> .....                      | pl. 6                                 |
| <i>edwardsi</i> .....                             | 14                                    |
| <i>modica</i> .....                               | 15, 16; pl. 6                         |
| <i>nitidula</i> .....                             | 15; pl. 5                             |
| <i>paucipunctata</i> .....                        | 14; pl. 5                             |
| <i>plebeia</i> .....                              | 4, 5, 14, 15, 16; pls. 5, 6           |
| <i>porcella</i> .....                             | 15, 16; pl. 6                         |
| <i>toumeyii</i> .....                             | 15; pl. 5                             |
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| <i>rugipunctata</i> .....                         | 3, 4, 5, 18                           |
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| Randle Cliffs, Md., Calvert Formation .....      | 6                  |
| Red Bay Formation, Florida .....                 | 17                 |
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| <i>Otikocythere</i> .....                        | 17                 |
| <i>reesidei</i> , <i>Trachyleberis</i> .....     | 17                 |
| <i>rugipunctata</i> , <i>Cythere</i> .....       | 4, 18              |
| <i>Favella</i> .....                             | 18                 |
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| <i>Cytherideis</i> .....                          | 4, 8                |
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| <i>Hulingsina</i> .....                           | 4, 6, 7, 8; pl. 2   |
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| <i>Paracytheridea</i> .....                   | 4, 21               |
| <i>Shattuckocythere</i> .....                 | 21                  |
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| Trachyleberidinae .....                | 9                   |
| Trachyleberidini .....                 | 9                   |
| <i>Trachyleberis clarkana</i> .....    | 13, 14              |
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| <i>exanthemata</i> .....               | 11                  |
| <i>martini</i> .....                   | 10, 19              |
| <i>radiata</i> .....                   | 4, 11               |
| <i>reesidei</i> .....                  | 17                  |
| <i>rugipunctata</i> .....              | 18                  |
| <i>vaughani</i> .....                  | 19                  |

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| Unit C, Claremont Manor Member, Eastover Formation .....  | 2, 7, 13, 17, 18, 20    |
| Unit D, Cobham Bay Member, Eastover Formation .....       | 2, 3, 7, 13, 17, 18, 20 |
| <i>vandenboldi</i> , <i>Paracytheridea</i> .....          | 20                      |
| <i>vaughani</i> , <i>Cythere</i> .....                    | 4, 19                   |
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| Zones 16-20, Choptank Formation .....             | 2                                    |
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## PLATES 1-7

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

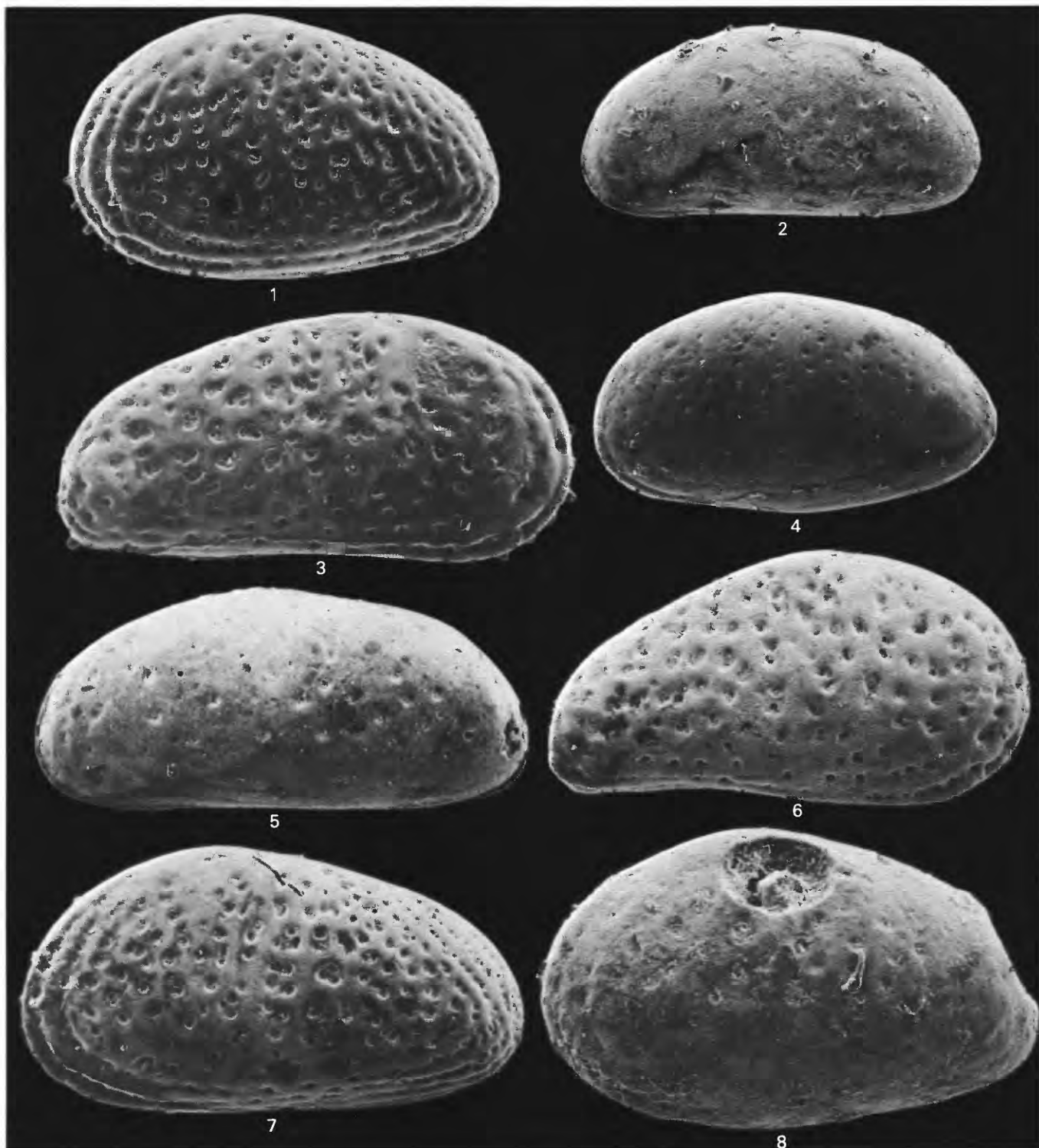
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## PLATE 1

