

Ostracoda From the
Upper Tertiary
Waccamaw Formation
Of North Carolina
And South Carolina

GEOLOGICAL SURVEY PROFESSIONAL PAPER 573-D



Ostracoda From the Upper Tertiary Waccamaw Formation Of North Carolina And South Carolina

By FREDERICK M. SWAIN

CONTRIBUTIONS TO PALEONTOLOGY

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*Descriptions, illustrations, geographic distribution,
stratigraphic ranges, and environmental aspects of
microfossils*



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CONTRIBUTIONS TO PALEONTOLOGY

OSTRACODA FROM THE UPPER TERTIARY WACCAMAW FORMATION OF
NORTH CAROLINA AND SOUTH CAROLINA

By FREDERICK M. SWAIN

ABSTRACT

The Ostracoda from 10 localities in the Waccamaw Formation are represented by 51 species. Eight species in the present collection are restricted to the Waccamaw deposits. Most of the rest of the species also occur in the closely associated upper Miocene Duplin Marl and upper part of the Yorktown Formation. An ostracode zone, typified by *Aurila conradi* (Howe and McGuirt) and *Mutilus confragosa* (Edwards) includes these three stratigraphic units and extends to the Recent.

On the basis of its ostracode and associated molluscan and foraminiferal faunas the Waccamaw Formation of North and South Carolina appears to be of transitional late Miocene to early Pliocene age.

INTRODUCTION

The Waccamaw Formation was named by Dall (1892) for exposures along Waccamaw River, Horry County, northern South Carolina. It is as much as about 20 feet thick and consists (Miller, 1912) of unconsolidated gray and buff fine quartz sand that in places is conglomeratic and phosphatic. Shell marls are abundant at certain levels. In North Carolina the Waccamaw beds may extend as far north as Hyde County, just south of Albemarle Sound. A molluscan fauna is represented in the Waccamaw. Gardner (1943, 1948) identified 21 species of Waccamaw pelecypods and 5 of gastropods confined to this formation and indicative, to her, of Pliocene age. Clark and others (1912) listed several restricted Waccamaw mollusk species that they believed represented a Pliocene age. A study by DuBar and Howard (1963) also suggests a Pliocene age for the Waccamaw.

As part of the U.S. Geological Survey's project, Atlantic Coast Permeability Distribution Analysis of Sediments, being conducted by the Water Resources Division, outcrop samples from the Waccamaw Formation were collected from five localities in northeastern South Carolina and from five localities in eastern North Carolina (fig. 1) by Philip M. Brown and Thomas G. Gibson. These samples were sent to the

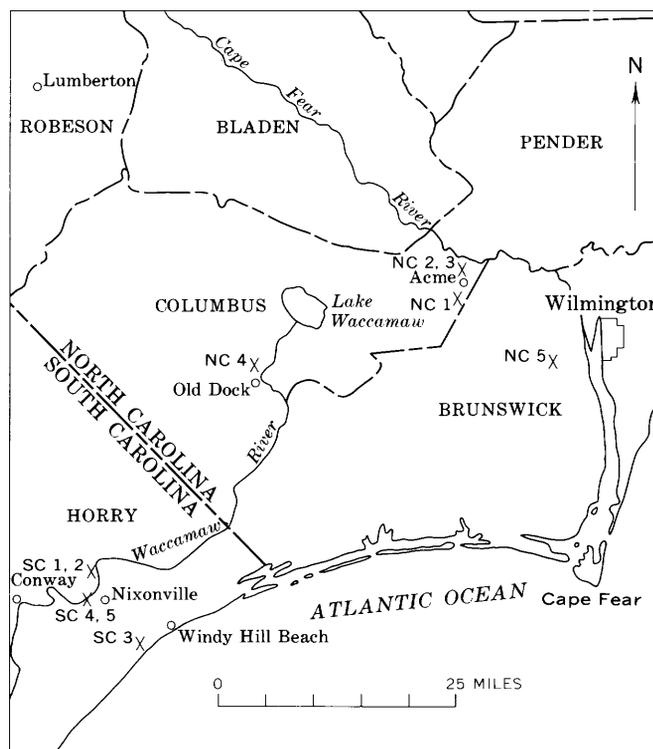


FIGURE 1.—Index map showing localities from which collections were obtained.

writer for stratigraphic and environmental analysis of their contained Ostracoda. The list of localities is as follows:

- NC-1. A marl pit 0.25 mile south of Acme Fertilizer plant at Acme, Columbus County, N.C.
- NC-2. A bluff at Neils Eddy Landing on southern bank of Cape Fear River 1 mile north of Acme, Columbus County, N.C. The fossiliferous bed is 2 feet thick and is 20 feet above the base of the bluff. The bluish-gray sand of the exposure contains mainly *Anomia*.
- NC-3. A small roadcut on the road across Second Branch 1 mile north of Acme, Columbus County, N.C. The exposure is 2 feet thick and is composed of yellow sand containing a great deal of comminuted shell fragments.

NC-4. A marl pit 0.5 mile north of Old Dock, Columbus County, N.C. The exposure consists of very coarse quartz sand in which macrofossils are common.

NC-5. Pierce Brothers quarry 8 miles southwest of Wilmington, Brunswick County, N.C. The material is coarse sand and contains numerous macrofossils, including *Anadara*, *Venus*, and *Busycon*.

SC-1. Parkers Landing, north bank of Waccamaw River, on Nixonville, S.C., 15-minute quadrangle; outcrop is due south of bench mark 38 on South Carolina Highway 905, 33°53'55" N., 78°52'00" W.; SC-1 is from a brown shelly sand 4 feet above river level; SC-1B is from a slightly indurated layer exposed at river level.

SC-2. Near Mount Calvary Church, S. 10° E. of bench mark 48 on South Carolina Highway 905, north bank of Waccamaw River, Nixonville, S.C., 15-minute quadrangle, 33°53'53" N., 78°52'47" W.; samples are from units 4 and 5 of DuBar's (1963) measured section, which is incorrectly located at Parkers Landing.

SC-3. About 3.1 miles south of city limits of Windy Hill Beach, Nixonville, S.C., 15-minute quadrangle, N. 45° E. of bench mark 48 on U.S. Highway 17, on south bank of Intracoastal Waterway, 33°46'52" N., 78°47'27" W.; about 3 feet of Waccamaw exposed above water level; Cretaceous material occurs here as spoil from dredging of waterway.

SC-4. Approximately 0.2 mile downstream from Tilly Lake, Waccamaw River on Nixonville, S.C., 15-minute quadrangle, south bank of river, 33°49'34" N., 78°54'52" W., Waccamaw Formation, light-gray shelly sand overlies dark-blue Cretaceous clay; represents DuBar's unit 1 at his locality WA-18 (1963).

SC-5. Approximately 0.1 mile downstream from Tilly Lake, near preceding locality.

Several specimens for the Duplin Marl, upper Miocene, at Walkers Bluff, 9 miles below Elizabethtown, N.C., on Cape Fear River, and from the Pleistocene at Longs, S.C., collected by T. G. Gibson, are also illustrated herein for comparative purposes.

TYPE LOCALITY OF THE WACCAMAW FORMATION

Locality SC-4 is here taken to be the type locality of the Waccamaw Formation. This locality was considered by DuBar and Howard (1963) to be representative of the Waccamaw and to occur in the type area of the formation. The section at this locality, modified after DuBar, is as follows:

Pleistocene:	
Sand, brown, gray and orange, silty, micaceous, and clay; unfossiliferous.....	Feet 13.4
Unconformity	
Waccamaw Formation (lower Pliocene to upper Miocene):	
2. Sand, calcareous, quartz, medium, subrounded, fairly well consolidated, fairly well sorted, light-gray (N7); fossils abundant, well-preserved, size-sorted(?), no apparent preferred orientation	7.0
1. Sand, calcareous, quartz, fine to medium, silty, unconsolidated, fairly well sorted, medium-blue-gray (5B, 5/Y); contains lumps of Peedee (Cretaceous) argillaceous sand reworked from below	

and small caliche nodules. Fossils abundant, well-preserved, size-sorted(?); most are small but not worn; some specimens of reworked

Exogyra sp.----- 2.0

DuBar and Howard noted (1963, p. 34) that at least 19 feet of sediments resembling the Waccamaw was penetrated in an auger hole near the above section before the Cretaceous Peedee Formation was reached.

OSTRACODE SPECIES OF THE WACCAMAW FORMATION

The species of Ostracoda identified in the present collections from the Waccamaw Formation and their geologic ranges are listed in table 1. Eight of the 51 Waccamaw species occur only in that formation or in Quaternary faunas of the area, but do not occur in the geographically associated upper Miocene Duplin Marl and Yorktown Formation. Twenty-three of the species occur only in the Waccamaw and in the Duplin and Yorktown Formations or older deposits but not in the Quaternary faunas of the area. The close similarity of the Waccamaw ostracode assemblages to those of the upper Miocene Yorktown (upper part) and Duplin Formations of the Middle Atlantic region and the Choctawhatchee Formation (of former usage) of Florida (Puri, 1954) suggests that the Waccamaw is nearly the same age as those formations.

The evidence of the age of the Waccamaw beds, based on the ostracodes and associated mollusks studied by others, is not conclusive but points toward a transitional late Miocene to early Pliocene age for the formation (table 2).

Unpublished studies by the writer on other Miocene ostracode faunas of the Middle Atlantic States show that the pre-upper Yorktown Miocene of the region is characterized by *Murrayina howei* Puri and *M. gunteri* (Howe and Chambers).

Cushman (1918) studied the Foraminifera from the Waccamaw Formation on Waccamaw River, S.C., and from two localities in North Carolina. Considering only the species he recorded from the South Carolina locality, which presumably are definitely from the Waccamaw Formation, Cushman identified 15 species. Of these he also recorded seven in the Miocene of the Atlantic Coastal Plain. Most of the other Waccamaw species were, at the time Cushman wrote, also recorded from the later Tertiary and Recent. Only one new species and a possibly distinct subspecies were restricted by Cushman to the Waccamaw of the Waccamaw River locality. The Foraminifera, like the Ostracoda, show a close relationship to the late Miocene of the region and suggest that the Waccamaw Formation is only slightly, if at all, younger than the upper Miocene Duplin Marl and Yorktown Formation of North Carolina and Virginia.

TABLE 1.—Ostracode species of the type Waccamaw, Horry County, S.C.

Species	Pre-Duplin	Duplin	Waccamaw	Post-Waccamaw
<i>Actinocythereis exanthemata</i> (Ulrich and Bassler).....	×	×	×	×
<i>Aurila conradi conradi</i> (Howe and McGuirt).....	×	×	×	×
<i>Aurila laevicula</i> (Edwards).....		×	×	
<i>Bairdia laevicula</i> Edwards.....	×	×	×	
<i>Bairdia</i> cf. <i>B. tuberculata</i> Brady.....				×
<i>Bairdoppilata triangulata</i> Edwards.....	×	×	×	
<i>Basslerites giganticus</i> Edwards.....	×	×	×	
<i>Bythocypris wicomicoensis</i> Swain.....	×	×	×	×
<i>Campylocythere laeva</i> Edwards.....	×	×	×	×
<i>Campylocythere laevis</i> (Edwards).....	×	×	×	×
<i>Caudites sellardsi</i> (Howe and Neill).....	×	×	×	
<i>Caudites?</i> sp.....	×?	×	×	
<i>Clitocythereis?</i> <i>mundorffi</i> (Swain).....	×	×	×	
<i>Cytheretta</i> cf. <i>C. calhounensis</i> Smith.....	×	×	×	
<i>Cytheromorpha curta</i> (Edwards).....	×	×	×	×
<i>Cytheropteron choctawhatcheensis</i> Puri.....	×	×	×	
<i>Cytheropteron yorktownensis</i> Malkin.....		×	×	×
<i>Cytherura</i> cf. <i>C. costata</i> Müller.....			×?	×
<i>Cytherura elongata</i> Edwards.....	×	×	×	×?
<i>Cytherura forulata</i> Edwards.....	×	×	×	×
<i>Eucytherura</i> sp.....			×	
<i>Echinocythereis garretti</i> (Howe and McGuirt).....	×	×	×	
<i>Haplocytheridea</i> aff. <i>H. blanpiedi</i> (Stephenson).....			×	
<i>Haplocytheridea bradyi</i> (Stephenson).....	×?	×?	×	×
<i>Haplocytheridea setipunctata</i> (Brady).....	×	×	×	×
<i>Hemicytherura howei</i> (Puri).....	×	×	×	
<i>Jonesia howei</i> (Puri).....	×	×	×	
<i>Bensonocythere whitei</i> (Swain).....	×	×	×	×
<i>Loxococoncha purisubrhomboidea</i> Edwards.....	×	×	×	×
<i>Loxococoncha reticularis</i> Edwards.....	×	×	×	×
<i>Loxococoncha wilberti</i> Puri.....	×	×	×	
<i>Loxocorniculum</i> sp.....			×	×?
<i>Munseyella subminuta</i> (Puri).....	×?	×?	×	
<i>Muellerina lienenklausi</i> (Ulrich and Bassler).....	×	×	×	×
<i>Murrayina?</i> sp.....			×	
<i>Mutilus confragosa</i> (Edwards).....	×?	×	×	×?
<i>Neocaudites triplistriata</i> (Edwards).....	×	×	×	
<i>Occultocythereis</i> sp.....			×	
<i>Orionina vaughani</i> (Ulrich and Bassler).....	×	×	×	×
<i>Paracytheridea</i> cf. <i>P. vandenboldi</i> Puri.....	×	×	×	×
<i>Pontocythere ashermani</i> (Ulrich and Bassler).....	×	×	×	×?
<i>Pontocythere</i> cf. <i>P. rugipustulosa</i> (Edwards).....	×	×	×	
<i>Pontocythere</i> cf. <i>P. wilberti</i> (Puri).....	×	×	×	
<i>Pteroloza?</i> sp.....			×	
<i>Pterygocythereis</i> sp. aff. <i>P. americana</i> (Ulrich and Bassler).....	×	×	×	×
<i>Puriana mesicostalis</i> (Edwards).....		×	×	
<i>Puriana rugipunctata</i> (Ulrich and Bassler).....	×	×	×	×
<i>Xenocythere?</i> sp.....			×	
<i>Xestoleberis choctawhatcheensis</i> Puri.....	×	×	×	
<i>Xestoleberis howei</i> Puri.....	×	×	×	
<i>Xiphichilus</i> sp.....			×	

TABLE 2.—Correlation chart of Waccamaw and related formations in southeastern United States

[Slightly modified after Cooke and others (1943).]

Series	Subdivision	North Carolina	South Carolina	Georgia	Florida
Pliocene	Upper	Croatan sand	Waccamaw Formation	Charlton Formation	Caloosahatchee Formation (southern Florida) Buckingham Marl (southern Florida) (of former usage)
	Lower				
Miocene	Upper	Duplin Marl Yorktown Formation	Duplin Marl Raysor Marl (of former usage)	Duplin Marl	Choctawhatchee Formation (western Florida) (of former usage)

ENVIRONMENTAL ASPECTS OF WACCAMAW OSTRACODE FAUNA

The following species that occur in the Waccamaw Formation in the present collection were identified by Puri (1960) from Recent localities off the Florida coast, but were not recorded from nearshore localities or from bays:

Bairdia cf. *B. tuberculata* Brady

Mutilus confragosa (Edwards)

The following species of the Waccamaw Formation were cited by Benson and Coleman (1963) as characteristic of waters deeper than 50 feet off southeastern Florida:

Bairdoppilata triangulata Edwards

Echinocythereis garretti (Howe and McGuirt)

Pontocythere ashermani (Ulrich and Bassler)

Pterygocythereis sp. aff. *P. americana* (Ulrich and Bassler)

All the Waccamaw localities studied herein yielded one or more of these species. In terms of numbers of specimens, however, the Acme and Neils Eddy Bluff localities, which were relatively farther downbasin than the South Carolina localities, yielded more abundant *Mutilus confragosa*. There is also a slight tendency for *Pontocythere ashermani* to be more abundant at the downbasin localities.

Among the species that Benson and Coleman cited as typically living in water less than 50 feet deep, *Haplocytheridea bradyi* (Stephenson), *Puriana rugipunctata* (Ulrich and Bassler), and *Campylocythere laevisissima* (Edwards) occur in the Waccamaw.

A study by Hulings and Puri (1965) of ostracode assemblages from the west coast of Florida provides a comparison with some of the Waccamaw material.

The following species were found by Hulings and Puri to prefer sand-mud substrate: *Haplocytheridea bradyi* (Stephenson) and *Puriana rugipunctata* (Ulrich and Bassler).

A preference for clean sand substrate was shown by *Campylocythere laevisissima* (Edwards). That species, together with *Aurila conradi* (Howe and McGuirt) and

Pontocythere ashermani, were found by Hulings and Puri to be typical of water less than 65 feet deep and of more than 30‰ (parts per thousand) salinity.

The following species of the Waccamaw were observed by Hulings and Puri to represent salinities slightly lower than the preceding assemblage and to prefer sand-mud substrate: *Actinocythereis exanthemata* (Ulrich and Bassler), *Haplocytheridea setipunctata* (Brady), and *Cytherura elongata* Edwards. Many of the other Recent species of marginal salinity do not occur in the Waccamaw, and a Recent assemblage of still lower salinity does not contain any Waccamaw species.

Comparison of the Waccamaw species with those from a modern Texas bay (Swain, 1955) shows the following relationships:

Haplocytheridea bradyi (Stephenson) occurs principally in the lower lagoonal part of San Antonio Bay, Tex., behind a barrier beach, in water about 5 feet deep; chlorinity range is 6.5 to 21‰, pH 7.35, Eh +202 mv (millivolts).

Pontocythere sp. aff. *P. mayeri* (Howe and Garrett) of San Antonio Bay is close to *P. rugipustulosa* (Edwards) of the present collection and occurs in the lower estuarine part of the Texas bay.

Paracytheridea vandenboldi Puri is represented in San Antonio Bay in the lower part of the lagoon in the same area with *Haplocytheridea bradyi*; it occurs in the intermediate localities in the Waccamaw.

Actinocythereis exanthemata Ulrich and Bassler has a close relative in San Antonio Bay which is concentrated in the lower part of the bay.

Loxococoncha cf. *L. australis* Brady, rare in the middle part of San Antonio Bay, closely resembles *L. wilberti* Puri of the Waccamaw at Acme, N.C. *Loxococoncha matagordensis* Swain of lower San Antonio Bay closely resembles *L. purisubrhomboidea* Edwards of some of the Waccamaw localities.

Aurila conradi (Howe and McGuirt) is abundant in lower San Antonio Bay and is present at nearly all the Waccamaw localities studied.

Cytheromorpha curta of the present collection is closely similar to *C. pascagoulensis* Mincher, a typical bay species. Furthermore, *C. curta* is living in Pamlico Sound.

Cytherura elongata Edwards of general distribution in San Antonio Bay also has general distribution in the Waccamaw.

The data suggest that the Waccamaw Ostracoda include species characteristic of an open shelf, as well as those of an indented coastline. The shallow-water biofacies is represented by most of the Waccamaw species, but in particular by *Cytheromorpha curta*, *Haplocytheridea bradyi*, *Campylocythere laevissima*, and *Puriana rugipunctata*. Other species which generally indicate a baylike environment that are common in the Waccamaw are *Cytherura elongata* Edwards, *C. forulata* Edwards and *Loxoconcha purisubrhomboidea* Edwards.

The deeper water, probably inner neritic biofacies, is represented by greater frequency of *Mutilus confragosa*, *Pontocythere ashermani*, *Bairdoppilata triangulata*, *Echinocythereis garretti*, and perhaps *Pterygocythereis* sp. aff. *P. americana*.

There is little evidence for a low-salinity brackish water or estuarine facies of the Waccamaw. The merging-assemblage character of the Waccamaw ostracodes suggests that insufficient time was available or that offshore slopes were too steep for barrier beaches to become well formed in the Waccamaw area.

With regard to the environmental aspects of the Waccamaw Foraminifera from the locality on Waccamaw River, compared to those from the Caloosahatchee Formation of Florida, of similar age, Cushman (1918, p. 5) states:

A comparison of the faunas shows marked differences in the conditions under which the two formations were deposited. Although the lots of material from the Waccamaw formation are not so rich as those from the Caloosahatchee marl, they nevertheless contain enough species clearly to show that the Waccamaw was laid down under conditions very dissimilar to those of the Caloosahatchee at its type locality. Nearly all the species in all the material are identical with those found at the present time along our Atlantic coast, but those from the Waccamaw formation of North and South Carolina and also some of those from Shell Creek, Fla., are much more similar to the material now found north of Cape Hatteras, while the Caloosahatchee River material represents a typically tropical shoal-water fauna such as may be found about southern Florida and in shallow water about the West Indies.

ACKNOWLEDGMENTS

Thomas G. Gibson collected the North Carolina samples and separated ostracode specimens from matrix. Philip M. Brown collected the South Carolina samples and provided advice as to the stratigraphic relationships of the Waccamaw Formation. Frederick J. Gun-

ther and June M. Gilby assisted in preparing the illustrations. Appreciation is expressed to these individuals.