FIGURES 1, 8. *Cytheridea subovalis* (Ulrich and Bassler, 1904).

1. Lateral view, left valve, female; Plum Point, Md., Calvert Formation. USNM 256021. × 95.
8. Lateral view, Left valve, female, Ulrich and Bassler's Paw Paw Point, Md., Choptank Formation. USNM 35439. × 105. Holotype.
- 2, 5. *Hulingsina calvertensis* new species.
  2. Lateral view, left valve, female; 0.8 km north of Randle Cliffs Beach, North Beach 7½-minute quadrangle, Maryland; Calvert Formation. USNM 256022. × 100. Holotype.
  5. Lateral view, left valve, female, Plum Point, Md., Calvert Formation. USNM 35446. × 120.
- 3, 6. *Cytheridea diagonalis* (Malkin, 1953).
  3. Lateral view, right valve, male; Malkin locality 13-3, Calvert Formation. USNM 256019. × 100. Paralectotype.
  6. Lateral view, right valve, female; Malkin locality 13-3, Calvert Formation. USNM 256018. × 100. Lectotype.
4. *Peratocytheridea subovata* (Ulrich and Bassler, 1904).
  - Left valve, male; Plum Point, Calvert Formation. USNM 648513. × 90. Paralectotype.
7. *Cytheridea virginiensis* (Malkin, 1953).
  - Lateral view, left valve, female; Malkin locality VA-10, Yorktown Formation. USNM 256020. × 125. Lectotype.