SYSTEMATIC DESCRIPTIONS

The illustrated specimens will be deposited in the U.S. National Museum. Some of the photographs of specimens were slightly retouched. In this paper the following abundance designations are used: very abundant, 50 or more specimens; abundant, 25–49 specimens; common, 10–24 specimens; frequent, 5–9 specimens; rare, 1–4 specimens.

Family BAIRDIIDAE Sars, 1888

Genus BYTHOCYPRIS Brady, 1880

Distinguished by its elongate-reniform shape, low convexity, rounded extremities, smooth surface, ridge-and-groove hinge, larger LV (left valve) than RV (right valve), broad inner lamellae, narrow zone of concrescence, short radial canals, and compact group of muscle-scar spots.

Lower Ordovician to Recent.

Type species.—*B. reniformis* Brady, Recent.

Bythocypris wicomicoensis Swain

Plate 1, figures 1a, b

Bythocypris? *wicomicoensis* Swain, 1948, Maryland Dept. Geology, Mines, and Water Resources Bull. 2, p. 191, pl. 12, fig. 1. Swain, 1952, U.S. Geol. Survey Prof. Paper 234A, p. 17, pl. 1, figs. 4, 5.

Diagnosis.—Elongate, subtriangular-subreniform in outline, highest medially; anterior rounded, posterior narrowly curved; venter slightly concave; LV slightly larger; surface smooth.

Hinge, as viewed by transmitted light in one specimen, consists of a groove on LV, lying on both flanks of apex of valve, into which fits edge of RV; muscle scar lies slightly posterior to midlength and consists of a group of three or four spots ventral to which lie one or more additional spots; zone of concrescence narrow; radial canals numerous, short, and closely spaced terminally; inner lamellae not clearly seen but apparently are broad both terminally and ventrally.

Length of figured specimen 0.70 mm, height 0.35 mm, convexity 0.20 mm.

Remarks.—*Bythocypris howei* Puri from the Choctawhatchee Formation (of former usage) of Florida is a closely similar if not identical species, but is apparently not quite as elongate as *B. wicomicoensis*.

Occurrence.—In the Waccamaw Formation the species is rare at locality NC-1, Acme, N.C. (upper zone), and from localities SC-3 and SC-4, Horry County, S.C.; previously described from the subsurface Miocene (Calvert Formation) of Maryland (Swain, 1948)

and questionably from the subsurface middle Eocene of Maryland (Swain, 1952).

Specimens studied.—Three.

Figured specimen.—USNM 649865.

Genus **BAIRDOPPILATA** Coryell, Sample, and Jennings, 1935

Resembles *Bairdia* but on anterior and posterior dorsal slopes in selvage area of each valve are small transverse ridges and grooves.

Lower Cretaceous to Tertiary

Type species.—*B. martyni* Coryell, Sample, and Jennings, Upper Cretaceous.

Although it is considered to be a synonym of *Bairdia* by van Morkoven (1963), it forms a useful stratigraphic taxon and the present writer favors retaining it.

Bairdoppilata triangulata Edwards

Plate 1, figures 2a, b; text figures 2, 3

Bairdoppilata triangulata Edwards, 1944, Jour. Paleontology, v. 18, p. 507, pl. 85, figs. 5, 6. Puri, 1954, Florida Geol. Survey Bull. 36, p. 223, pl. 1, figs. 3, 4; text figs. 1a, b.

Diagnosis.—Subtriangular, highest medially, anterior extended medially, rounded below; posterior bluntly angulated, extended below; venter straightened medially; greatest convexity median; LV with strong middorsal and midventral overlap; surface sparsely and faintly pitted. Internal structures are as shown in text figures 2 and 3; radial canals not observed; terminodorsal marginal denticulations seen on LV but not on RV.

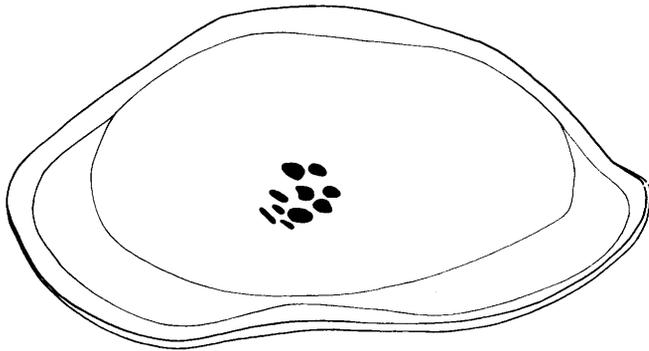


FIGURE 2.—*Bairdoppilata triangulata* Edwards. Interior of right valve; locality NC-1.

Length of figured specimen (pl. 1, fig. 2a) 0.78 mm, height 0.45 mm, convexity 0.33 mm.

Remarks.—No separated valves were found in the Waccamaw collections, but the external form of the specimens is typical for the species.

Occurrence.—In the Waccamaw Formation at locality NC-1, Columbus County, N.C. (upper zone), and at localities SC-2 and SC-3, Horry County, S.C.; also from the Duplin Marl and the upper and middle parts of the Yorktown Formation, upper Miocene of

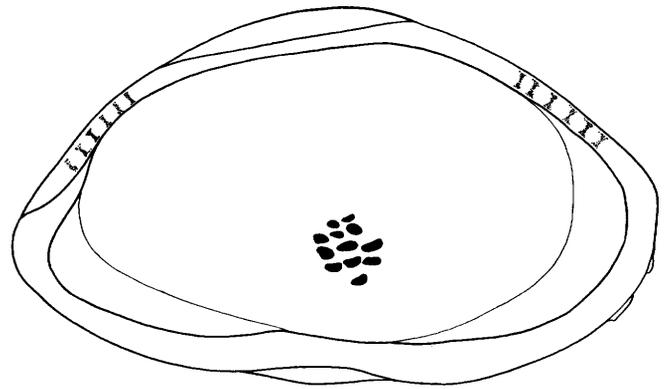


FIGURE 3.—*Bairdoppilata triangulata* Edwards. Interior of left valve; locality NC-1

North Carolina (Edwards, 1944).

Specimens studied.—Seven.

Figured specimens.—USNM 649866, 650006, 650007.

Genus **BAIRDIA** McCoy, 1844

Nesidea Costa, 1849, Accademia pontaniana, Naples, Atti, v. 5, p. 183.

Morrisitina Gibson, 1955, Jour. Paleontology, v. 29, p. 1069, [(*pro Morrisites*, Bull. Am. Paleontology, v. 35, p. 21 not Buckman, 1921)].

Acraatinella Schneider, 1956, in Mandelstam and others, Material of Paleont., new ser., v. 12, VSEGEI, Geol. Inst., Min. Geol. Moscow, p. 92.

Characterized by elongate fusiform shape, arched dorsum, rounded anterior, pointed posterior, smooth to pitted or tuberculate surface, larger LV with short hinge groove, muscle scars a compact median group, zone of concrescence wide, numerous close-set radial canals. Ordovician to Recent.

Type species.—*B. curtus* McCoy, Carboniferous.

Bairdia cf. *B. tuberculata* Brady

Plate 1, figures 3a, b; text figure 4

Bairdia rhomboidea Brady, 1870, Les Fonds de la Mer, v. 1, p. 162, pl. 19, figs. 14, 15, [not *B. rhomboidea* Kirkby, 1858].

Bairdia tuberculata Brady, 1880, Challenger reports, Zoology, v. 1, pt. 3, p. 60, pl. 10, fig. 3 Puri, 1960, Gulf Coast Geol. Soc. Trans., v. 10, p. 131, pl. 6, figs. 9, 10.

Nesidea tuberculata (Brady) Müller, 1912, Das Tierreich, p. 243.

Diagnosis.—Shell elongate-subtriangular, highest medially, dorsum moderately arched, venter straightened, anterior sharply curved medially; posterior bluntly pointed, extended below; dorsal slopes strongly truncated; posteroventral margin spinose; few spines on anterior; LV overlaps strongly, terminally and ventrally; valve convexity greatest median to postero-median; surface densely punctate. Internal structures as observed in present specimens are shown in text figure 4.

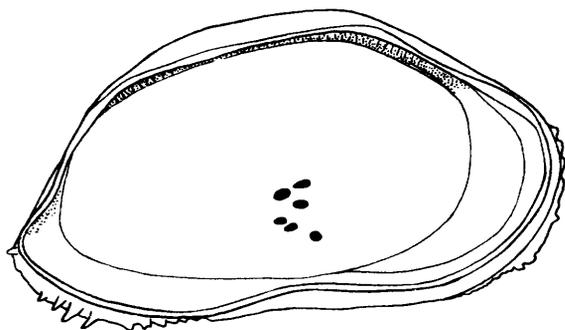


FIGURE 4.—*Bairdia* cf. *B. tuberculata* Brady. Interior of left valve; locality SC-2.

Length of figured specimen 0.70 mm, height 0.66 mm, convexity 0.32 mm.

Remarks.—The form, internal structures, and external ornamentation of the shell are like those prescribed for *B. tuberculata*.

Occurrence.—Rare in Waccamaw Formation, localities NC-5, Brunswick County, N.C., and SC-2, Horry County, S.C.; also living in Gulf of Mexico and elsewhere (Brady, 1868-86, 1880; Müller, 1912).

Specimens studied.—Two.

Figured specimen.—USNM 649867.

***Bairdia laevicula* Edwards**

Plate 1, figures 4a, b; plate 7, figure 2; text figure 5

Bairdia laevicula Edwards, 1944, Jour. Paleontology, v. 18, p. 506, pl. 85, figs. 3, 4. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 17. Puri, 1954, Florida Geol. Survey Bull. 36, p. 223, pl. 1, fig. 1, text fig. 1d.

Diagnosis.—Elongate-ovate, highest anterior to middle, dorsum moderately concave, venter straightened; anterior rounded below, truncate above; posterior pointed, extended submedially, slightly concave above; valves moderately convex; LV overlaps strongly mid-ventrally, less strongly dorsally; surface weakly and densely punctate; inner lamellae of moderate width; muscle scar median, composed of 8-10 spots in a dorso-ventrally oval group; hinge and other marginal features of a LV are as shown in text figure 5.

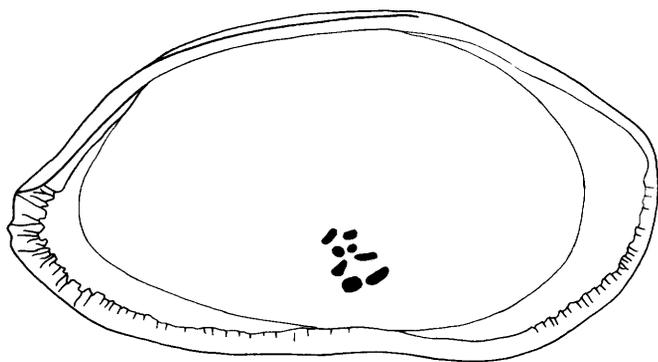


FIGURE 5.—*Bairdia laevicula* Edwards. Interior of left valve; locality NC-5.

Length of figured specimen (pl. 1, fig. 4a) 0.78 mm, height 0.45 mm, convexity 0.33 mm.

Remarks.—The surface pitting, outline, and other shell characteristics of the present specimens are like those of *B. laevicula*.

Occurrence.—Rare in Waccamaw Formation, locality NC-1, Columbus County, N.C.; locality NC-5, Brunswick County, N.C.; localities SC-2 and SC-4, Horry County, S.C.; previously described from the Duplin Marl and the upper and middle parts of the Yorktown Formation, upper Miocene of North Carolina.

Specimens studied.—Four.

Figured specimen.—USNM 649868.

Family CYTHERIDEIDAE Sars, 1925

Subfamily CYTHERIDEINAE Sars, 1925

Genus HAPLOCYTHERIDEA Stephenson, 1936

Leptocytheridea Stephenson, 1937, Jour. Paleontology, v. 11, p. 157.

Phractocytheridea Sutton and Williams, 1939, Jour. Paleontology, v. 13, p. 571.

Elongate-subovate, moderate convexity, ends blunt to tapering in dorsal view, anterior rounded, posterior rounded to pointed, larger LV with merodont hinge; surface smooth, pitted, or with vertical and concentric furrows; zone of concrescence broad, vestibules narrow, radial canals numerous, muscle scars a vertical undivided row of spots with anterior spots. Upper Cretaceous to Recent.

Type species.—*C. montgomeryensis* Howe and Chambers, upper Eocene.

Although some authors (van Morkoven, 1963, p. 279) restrict the genus to the pre-Miocene on basis of minor details of hinge and other features, the present writer concurs with Sandberg (1964) in extending the range of the genus into the Neogene.

***Haplocytheridea setipunctata* (Brady)**

Plate 1, figures 5a-c; plate 7, figures 1a, b

Cytheridea setipunctata Brady, 1869, Les Fonds de la Mer, v. 1, p. 124, pl. 14, figs. 15, 16.

Cytheridea (Haplocytheridea) ponderosa Stephenson, 1938, Jour. Paleontology, v. 12, p. 133, pl. 23, fig. 10; pl. 24, figs. 1, 2.

Haplocytheridea ponderosa (Stephenson). Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans., v. 10, p. 110. Curtis, 1960, Am. Assoc. Petroleum Geologists Bull., v. 44, pl. 23, fig. 2.

Cyprideis floridana Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans., v. 10, p. 100, pl. 2, fig. 5; text fig. 1-3 [not *Cytheridea floridana* Howe and Hough, 1935].

Haplocytheridea bassleri Stephenson, Swain, 1955 [part], Jour. Paleontology, v. 29, p. 617, pl. 59, fig. 9a [not fig. 9b = *Cyprideis ovata* (Mincher), fide Sandberg, 1964]. See Sandberg, 1964, Micropaleontology, v. 10, p. 361, for other questionable references to this species.

Haplocytheridea gigantea Benson and Coleman, 1963, Kansas Univ. Paleont. Contr., Arthropoda, Art. 2, pl. 27, pl. 3, figs. 10-14; text fig. 14.

?*Cytheridea puncticollata* Brady, Tressler and Smith, 1948 [part]. Chesapeake Biol. Lab. pub., v. 71, pl. 1, fig. 2 [fide Sandberg 1964].

Haplocytheridea setipunctata (Brady). Sandberg, 1964, Micropaleontology, v. 10, p. 361. Sandberg, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 508, pl. 3, fig. 12. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 329, fig. 14.

Diagnosis.—Shell subovate, dorsum moderately arched, venter convex, sinuous anteriorly; anterior rounded, extended below; posterior broadly rounded, extended medially; moderately convex, blunt-ended in edge view. LV overlaps RV around entire margin. Surface sparsely punctate. Internal structures are as described by Sandberg (1964).

Length of figured specimen (pl. 1, fig. 5a) 0.81 mm, height 0.53 mm, convexity 0.43 mm.

Remarks.—The present writer has followed the recent study by Sandberg (1964) in the assignment of the Waccamaw specimens to this species and genus.

Occurrence.—Rare in Waccamaw Formation, locality NC-3, Columbus County, N.C.; locality NC-5, Brunswick County, N.C.; localities SC-1, SC-1b, and SC-4, Horry County, S.C.; also throughout the Miocene and in the Recent of Gulf of Mexico region and Chesapeake Bay.

Specimens studied—nine.

Figured specimens.—USNM 649869, 649870.

***Haplocytheridea* sp. aff. *H. blanpiedi* (Stephenson)**

Plate 1, figures 6a, b

Shell subovate to subtriangular in side view, highest anteromedially; dorsal margin moderately convex, with steeper anterodorsal than posterodorsal slope; ventral margin nearly straight; anterior margin broadly curved; posterior margin narrowly curved, strongly extended below. LV larger than RV, extending most strongly beyond right along venter; valves moderately convex, sloping steeply toward margins; blunt-ended in edge view. Surface coarsely pitted; in marginal areas pits are arranged in shallow grooves. Internal shell characters are as described by Sandberg (1964).

Length of figured shell 0.81 mm, height 0.47 mm, convexity 0.40 mm.

Relationships.—This species is similar to *H. blanpiedi* (Stephenson), but that form is spinose terminally and less coarsely pitted.

Occurrence.—Rare in Waccamaw Formation, locality NC-5, Brunswick County, N.C.

Specimens studied.—One.

Figured specimen.—USNM 649871.

***Haplocytheridea bradyi* (Stephenson)**

Plate 1, figures 7a, b, 8a, b; plate 2, figure 8

Cytheridea (Haplocytheridea) bradyi Stephenson, 1938, Jour. Paleontology, v. 12, p. 129, pl. 23, fig. 22; pl. 24, figs. 5, 6; text fig. 10.

Haplocytheridea bradyi (Stephenson). Swain, 1955, Jour. Paleontology, v. 29, p. 618, pl. 59, figs. 12a, b. Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans. v. 10, p. 110, pl. 2, figs. 3, 4; pl. 6, fig. 19; text figs. 4, 5. Sandberg, 1964, Micropaleontology, v. 10, p. 362, pl. 2, figs. 7-16. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 321, fig. 12.

Haplocytheridea bradyi Swain, Byrne, LeRoy, and Riley, 1959, Gulf Coast Assoc. Geol. Soc. Trans. v. 9, p. 240, pl. 4, fig. 10; pl. 5, fig. 11.

Cytheridea (Haplocytheridea) wadei Stephenson, 1941, Jour. Paleontology, v. 15, p. 428, text figs. 3, 4, 14-18.

Haplocytheridea wadei (Stephenson). Puri, 1954, Florida Geol. Survey Bull. 36, p. 231, pl. 3, figs. 5, 6; text fig. 3g.

Haplocytheridea probosciduala (Edwards). Benson and Coleman, 1963, Kansas Univ. Paleont. Contr., Arthropoda, Art. 2, p. 28, pl. 3, figs. 4-9; text fig. 15.

[Not] *Haplocytheridea* cf. *H. probosciduala* (Edwards). Puri, 1954, Florida Geol. Survey Bull. 36, p. 234, pl. 2, figs. 17, 18; text figs. 3e f [= ?*Haplocytheridea subovata* Ulrich and Bassler, fide Sandberg, 1964].

Diagnosis.—Shell elongate, subtriangular to subovate, dorsum strongly arched, venter slightly convex and sinuous; anterior moderately to narrowly curved, strongly extended below. Immature shells more unequally than adults. Either RV or LV the larger, overreaching the other dorsally more than elsewhere; valves moderately convex, tapering from midlength toward ends in dorsal view. Surface coarsely and deeply pitted except for smooth marginal zone; narrow shallow dorsomedian furrow extends obliquely toward anteroventral region in dorsal one-third of valves. Reversal of hingement as well as of valve size occurs in species.

Hinge of LV, terminal, finely transversely notched elongate sockets and interterminal crenulate furrow; inner lamellae narrow, small vestibule present, radial canals few and widely spaced along free margin; adductor scars a median group of four spots in a vertical row and two more anterior spots, the dorsal one V-shaped.

Length of figured specimen (pl. 1, fig. 7a) 0.73 mm, height 0.41 mm, convexity 0.36 mm.

Occurrence.—The species is rare in the Waccamaw Formation, locality SC-5, Horry County, S.C.; locality NC-5, Brunswick County, N.C. Elsewhere it has been recorded from the Miocene Choctawhatchee Formation (of former usage) of Florida and Duplin Marl of North Carolina; the Pliocene Caloosahatchee Formation of Florida; the Pleistocene of Louisiana; the Recent of the Gulf Coast area, of the United States and Mexico, and from Puerto Rico.

Specimens studied.—Four.

Figured specimens.—USNM 649872, 649873.

Subfamily NEOCYTHERIDEINAE Puri, 1957

Genus PONTOCYTHERE Dubowsky, 1939

Hemicytherideis Ruggieri 1952, Bologna Univ., Inst. Zool., Note del. Lab. Biol. Marina di Fano, v. 1, p. 62.

Hulingsina Puri, 1958, Gulf Coast Assoc. Geol. Soc. Trans, v. 8, p. 173.

Much elongated, venter straight to concave, dorsum weakly convex, ends rounded, anterior broader, posterior with flangelike extension below, surface smooth to pitted or ventrally striate, may have median subvertical sulcus, larger LV with anterior long hinge furrow and subjacent "antislip bar;" intermediate long ridge and posterior short crenulate furrow, muscle scars a median undivided subvertical row and more anterior and more ventral spots. Conspicuous vestibules terminally, otherwise zone of concrescence broad; numerous, in part complex, radial canals. Eocene to Recent.

Type species.—*P. tchernjawkii* Dubowsky, Recent.

Soft parts of *Hulingsina ashermani* (Ulrich and Bassler) were found by Hulings (1966) to be like *Pontocythere*.

Pontocythere cf. P. wilberti (Puri)

Plate 1, figures 9a-f; plate 2, figures 2a-c; text figures 6A, B

Cytherideis wilberti Puri, 1952, Jour. Paleontology, v. 26, p. 908, pl. 130, figs. 9, 10; text figs. 7, 8. Puri, 1954, Florida Geol. Survey Bull. 36, p. 288, pl. 9, figs. 9, 10.

Hulingsina wilberti (Puri). Puri, 1958, Gulf Coast Assoc. Geol. Soc. Trans. v. 8, p. 175.