*CYTHERIDEA, HULINGSINA, AND PERATOCYTHERIDEA*



## PLATE 2

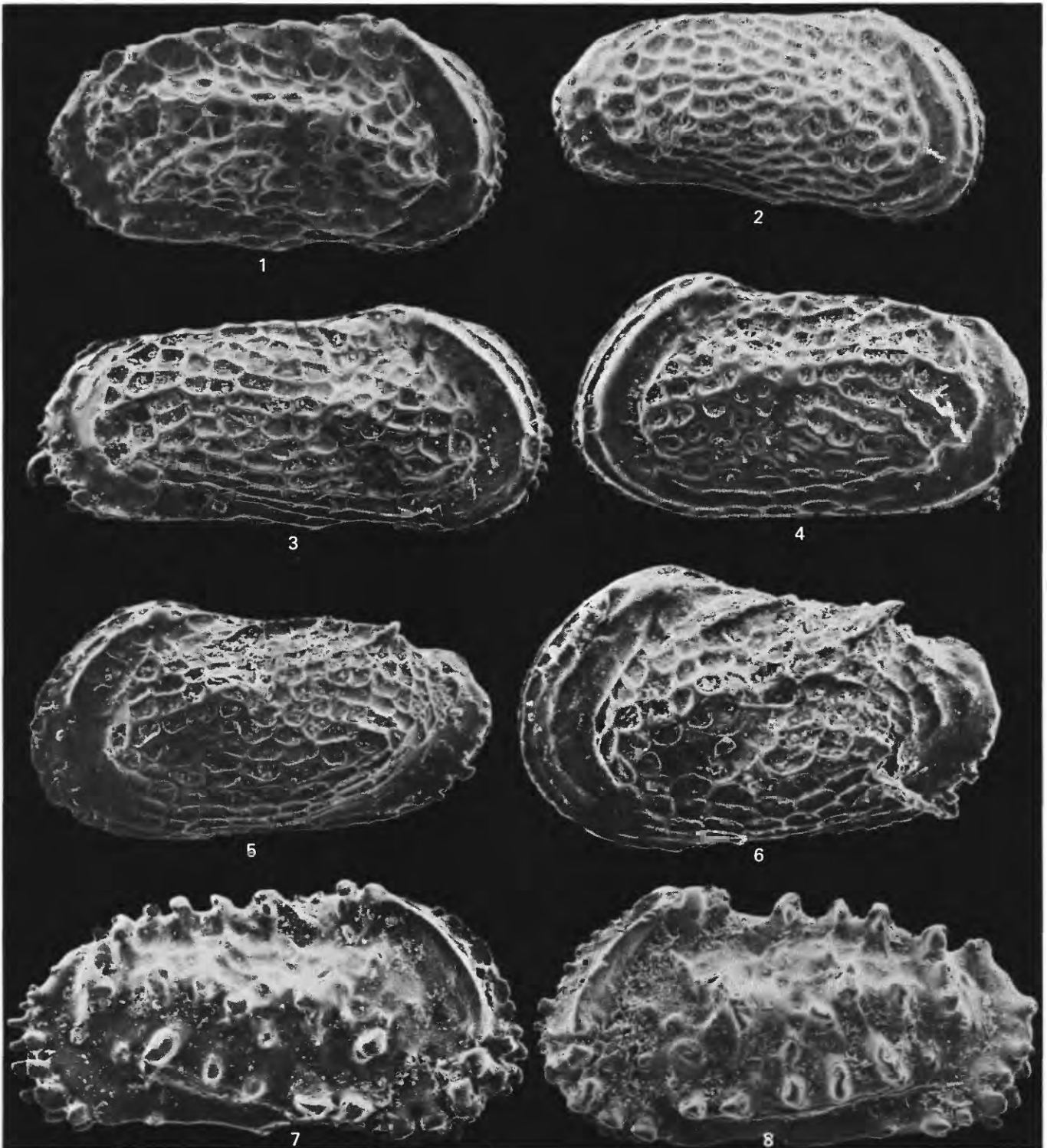
- FIGURE 1. *Hulingsina rugipustulosa* (Edwards, 1944).  
Lateral view, right valve, male; Malkin locality VA-12, Yorktown Formation. USNM 256023. (Lectotype of *H. echolsae* (Malkin, 1953)). × 150.
2. *Hulingsina cylindrica* (Ulrich and Bassler, 1904).  
Lateral view, left valve, male (?); Ulrich and Bassler's Plum Point locality, Calvert Formation. USNM 35447. × 110. Holotype.
- 3-5. *Hulingsina semicircularis* (Ulrich and Bassler, 1904).  
3. Lateral view, right valve, male; Ulrich and Bassler's Plum Point locality, Calvert Formation. USNM 35448 a. (= lectotype of *H. longula* (Ulrich and Bassler, 1904)). × 100.  
4. Lateral view, left valve, male; Ulrich and Bassler's Plum Point locality, Calvert Formation. USNM 35448 b. (= paralectotype of *H. longula* (Ulrich and Bassler, 1904)). × 110.  
5. Lateral view, right valve, female; Ulrich and Bassler's Plum Point locality, Calvert Formation. USNM 35449 a. × 120. Lectotype.
6. *Hulingsina subaequalis* (Ulrich and Bassler, 1904).  
Lateral view, female; Ulrich and Bassler's Plum Point locality, Calvert Formation. USNM 35450. × 110. Holotype.
7. *Cytheropteron? yorktownensis* (Malkin, 1953).  
Lateral view, left valve, female; Malkin locality VA-4, Yorktown Formation. USNM 256025. × 250. Lectotype.
8. *Cytherura coryelli* Malkin, 1953.  
Lateral view, left valve, female; Malkin locality 14-5, Choptank Formation. USNM 256024. × 200. Lectotype.