Diagnosis.—Elongate-subelliptical, dorsum gently convex, venter slightly concave; anterior rounded, extended below; posterior more narrow, extended below, truncate above; valves moderately convex; dimorphic, males more elongate and less convex than females. LV larger than and extending beyond RV, especially along dorsal slopes. Surface bears concentric grooves anteriorly, ventrally, and to a less extent posteriorly; remainder of surface smooth or with obscure markings. Hinge of LV with anterior long furrow; interterminal bar and posterior shorter furrow.

Inner lamellae broadest and with vestibule anteriorly, radial canals distributed as shown in text figure 6B; observable adductor muscle scars are as shown in text figure 6A.

Length of figured mature male shell (pl. 1, fig. 9d) 0.91 mm, height 0.38 mm, convexity 0.35 mm.

Remarks.—The shape and general surface ornamentation are like *P. wilberti*, but the present specimens are less nodose over general surface of shell than is typical in that species. The assignment of the species to *Pontocythere* Dubowsky (1939) is based on Hulings' (1966) discovery that the shell and soft parts of *Hulingsina Puri* (1958) and *Pontocythere* are basically the same.

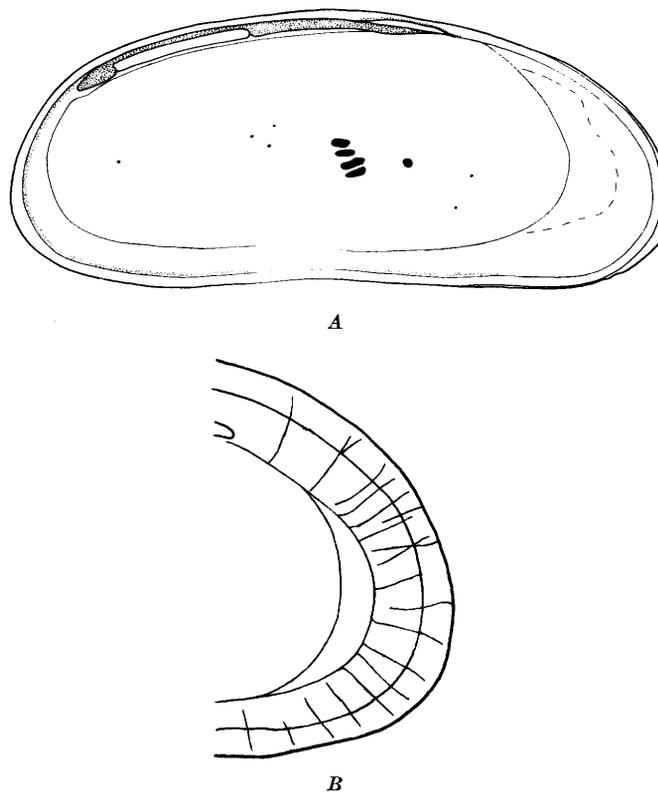


FIGURE 6.—*Pontocythere* cf. *P. wilberti* (Puri). A, Interior of left valves of female?, locality NC-5. B, Anterior part of male?, locality NC-2.

Occurrence.—Frequent in Waccamaw Formation at locality NC-2, Columbus County, N.C.; frequent at locality NC-1, Columbus County, N.C.; rare at localities NC-3, Columbus County and NC-5, Brunswick County, N.C. The species is present in the Choctawhatchee Formation (of former usage) and the Alum Bluff Group of Florida (lower and middle Miocene).

Specimens studied.—Six.

Figured specimens.—USNM 649874, 649879, 649884, 649885.

Pontocythere rugipustulosa (Edwards)

Plate 1, figure 10; text figure 7

Cytherideis rugipustulosa Edwards, 1944, Jour. Paleontology, v. 18, p. 514, pl. 86, figs. 5-7. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 20. Puri, 1954, Florida Geol. Survey Bull. 36, p. 287 (table 9). Malkin, 1953, Jour. Paleontology, v. 27, p. 780, pl. 78, figs. 20, 22, 23. Puri, 1958, Gulf Coast Assoc. Geol. Soc. Trans., v. 8, p. 175.

Diagnosis.—Elongate, subelliptical to subreniform, highest anteromedially, dorsum moderately arched, venter slightly concave; anterior rounded, slightly extended above. Surface ornamented by rows of tiny nodes arranged concentrically in anterior, ventral, and posterior parts of shell, in longitudinal rows in postero-dorsal part; oblique shallow sulcus.

Hinge of LV anterior elongate groove socket; interterminal, slightly recessed bar formed of valve edge and posterior short groove; inner lamellae broad anteriorly, vestibule narrow, radial canals relatively few and widely spaced.

Length of figured specimen 0.71 mm, height 0.35 mm, convexity of left valve 0.18 mm.

Occurrence.—Rare in Waccamaw Formation at locality SC-5, Horry County, S.C. The species occurs also in the Choctawhatchee Formation (of former usage) of Florida and the Duplin Marl of North Carolina. The illustrated specimen (pl. 1, fig. 10) is from the Duplin.

Specimens studied.—Three.

Figured specimen.—USNM 649880.

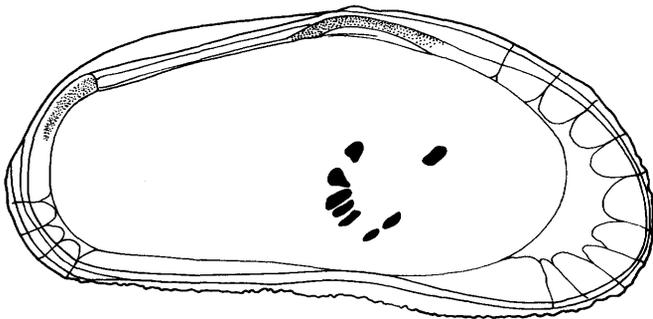


FIGURE 7.—*Pontocythere rugipustulosa* (Edwards). Interior of left valve; Duplin Formation, Walkers Bluff, N.C.

***Pontocythere ashermani* (Ulrich and Bassler)**

Plate 2, figures 1a-d; plate 6, figure 4; text figure 8

Cytherideis ashermani Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 126, pl. 37, figs. 10-16. Howe and others, 1935, Florida Geol. Survey Bull. 13, p. 14, pl. 3, figs. 8-10. Swain, 1948, Maryland Dept. Geology, Mines, and Water Resources Bull. 2, p. 195, pl. 14, fig. 1. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 19. Puri, 1952, Jour. Paleontology, v. 26, p. 910, pl. 13, figs. 4-8; text figs. 1, 2. Puri, 1954, Florida Geol. Survey Bull. 36, p. 286, pl. 9, figs. 4-8. Malkin, 1953, Jour. Paleontology, v. 27, p. 778, pl. 78, figs. 1-3.

Cytherideis longula Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 128, pl. 37, figs. 21-27.

Cytherideis semicircularis Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 127, pl. 37, fig. 18-20.

Hulingsina ashermani (Ulrich and Bassler). Puri, 1958, Gulf Coast Assoc. Geol. Soc. Trans., v. 8, p. 173. Benson and Coleman, 1963, Kansas Univ. Paleont. Contr., Arthropoda, Art. 2, p. 30, pl. 4, figs. 1-3; text fig. 17. Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropoda, Art. 8, p. 45, pl. 6, fig. 5; pl. 8, figs. 1-3. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 323, fig. 12A.

Pontocythere ashermani (Ulrich and Bassler). Hulings, 1966, Chesapeake Sci., v. 7, p. 51, figs. 2a-g, 6n.

Diagnosis.—Shell elongate, subtrapezoidal to sublanceolate; dorsum straightened medially, forming

broadly obtuse angles with dorsal slopes; venter slightly concave; anterior rounded, extended below; posterior bluntly subacuminate, strongly extended below; flange on LV. LV overreaches RV along dorsal slopes. Valves more strongly convex in shorter and higher female dimorphs. Surface in adult shells bears numerous large pits in which interspaces vary from the same to twice the diameter of pits.

Hinge of LV consists of anterior smooth short groove supported by a bar below, interterminal bar formed of valve edge and posterior furrow, shorter than anterior; inner lamellae broad anteriorly, narrow elsewhere; vestibule fairly wide, anteriorly; about 15 radial canals anteriorly; adductor scar not seen in present specimens; specimens from the Duplin Marl at Lumberton, N.C., have anteromedian vertical row of three or four spots and one or two more anterior spots, dorsal of which is larger.

Length of figured female specimen (pl. 2, fig. 1a) 0.85 mm, height 0.45 mm, convexity 0.40 mm.

Remarks.—Hulings (1966) assigned the species to *Pontocythere* on the basis of its appendages and shell features.

Occurrence.—Rare to common in Waccamaw Formation at localities SC-1, SC-1b, SC-3, and SC-4, Horry County, S.C.; rare at locality NC-2, Columbus County, N.C.; frequent at locality NC-3; rare at locality NC-4, Columbus County, N.C.; common at locality NC-5, Brunswick County, N.C. Common throughout Miocene of Atlantic Coastal Plain; has been reported living off west coast of Florida (Hulings and Puri, 1965, p. 320), but the present writer feels those specimens are too strongly sulcate for the species; is living in Atlantic Ocean off Virginia according to Hulings (1966).

Specimens studied.—Forty-eight.

Figured specimens.—USNM 649881-649883, 650009.

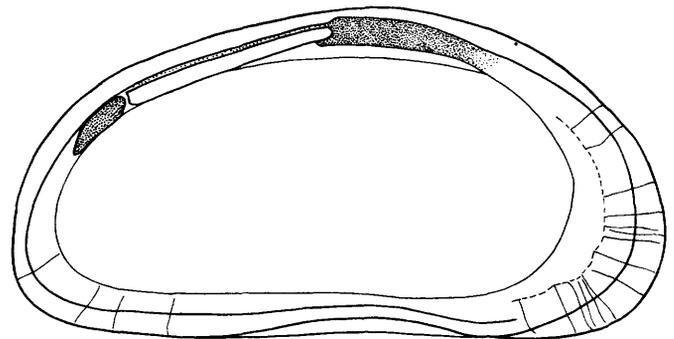


FIGURE 8.—*Pontocythere ashermani* (Ulrich and Bassler). Interior of left valve; locality NC-1.

Family CYTHERURIDAE Müller, 1894

Genus PARACYTHERIDEA Müller, 1894

? *Vicinia* Kuznetsova, 1957, in Mandelstam and others, All Union Paleont. Soc., Annual, Moscow, v. 16, p. 183.

? *Mooreina* Harlton, 1933, Jour. Paleontology, v. 7, p. 21.

Subquadrate, pointed posteriorly, straight-hinged, strongly alate ventrally, surface generally rugose, posterior compressed, hinge weak, LV with terminal crenulate sockets and intervening crenulate bar, radial canals few, zone of concrescence broad, muscle scars an antero-medial vertical row of three or four spots and more anterior spot(s). Upper Cretaceous to Recent.

Type species.—*P. depressa* Müller, Recent.

Paracytheridea cf. *P. vandenboldi* Puri

Plate 2, figures 4a, b

Cytheropteron nodosa Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 129, pl. 38, figs. 37-40 [not *C. nodosa* Brady, 1868].

Paracytheridea nodosa (Ulrich and Bassler). Howe and others, 1935, Florida Geol. Survey Bull. 13, p. 37, pl. 3, fig. 7. van den Bold, Contr. Study Ostracoda, 1946, p. 86, pl. 16, fig. 7. Swain, 1952 U.S. Geol. Survey Prof. Paper 234-A, p. 51, pl. 3, figs. 19-22.

Paracytheridea vandenboldi Puri, 1953, Jour. Paleontology, v. 27, p. 751. Puri, 1954, Florida Geol. Survey Bull. 36, p. 238, pl. 3, fig. 7; text figs. 5a, b. Swain, 1955, Jour. Paleontology, v. 29, p. 625, pl. 62, figs. 2a, b.

Diagnosis.—Subquadrate to subtrapezoidal, dorsum nearly straight, venter sinuous; anterior broadly rounded, posterior with dorsomedian caudate extension, concave above. Valve with prominent ventral ridge, expanded as an ala posteriorly; median longitudinal ridge, anterodorsal cardinal eye node and subjacent oblique furrow; scattered ridges anteromedially; general surface coarsely pitted; strongly convex ventromedially. LV hinge with terminal crenulate sockets and interterminal crenulate bar. Inner lamellae of moderate width, no vestibule; radial canals few and widely spaced; adductor scar a median row of four spots; more anterior antennal? spots also occur.

Length of LV figured (pl. 2, fig. 4a) 0.67 mm, height 0.33 mm, convexity of LV 0.21 mm.

Occurrence.—Rare in Waccamaw Formation at locality NC-2, Columbus County, N.C. Also occurs in middle and upper Miocene of Atlantic Coastal Plain, Choctawhatchee Formation (of former usage) of Florida, Miocene of Cuba and Guatemala, and Recent of Texas bays.

Specimens studied.—One.

Figured specimen.—USNM 649887.

Genus HEMICYTHERURA Elofson, 1941

Cytherurina Mandelstam, 1958, in Abushik and others, Microfauna USSR, v. 9, VNIGRI, Trans., no. 115, p. 285 [proposed without description or type species but with apparent intent to include *Hemicytherura cellulosa* (Norman) Hornibrook, 1952].

Subtriangular, almond-shaped, LV larger, but RV overlaps dorsally, reticulate or pitted, valves compressed, posteriorly caudate, hinge merodont, zone of concrescence broad, radial canals irregularly spaced, vestibule small or absent, muscle scars questionably a median vertical undivided row of several spots and a more anterior spot. Upper Cretaceous to Recent.

Type species.—*Cythere cellulosa* Norman, Recent.

Hemicytherura howei (Puri)

Plate 4, figures 5a, b; text figure 9

Kangarina howei Puri, 1954 Florida Geol. Survey Bull. 36, p. 246, pl. 4, fig. 7; text figs. 6i, j.

Hemicytherura howei (Puri). Pooser, 1965, Kansas Univ. Paleontology Contr., Arthropoda, Art. 8, p. 49, pl. 9, figs. 1-3.

Diagnosis.—Small, subtriangular to subtrapezoidal, highest medially; dorsum strongly convex, venter nearly straight; anterior narrowly rounded, extended below; posterior acuminate, strongly extended above, LV slightly larger than RV, overreaching it dorsally; valves only moderately convex, posterior end compressed; surface weakly ornamented by narrow reticulating ridges. Internal features of a RV are shown in text figure 9.

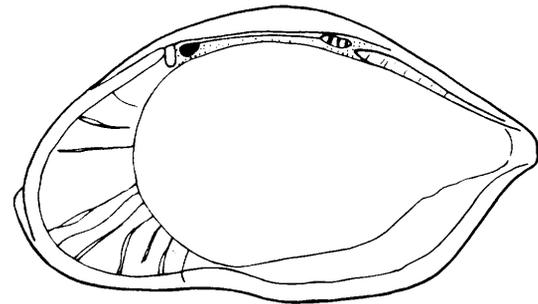


FIGURE 9.—*Hemicytherura howei* (Puri). Interior of right valve; locality SC-4.

Length of figured specimen (pl. 4, fig. 5a) 0.40 mm, height 0.21 mm, convexity 0.16 mm.

Remarks.—The present writer agrees with Pooser (1965, p. 49) that the shape and surface ornamentation of this species are more typical of *Hemicytherura* than of *Kangarina*.

Occurrence.—Rare in Waccamaw Formation at locality NC-4, Columbus County, N.C.; localities SC-1b, SC-3, and SC-4, Horry County, S.C. The species was described from the Choctawhatchee Formation (of for-

mer usage) of Florida, and occurs also in the Duplin Marl and in the Yorktown Formation of the Atlantic Coastal Plain.

Specimens studied.—Four.

Figured specimens.—USNM 649937, 649938, 650010.

Genus CYTHERURA Sars, 1868

Small subquadrate, moderately convex, LV larger, but RV overreaches LV dorsally, posterior caudal process, ventral low alae in some forms, flattened venter, ribbed, reticulate, or punctate surface, hinge modified merodont, zone of concrescence of moderate width, radial canals few, may be paired, vestibule absent or narrow, muscle scars an anterior median vertical undivided row of four spots and additional anterior and ventral spot(s). Cretaceous (?), Eocene to Recent.

Type species.—*C. gibba* O. F. Müller.

***Cytherura elongata* Edwards**

Plate 6, figures 11a-c

Cytherura elongata Edwards, 1944, Jour. Paleontology, v. 18, p. 526, pl. 88, figs. 21-25. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 50, pl. 7, figs. 24, 25. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 331, fig. 15.

Diagnosis.—Subquadrate-sublanceolate in side view, highest posteromedially, dorsum slightly sinuous, nearly straight, venter slightly concave medially, subparallel to dorsum; anterior rounded, somewhat extended below, posterior bluntly caudate, strongly extended medially. LV slightly larger than RV, overlapping most in cardinal areas; valves moderately convex; posterior end compressed. Surface with narrow longitudinal ridges between which lie transverse reticulating ridges; longitudinal ridges converge toward ends. Male dimorphs more elongate than female; latter have posterior part of shell swollen.

Length of figured female shell (pl. 6, fig. 11b) 0.43 mm, height 0.20 mm, convexity 0.18 mm.

Occurrence.—Rare in Waccamaw Formation at locality NC-2, Columbus County, N.C.; frequent at locality NC-1, Columbus County, N.C.; frequent at locality SC-2, Horry County, S.C. The species also occurs in the Duplin Marl and throughout the Yorktown Formation of North Carolina and Virginia; it has been recorded living off the west coast of Florida.

Specimens studied.—Twelve.

Figured specimens.—USNM 649998-650000.

***Cytherura forulata* Edwards**

Plate 5, figure 10; text figure 10

Cytherura forulata Edwards, 1944, Jour. Paleontology, v. 18, p. 526, pl. 88, figs. 17-20. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 50. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 329, fig. 14.

Diagnosis.—Shell subquadrate, dorsum and venter nearly straight to slightly convex, anterior margin broadly curved, posterior bluntly caudate; valves moderately convex; greatest convexity ventromedian. LV slightly larger than RV. Surface ornamented by 8-10 longitudinal ridges curved subparallel to margins dorsally and ventrally; numerous crossbars connect ridges; anterodorsally is an oblique eye tubercle. Internal shell features of a Waccamaw specimen are shown in text figure 10.

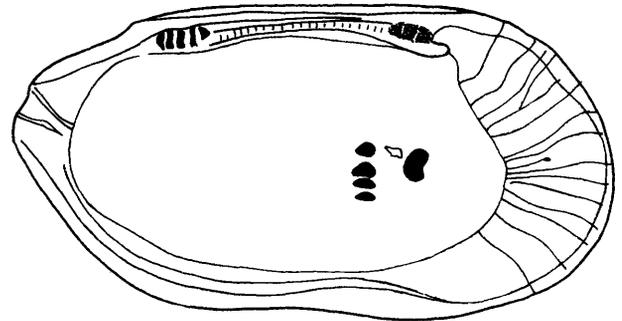


FIGURE 10.—*Cytherura forulata* Edwards. Interior of left valve; locality SC-3.

Length of figured specimen 0.45 mm, height 0.25 mm, convexity 0.20 mm.

Occurrence.—Rare in Waccamaw Formation at localities SC-2, SC-3, SC-4, and SC-5, Horry County, S.C. Elsewhere the species occurs in the Duplin and throughout the Yorktown Formation, upper Miocene of the Middle Atlantic region; reported living off west coast of Florida.

Specimens studied.—Six.

Figured specimens.—USNM 649978, 650011.

***Cytherura* cf. *C. costata* Müller**

Plate 4, figure 10

Cytherura costata G. W. Müller, 1894, Fauna und Flora des Golfes von Neapel, v. 21, p. 295, pl. 8, figs. 11, 15; pl. 32, fig. 33. Swain, 1955, Jour. Paleontology, v. 29, p. 629, pl. 64, figs. 11a, b.

Diagnosis.—Shell elongate-lanceolate, dorsum slightly convex, venter sinuous, concave medially; anterior rounded, extended below; posterior margin caudate, strongly extended ventromedially. Valves not strongly convex, posterior caudate extension compressed. Valve surface with about six narrow longitudinal ridges, upper three curved subparallel to dorsal margin; median ridge bifurcate posteriorly. Internal features not clearly seen in present specimens; they were partially illustrated by Müller.

Length of figured specimen 0.42 mm, height 0.20 mm, convexity 0.17 mm.

Remarks.—The shape, surface ribbing, and strong posteroventral caudation suggest to the writer a similarity to Müller's (1894) Recent species.

Occurrence.—Rare in Waccamaw Formation locality SC-3, Horry County, S.C.; the species is living in the Mediterranean and Atlantic regions, in shallow water. In the Bay of Naples the species is associated with calcareous algae (Puri and others, 1964).

Specimens studied.—One.

Figured specimen.—USNM 649949.

Genus **CYTHEROPTERON** Sars, 1866

Ovate-subrhomboidal lateral outline, arched dorsum, sinuous venter, weak to strong ventral alae; surface smooth, pitted, reticulate, or ribbed; RV slightly larger, overlapping along hinge margin; hinge merodont, with well-developed crenulate interterminal bar in LV and groove in RV; zone of concrescence moderately broad, vestibules small or absent; radial canals few, in part paired or irregular; adductor muscle scars an antero-medial vertical row of four undivided spots and more anterior V-shaped spot in which is a small subsidiary spot. Lower Jurassic to Recent.

Type species.—*Cythere latissima* Norman, Recent.