*HULINGSINA, CYTHEROPTERON, AND CYTHERURA*

### PLATE 3

- FIGURE 1. *Murrayina radiata* (Malkin, 1953).  
Lateral view, right valve, female; Malkin locality NJ-9, Kirkwood Formation. USNM 256026. × 110. Lectotype.
- 2, 4. *Murrayina martini* (Ulrich and Bassler, 1904).  
2. Lateral view, right valve, male; Plum Point, Md., Calvert Formation. USNM 35423 a. × 110. Lectotype.  
4. Lateral view, left valve, female; Plum Point, Calvert Formation. USNM 35423 b. × 120. Paralectotype.
- 3, 5. *Murrayina howei* (Ulrich and Bassler, 1904).  
3. Lateral view, right valve, male; Plum Point, Calvert Formation. USNM 35433 a. × 100. Lectotype.  
5. (Holotype of *M. dorsicornis* (Ulrich and Bassler, 1904)). Lateral view, left valve, juvenile; Plum Point, Calvert Formation. USNM 35415. × 145.
6. *Murrayina martini*? (Ulrich and Bassler, 1904).  
(= holotype of *M. dorsicornis bicornis* (Ulrich and Bassler, 1904)). Lateral view, left valve, juvenile; Ulrich and Bassler's Paw Paw Point, Md., Choptank Formation. USNM 35416. × 210.
- 7, 8. *Actinocythereis exanthemata* (Ulrich and Bassler, 1904).  
7. Lateral view, right valve, female; Plum Point, Calvert Formation. USNM 35419 b. × 120. Paralectotype.  
8. Lateral view, right valve, female; Plum Point, Calvert Formation. USNM 35419 a. × 110. Lectotype.

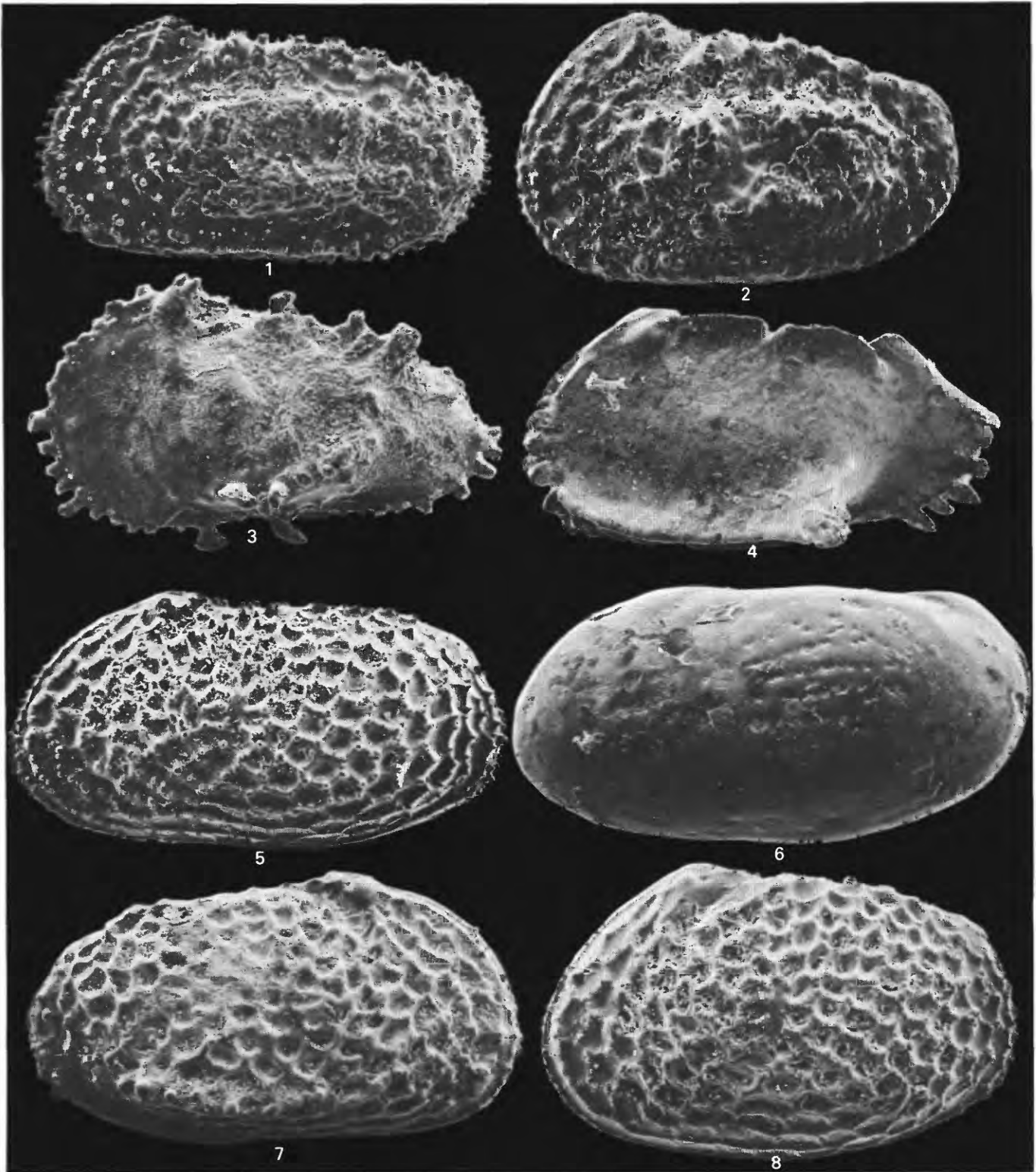


*MURRAYINA AND ACTINOCYHEREIS*

## PLATE 4

FIGURES 1, 2. *Henryhowella evax* (Ulrich and Bassler, 1904).

1. Lateral view, left valve, male (*H. oblongata*); Plum Point, Md., Calvert Formation. USNM 35418 a. × 100. Lectotype.
2. Lateral view, left valve, female; Plum Point, Calvert Formation. USNM 35417 a. × 110. Lectotype.
3. *Actinocythereis alaris* (Ulrich and Bassler, 1904).  
Lateral view, left valve, juvenile; James River, Va., Yorktown Formation. USNM 35451. × 120. Holotype.
4. *Pterygocythereis americana* (Ulrich and Bassler, 1904).  
Lateral view, left valve, female; Plum Point, Calvert Formation. USNM 35452 a. × 95. Lectotype.
5. *Echinocythereis clarkana* (Ulrich and Bassler, 1904).  
Lateral view, left valve, male; Plum Point, Calvert Formation. USNM 35413 a. × 80. Lectotype.
6. *Pseudocytheretta burnsi* (Ulrich and Bassler, 1904).  
Lateral view, left valve, male; Plum Point, Calvert Formation. USNM 35411 a. × 90. Lectotype.
7. *Echinocythereis planibasalis* (Ulrich and Bassler, 1904).  
Lateral view, right valve, male; James River, Yorktown Formation. USNM 35428. × 95. Holotype.
8. *Echinocythereis miniscula* (Ulrich and Bassler, 1904).  
Lateral view, left valve, female; Plum Point, Calvert Formation. USNM 35414 a. × 100. Lectotype.



*HENRYHOWELLA, ACTINOCYHEREIS, PTERYGOCYHEREIS, ECHINOCYHEREIS, AND PSEUDOCYHERETTA*

## PLATE 5

FIGURES 1, 4, 5. *Pseudocytheretta plebeia* (Ulrich and Bassler, 1904).

1. Lateral view, right valve, female; Plum Point, Md., Calvert Formation. USNM 256028.  $\times 80$ .

4. Lateral view, left valve, female; Plum Point, Calvert Formation. USNM 35429 a.  $\times 85$ . Lectotype.

5. Lateral view, right valve, female (lectotype of *P. capax* (Ulrich and Bassler, 1904)); Calvert Formation. USNM 35430 a.  $\times 85$ .

2, 3, 6, 7, 8. *Pseudocytheretta burnsi* (Ulrich and Bassler, 1904).

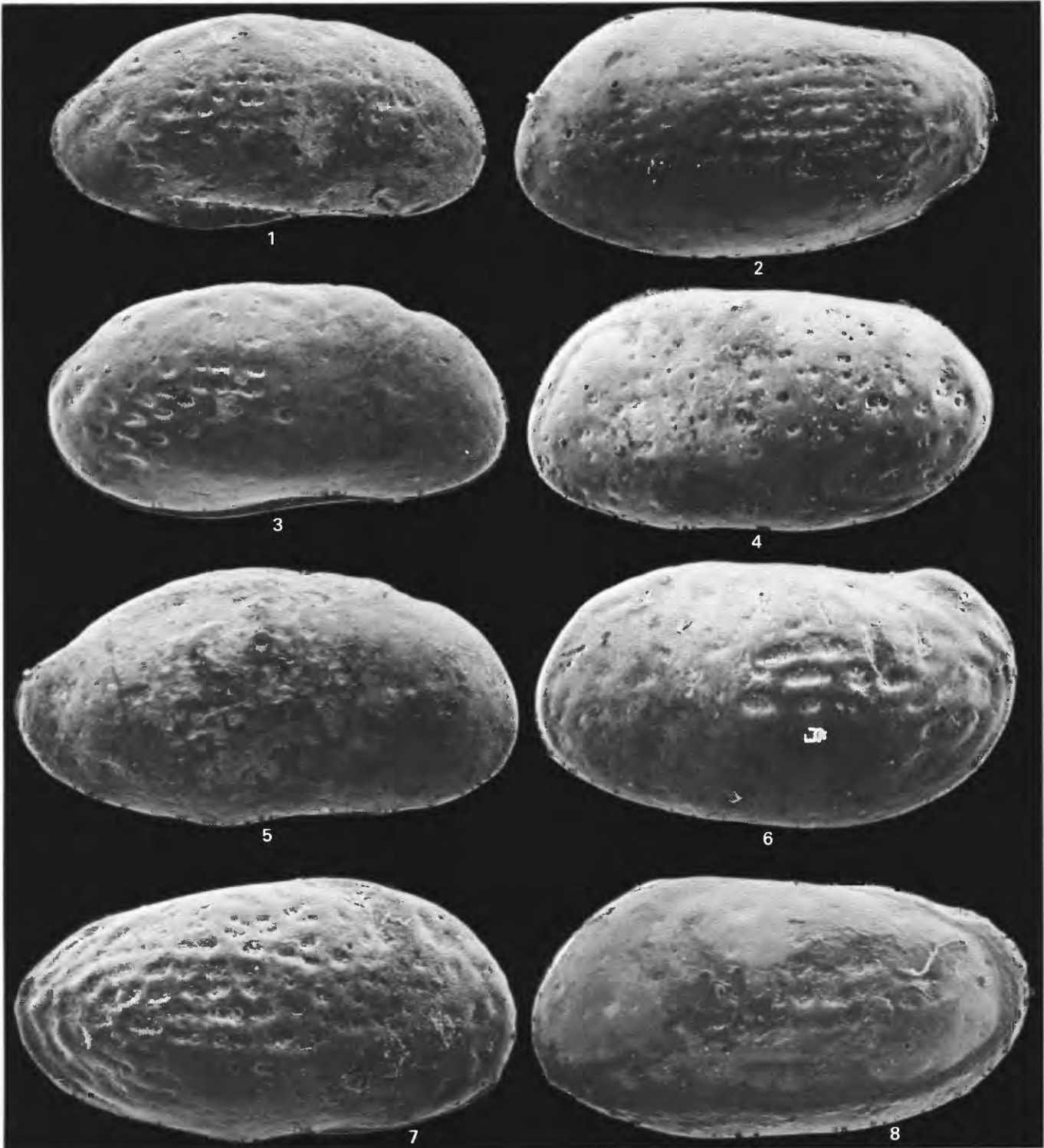
2. Lateral view, left valve, juvenile (lectotype of *P. nitidula* (Ulrich and Bassler, 1904)), Plum Point, Calvert Formation. USNM 35425 a.  $\times 105$ .