Cytheropteron yorktownensis (Malkin)

Plate 4, figures 7a-c; text figure 11

Eocytheropteron yorktownensis Malkin, 1953, Jour. Paleontology, v. 27, p. 780, pl. 79, figs. 1-4.

Diagnosis.—Small, subovate; dorsum nearly straight to slightly convex; venter sinuous, anterior rounded, extended below; posterior narrowly rounded, extended above; LV larger than RV; valves strongly convex; inflated ventrally in low alaform expansion; ala abruptly terminated posteroventrally; median surface with low, longitudinal, narrow, somewhat sinuous ridges, and with a weakly reticulate ridge pattern. Internal features of shell are shown in text figure 11.

Length of figured specimen (pl. 4, fig. 7a) 0.40 mm, height 0.28 mm, convexity 0.23 mm.

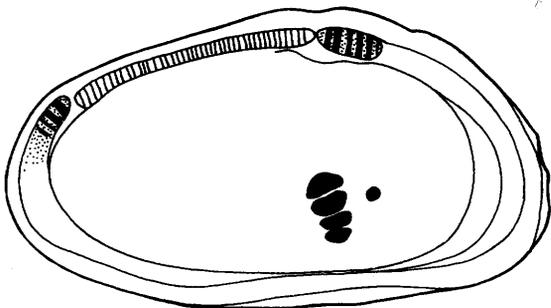


FIGURE 11.—*Cytheropteron yorktownensis* (Malkin). Interior of left valve; Pleistocene, Longs, S.C.

Remarks.—Although the weak alation of this species is more like *Eocytheropteron*, the hingement and other internal features as outlined by Malkin are believed by the present writer to be closer to *Cytheropteron*.

Occurrence.—Rare in Waccamaw Formation at locality NC-2, Columbus County, N.C.; and in the Pleistocene at Longs, S.C. The species was described from the Yorktown Formation of Virginia. It occurs throughout the Yorktown Formation and in the Duplin Marl, upper Miocene of the Middle Atlantic region.

Specimens studied.—Four.

Figured specimens.—USNM 649940-649942.

Cytheropteron choctawhatcheensis Puri

Plate 3, figure 9

Cytheropteron choctawhatcheensis Puri, 1954, Florida Geol. Survey Bull. 36, p. 242, pl. 5, figs. 1, 2.

Diagnosis.—Shell elongate-subtrapezoidal in outline, dorsum nearly straight and about three-fifths shell length, venter slightly sinuous and subparallel to dorsum; anterior margin broadly rounded, slightly extended below, posterior margin narrowly rounded, strongly extended below. Valves strongly convex, greatest convexity ventroposterior; LV larger than RV, overreaching along dorsal slopes. Ventral surface flattened owing to alaform expansion of valves. General surface smooth. Internal shell features not seen, and were not described by Puri.

Length of figured specimen 0.57 mm, height 0.28 mm, convexity 0.28 mm.

Occurrence.—Rare in Waccamaw Formation at locality SC-1b, Horry County, S.C. The species was described from the Choctawhatchee Formation (of former usage), upper Miocene of Florida.

Specimens studied.—One.

Figured specimen.—USNM 649923.

Genus **EUCYTHERURA** Müller, 1894

Small subquadrate, broader anteriorly than posteriorly where margin is extended above, low alae ventrally, surface pitted or rugose, anteromedial swelling or node, LV slightly larger than RV; hinge merodont but terminal teeth and sockets may or may not be crenulate; inner lamellae broad, no vestibules, radial canals few, adductor muscle scars a median vertical undivided row of about four spots and more anterior spot(s), Lower Cretaceous to Recent.

Type species.—*Cythere complexa* Brady, Recent.

Eucytherura sp.

Plate 5, figures 1a, b

Shell small, subquadrate in side view, highest medially; dorsal margin nearly straight except for posterior

step; ventral margin gently convex; anterior margin broadly curved, slightly extended below; posterior margin more narrowly curved, slightly extended medially; LV larger than RV; valves moderately convex; posterior fifth of valves compressed. A ridgelike expansion of shell along dorsum and an opposing ventral subalate expansion terminate abruptly at posterior depressed part of shell. Irregular depressions and short ridges ornament surface of valve. Internal shell features not seen.

Length of shell 0.41 mm, height 0.27 mm, convexity 0.21 mm.

Relationships.—This form is less quadrangular and has different surface ornamentation than *E. complexa* (Brady) of the upper Miocene of Trinidad (van den Bold, 1963b) or *E. weingeisti* Puri from the Choctawhatchee Formation (of former usage) (*Arca* facies) of Florida (Puri, 1954). Insufficient specimens are available for establishment of a new species.

Occurrence.—Rare in Waccamaw Formation at locality NC-4, Columbus County, N.C.

Specimens studied.—One.

Figured specimen.—USNM 649954.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Genus ACTINOCYHEREIS Puri, 1953

Subquadrate, medium size, compressed valves; dorsal, oblique, median-longitudinal, and ventral submarginal rows of short thick spines; terminal marginal spinose rims, postdorsal short vertical row of spines, hinge amphidont, inner lamellae broad, vestibule narrow to absent, radial canals numerous terminally; adductor muscle scar an anteromedian vertical row of four spots and more anterior spot(s). Oligocene to Recent.

Type species.—*Cythere exanthemata* Ulrich and Bassler, Miocene.

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

Plate 2, figures 5a-f; text figure 12

Cythere exanthemata Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 117, pl. 36, figs. 1-5.

Cythereis exanthemata (Ulrich and Bassler). Van den Bold, 1946, Contr. Study Ostracoda, Amsterdam, p. 88, fig. 2.

Trachyleberis exanthemata (Ulrich and Bassler). Swain, 1948, Maryland Dept. Geology, Mines, and Water Resources Bull. 2, pl. 12, figs. 14, 15. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 37, pl. 6, fig. 5.

Actinocythereis exanthemata (Ulrich and Bassler). Puri, 1953, Am. Midland Naturalist, v. 49, p. 179, pl. 2, figs. 4-8; text figs. e, f. Puri, 1954, Florida Geol. Survey Bull. 36, p. 252, pl. 13, figs. 6-13. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 329, fig. 14.

Diagnosis.—Subquadrate, straight dorsum modified by five to six projecting nodes and high anterior cardinal projection; venter slightly concave medially; an-

terior broadly curved, somewhat extended below, truncate above, spinose; posterior narrower, but also broadly curved to subtruncate, spinose. Rim extends around free margins; rim spinose ventrally and in some specimens terminally; dorsum with row of spines converging posteriorly toward dorsum; ventro-posterior border of valves compressed; vertical short cleatlike row of spines posterodorsally. Internal features not seen in present specimens but a specimen from the Yorktown Formation near Tar Ferry Landing, Hertford County, N.C., had the following: hinge of LV consists of an anterior rounded deep socket, posterojacent small tooth, interterminal bar formed of valve edge, slightly serrate, and a posterior rounded socket; inner lamellae fairly broad, vestibule narrow to absent; radial canals numerous and closely spaced terminally; adductor scar an anteromedian vertical row of four elongate spots and one or two more anterior spots.

Length of figured male LV (pl. 2, fig. 5f) 0.90 mm, height 0.45 mm, convexity 0.41 mm.

Remarks.—The range of features that characterize this species are in need of detailed study. The writer believes that the subspecies *gomillionensis* Howe and Ellis (Howe and others, 1935) and *marylandica* Howe and Hough (Howe and others, 1935) may be immature molts and (or) ecologic variants of *exanthemata*. Until these uncertainties are resolved it is believed preferable to assign the Waccamaw specimens to *exanthemata*.

Occurrence.—Common in the Waccamaw Formation at locality NC-5, Brunswick County, N.C.; at localities NC-1, and NC-3, Columbus County, N.C.; localities SC-1, SC-3, and SC-5, Horry County, S.C. Malkin (1953) recorded it from the Calvert and Choptank Formations, middle Miocene, and stated that *A. exanthemata gomillionensis* is characteristic of the Yorktown Formation, upper Miocene. Edwards (1944) found that subspecies in the Duplin Marl, upper Miocene. The present writer (Swain, 1952) recorded *A. exanthemata* from the subsurface upper Miocene. The species apparently ranges throughout the Miocene and

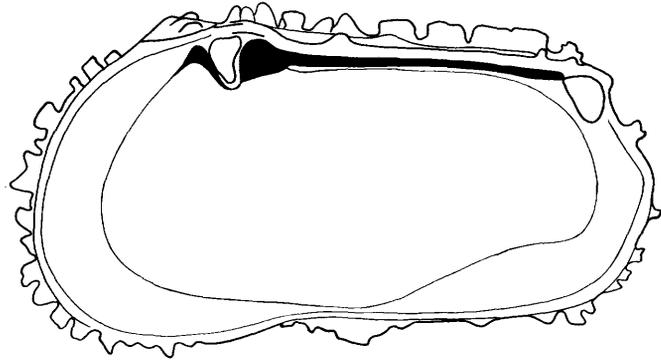


FIGURE 12.—*Actinocythereis exanthemata* (Ulrich and Bassler). Interior of right valve; locality SC-3.

into the Pliocene of the Middle Atlantic region. Puri (1954) recorded it throughout the Miocene of the Florida panhandle.

Specimens studied.—Fourteen.

Figured specimens.—USNM 649889—649894, 650012.

Genus ECHINOCYHEREIS Puri, 1954

Subovate, medium to large, LV larger than RV; shell inflated, spinose or tuberculate and pitted, has eye tubercle, ends compressed, hinge amphidont, inner lamellae of moderate width, radial canals numerous, vestibule narrow or absent, adductor muscle scar a median vertical row of four spots and additional more anterior spots. Paleocene (?), Eocene to Recent.

Type species.—*Cythereis garretti* Howe and McGuirt, Miocene.

***Echinocythereis garretti* (Howe and McGuirt)**

Plate 4, figure 12; text figure 13

Cythereis garretti Howe and McGuirt, 1935, Florida Geol. Survey Bull. 13, p. 20, pl. 3, figs. 17–19; pl. 4, figs. 5, 15.

Buntonia? cf. B.? garretti (Howe and McGuirt). Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 39, pl. 3, fig. 6; pl. 4, figs. 4–6.

Echinocythereis garretti (Howe and McGuirt). Puri, 1954, Florida Geol. Survey Bull. 36, p. 260, pl. 12, figs. 2–5; text figs. 9a, b.

Diagnosis.—Shell subquadrate in side view, dorsum nearly straight to sinuous, about two-thirds of shell length; venter nearly straight, slightly convex; terminal margins broadly rounded, the posterior narrower than anterior and coarsely spinose. LV larger than RV; moderately convex, most convex posterior in position. Anterior marginal zone with three subparallel concentric rows of pustules; general surface densely pustulose; anterodorsal eye tubercle projects slightly beyond dorsal margin. Internal features are as shown in text figure 13.