3. Lateral view, right valve, female, Bed 10, 0.8 km north of Plum Point, Calvert Formation. USNM 256027.  $\times 80$ .

6. (Holotype of *P. paucipunctata* (Ulrich and Bassler, 1904)). Lateral view, left valve, female; 4.8 km southwest of Easton, Md., Choptank Formation. USNM 35427.  $\times 85$ .

7. (Lectotype of *P. toumeyii* (Ulrich and Bassler, 1904)). Lateral view, right valve, juvenile; Peachblossom Creek, Trappe 7½-minute quadrangle, Maryland; Choptank Formation. USNM 35440.  $\times 160$ .

8. (Lectotype of *P. calvertensis* (Ulrich and Bassler, 1904)). Lateral view, left valve, juvenile; Plum Point, Calvert Formation. USNM 35426 a.  $\times 120$ .



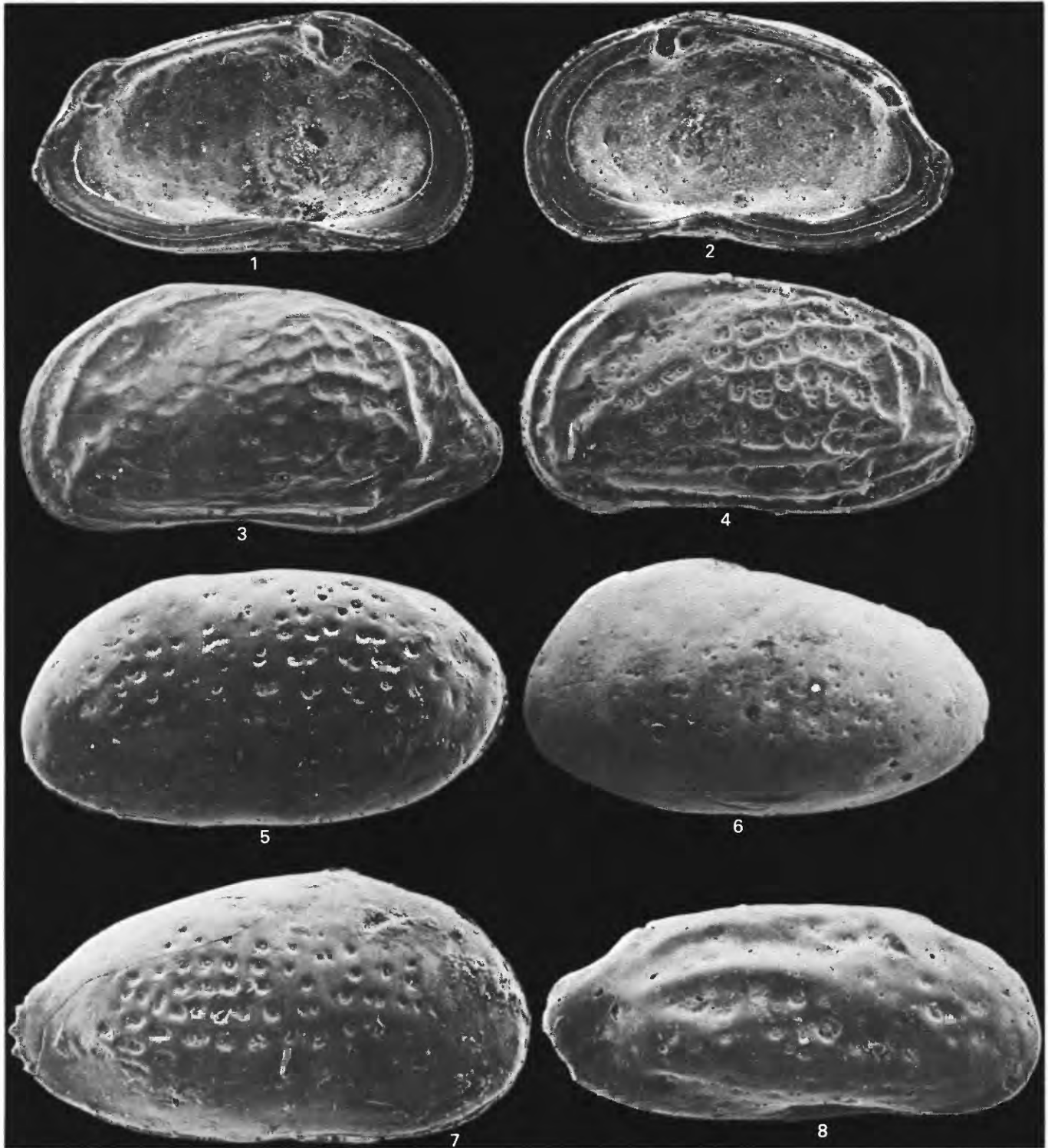
*PSEUDOCYTHERETTA*



## PLATE 6

FIGURES 1-4. *Otikocythere punctistriata* (Ulrich and Bassler, 1904). New genus

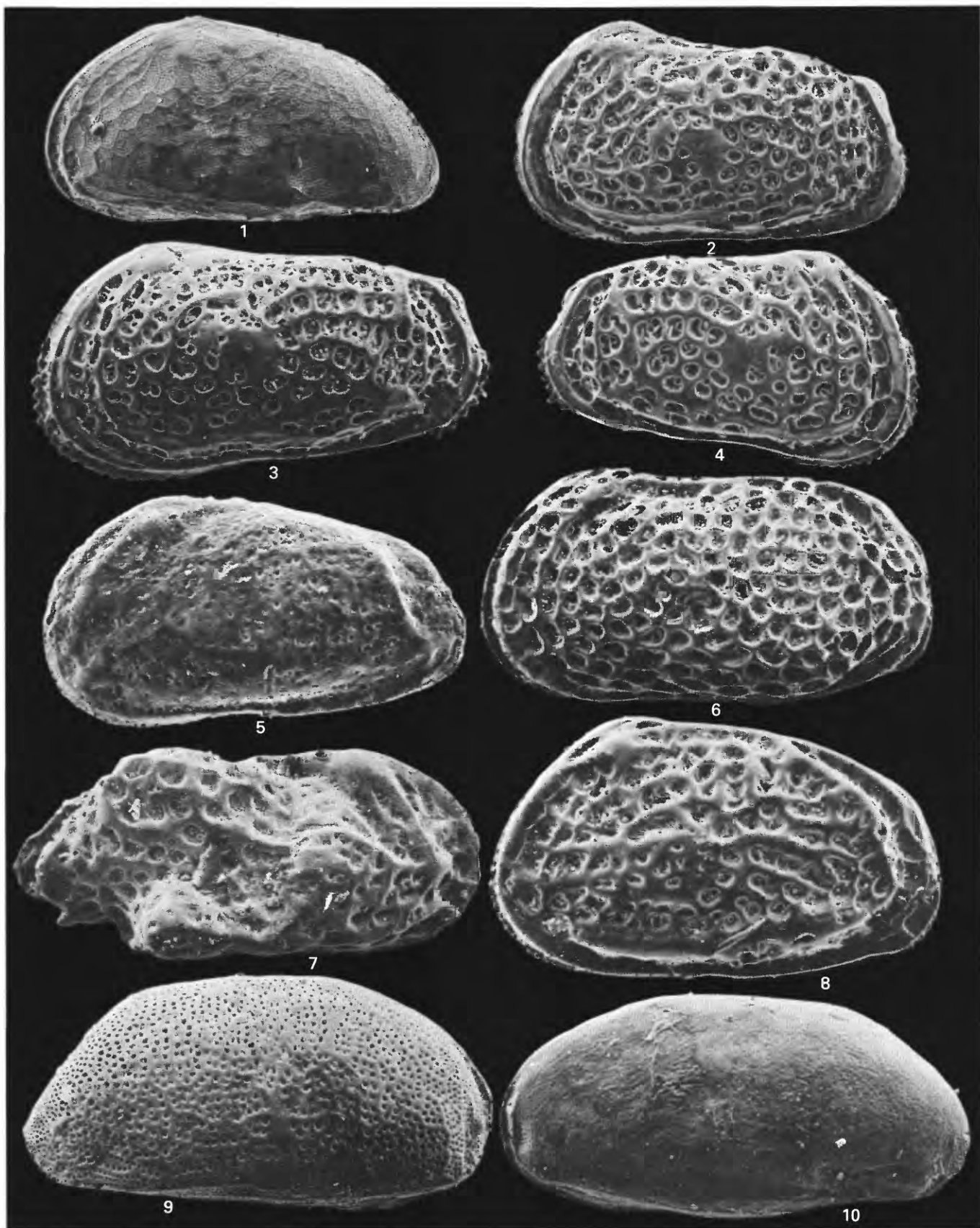
1. Lateral view, left valve, interior, female; Peachblossom Creek, Md., Choptank Formation. USNM 256029.  $\times 135$ .
  2. Lateral view, right valve, interior, female; Peachblossom Creek, Choptank Formation. USNM 256030.  $\times 135$ .
  3. Lateral view, left valve, female; Church Hill, Md., Calvert Formation. USNM 35435.  $\times 155$ . Paratype.
  4. Lateral view, left valve, female; Peachblossom Creek, Choptank Formation. USNM 256031.  $\times 160$ .
- 5-7. *Pseudocytheretta plebeia* (Ulrich and Bassler, 1904).
5. (Lectotype of *P. modica* (Ulrich and Bassler, 1904)). Lateral view, left valve, female; Plum Point, Md., Calvert Formation. USNM 35431 a.  $\times 100$ .
  6. (Lectotype of *P. porcella* (Ulrich and Bassler, 1904)). Lateral view, left valve, juvenile; Plum Point, Calvert Formation. USNM 35432 a.  $\times 130$ .
  7. (Holotype of *P. chesapeakensis* (Ulrich and Bassler, 1904)). Lateral view, right valve, juvenile; Plum Point, Calvert Formation. USNM 35444.  $\times 130$ .
8. *Protocytheretta inaequalis* (Ulrich and Bassler, 1904).  
Lateral view, right valve; Plum Point, Calvert Formation. USNM 35421 a.  $\times 85$ . Lectotype.



*OTIKOCYHERE, PSEUDOCYTHERETTA, AND PROTOCYTHERETTA*

## PLATE 7

- FIGURE 1. *Microcytherura shattucki* (Ulrich and Bassler, 1904).  
Lateral view, left valve, female, Bed 17, Scientists Cliffs, Md., Choptank Formation. USNM 256036. × 135.
- 2, 3. *Muellerina micula* (Ulrich and Bassler, 1904).  
2. Lateral view, left valve, female, Calvert Formation. USNM 256035. × 125.  
3. Lateral view, left valve, Juvenile, Plum Point, Md., Calvert Formation. USNM 35424 a. × 180. Lectotype.
4. *Muellerina lienenklausi* (Ulrich and Bassler, 1904).  
Lateral view, left valve, female, Plum Point, Calvert Formation. USNM 256034. × 120.
5. *Otikocythere punctistriata* (Ulrich and Bassler, 1904).  
Lateral view, left valve, juvenile, Peachblossom Creek, Md., Choptank Formation. USNM 256032. × 160.
6. *Bensonocythere calverti* (Ulrich and Bassler, 1904).  
Lateral view, left valve, Plum Point, Calvert Formation. USNM 35412. × 115. Holotype.
7. *Paracytheridea altila* Edwards, 1944.  
(= holotype of *Cytheropteron nodosum* Ulrich and Bassler, 1904). Lateral view, right valve, James River, Va., Yorktown Formation. USNM 35443. × 145.
8. *Thaerocythere schmidtæ* (Malkin, 1953).  
Lateral view, left valve, female, Malkin (1953) locality VA-9, Yorktown Formation. USNM 256033. × 130. Lectotype.
9. *Microcytherura similis* (Malkin, 1953).  
Lateral view, left valve, female, Malkin (1953) locality VA-10, Yorktown Formation. USNM 256038. × 170. Lectotype.
10. *Microcytherura curta* (Malkin, 1953).  
Lateral view, left valve, female, Malkin (1953) locality VA-10, Yorktown Formation. USNM 256037. × 160. Lectotype.



*MICROCYTHERURA, MUELLERINA, OTIKOCYTHERE, BENSONOCYTHERE,  
PARACYTHERIDEA, AND THAEROCYTHERE*