Length of figured specimen 0.83 mm, height 0.55 mm, convexity 0.50 mm.

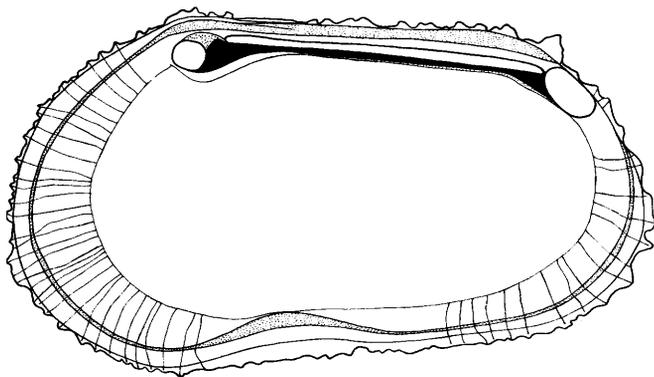


FIGURE 13.—*Echinocythereis garretti* (Howe and McGuirt). Interior of right valve; locality SC-2.

Occurrence.—Waccamaw Formation, locality SC-2; elsewhere the species occurs in the upper Miocene Chocatawchee Formation (of former usage) of Florida and from the middle and upper Miocene, subsurface of Florida.

Specimens studied.—Two.

Figured specimens.—USNM 649951, 650013.

Genus CLETOCYHEREIS Swain, 1963

Subquadrate, medium size, dimorphic; males more elongate than females and with posteroventral flange-like extension; surface reticulate, anteromedian swelling, posterodorsal subvertical cleatlike row of spines; longitudinal rows of spines dorsally and ventrally and perhaps medially, terminal spinose rims, hinge modified amphidont, inner lamellae of moderate width, line of concrescence irregular owing to funnel-shaped internal openings of canals, adductor muscle scar a median vertical row of three or four undivided spots and more anterior spots, diductor scar present. Miocene (?), Pleistocene to Recent.

Type species.—*Cythere rastromarginata* Brady, Recent.

***Cletocythereis? mundorffi* (Swain)**

Plate 2, figure 6

Trachyleberis mundorffi Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 36, pl. 5, fig. 19; pl. 6, fig. 4.

Diagnosis.—Shell subquadrate, highest near anterior end, dorsum and venter nearly straight, converging posteriorly; anterior broadly curved, extended below, spinose; posterior narrower, but with broad curvature, coarsely spinose; anterior with submarginal narrow ridge that passes below into a series of spines; dorsal margin with spinose ridge that projects beyond valve margin; anterior end of which is an enlarged node; posterior end of dorsal ridge with ventrally extending short ridge; medially is an oblique peculiarly “pulled-looking” longitudinal ridge from which extend short spines; median low nodelike swelling; ventrally is an oblique row of spines or spinose ridge; ventroposterior marginal area of valves compressed. Internal structures described by Swain (1952).

Length of figured specimen 0.70 mm, height 0.40 mm, convexity 0.31 mm.

Remarks.—The posterodorsal subvertical short ridge, median nodelike swelling, longitudinal ridges, and flange-like posteroventral spinose marginal extension ally this species with *Cletocythereis* rather than with *Trachyleberis* Brady, which is more generally spinose, or with *Actinocythereis* Puri which has similar rows of spines but lacks the median swelling of *Cletocythereis*.

Occurrence.—Rare in Waccamaw Formation at locality NC-5, Brunswick County, N.C.; previously re-

corded from the middle and upper Miocene from wells in North Carolina. According to Malkin, *C. mundorffi* (1953, p. 792) is equivalent to *Actinocythereis ewanthemata gomillionensis* (Howe and Ellis), but that form is smaller and has longitudinal rows of spines rather than nodose ridges as in *mundorffi*. The specimen illustrated as *gomillionensis* by Malkin (1953, pl. 81, figs. 15, 17, 18) may represent *mundorffi*.

Specimens studied.—One.

Figured specimen.—USNM 649895.

Genus NEOCAUDITES Puri, 1960

Subquadrate-subelliptical, compressed and thin-shelled, free margins with rim, terminal spines, dorsal and ventral submarginal ridges, median oblique ridge, eye tubercle, surface smooth or pitted, hinge holamphidont, inner lamellae broad, radial canals numerous, adductor muscle scars a median vertical row of three spots and two more anterior antennal spots. Miocene to Recent.

Type species.—*N. nevirianii* Puri, Recent.

***Neocaudites triplistriata* (Edwards)**

Plate 3, figures 1a–d, text figure 14

Cythereis triplistriata Edwards, 1944, Jour. Paleontology, v. 18, p. 522, pl. 87, figs. 24–26.

Trachyleberis? cf. *T.?* *triplistriata* Edwards. Swain, 1952, U.S. Geol. Survey Prof. Paper 234–A, p. 37, pl. 6, figs. 2, 3.

Rectotrachyleberis cf. *R. triplistriata* (Edwards). Puri, 1954, Florida Geol. Survey Bull. 36, p. 264, pl. 11, figs. 1, 2.

Neocaudites triplistriata (Edwards). Van den Bold, 1963b, Micropaleontology, v. 9, p. 389, pl. 8, fig. 4.

Diagnosis.—Subquadrate, highest anteriorly, dorsum slightly sinuous, venter nearly straight, slightly concave medially; anterior broadly curved, fringed with thick spines, slightly truncate above; posterior narrower, truncate above, spinose below; terminal submarginal elevated smooth rims; dorsal and ventral submarginal narrow rims; anterodorsal eye tubercle; oblique median longitudinal broad ridge extends from posterodorsal to anteroventral marginal areas; general surface smooth or pitted. LV slightly larger than RV; valves strongly compressed. Internal features of a RV are as shown in text figure 14.

Length of figured shell (pl. 3, fig. 1a) 0.68 mm, height 0.35 mm, convexity 0.21 mm.

Remarks.—*Rectotrachyleberis* was placed in synonymy with *Costa Neviani* by Howe (in Moore and others, 1961), but that genus is characterized by a median ridge that bends ventrally at the posterior end. Bold (1963b, p. 389) placed the species in *Neocaudites*. The present writer believes his specimens from the North Carolina subsurface (1952, p. 37) are this species, but Vanden Bold disagrees (1963b, p. 389). The status of *triplistriata* remains somewhat in doubt.

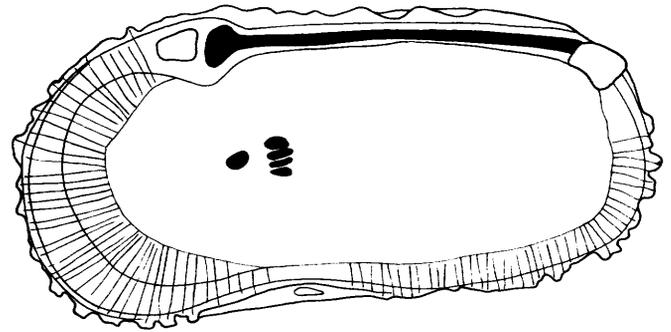


FIGURE 14.—*Neocaudites triplistriata* (Edwards). Interior of right valve; locality NC-1.

Occurrence.—Rare in Waccamaw Formation at localities SC-2 and SC-4, Horry County, S.C.; locality NC-4, Columbus County, N.C.; frequent at localities NC-1 and NC-3, Columbus County, N.C.; rare at locality NC-5, Brunswick County, N.C. The species was previously recorded from the Duplin Marl of North Carolina, the middle part of the Yorktown Formation of Virginia, and from the Choctawatchee Formation (of former usage) of Florida, upper Miocene.

Specimens studied.—Fourteen.

Figured specimens.—USNM 649898, 649899.

Genus MUELLERINA Bassiouni, 1965

Subquadrate, small to medium size, marginal rims, ocular and anteromedian tubercles, reticulate surface pattern of ridges, hinge amphidont, inner lamellae rather broad, vestibule narrow or absent, radial canals few to numerous anteriorly, adductor muscle scars an anteromedian divided row of 4 spots and 1–3 anterodorsal spots together with a more anterior spot(s). Miocene to Pliocene.

Type species.—*Cythere latimarginata*, Speyer, Oligocene.

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

Plate 3, figures 2a–h, 3a–b, 4a–b; text figure 15

Cythere lienenklausi Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 112, pl. 36, figs. 11–15.

Cythere micula Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 116, pl. 36, figs. 18–20.

Trachyleberis? *martini* (Ulrich and Bassler). Swain, 1952, U.S. Geol. Survey Prof. Paper 234–A, p. 29, pl. 3, figs. 8, 15.

Trachyleberis martini (Ulrich and Bassler). Malkin, 1953, Jour. Paleontology, v. 27, p. 793, pl. 82, figs. 6–13.

Trachyleberis? cf. *T.?* *micula* (Ulrich and Bassler). Swain, 1952, U.S. Geol. Survey Prof. Paper 234–A, p. 29, text fig. 31.

Murrayina martini (Ulrich and Bassler). Puri, 1954, Florida Geol. Survey, Bull. 36, p. 256, pl. 12, figs. 11–13; text figs. 8e, f. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, pl. 11, figs. 1a–c, 2a, b, 3a–d. Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropoda, Art. 8, p. 60, pl. 21, figs. 3, 5, 8.

Muellerina lienenklausi (Ulrich and Bassler). Hazel, 1967, U.S. Geol. Survey Prof. Paper 564, p. 21, pl. 3, figs. 3–6, 11; pl. 7, figs. 1, 4, 5, 7.

Diagnosis.—Subquadrate, highest one-fourth from anterior end; dorsum sinuous, high anterocardinal projection, venter nearly straight to slightly concave medially, converging posteriorly with dorsum; anterior broadly curved, spinose below; posterior narrower, rounded, and finely spinose below, truncate or concave above. LV the larger, overreaching at cardinal angles. Free margins with narrow elevated rim and adjacent furrow or inner rib; surface coarsely reticulate, pits elongated longitudinally; low anteromedian swelling and faint posterojacent furrow; slightly elevated ridge extends sinuously from posterocardinal angle, obliquely forward and venterad; a second shorter ridge subjacent to first in posterior half; small anterocardinal eye tubercles. RV hinge with anterior ovate, coarsely crenulate tooth, postjacent small socket, narrow, finely crenulate interterminal groove, anteromedian "anti-slip" projection, posterior elongate tooth. Line of concrecence and inner margin nearly coincide, inner lamellae rather broad; about 30 radial canals anteriorly, less numerous elsewhere. Muscle scar consists of a median crescentic row of four spots, a slightly more anterior set of one to three spots, varying with the specimen, and a more anterior set of two spots opposite dorsal end of other groups and additional more ventral spot or spots.

Length of figured specimen (pl. 3, fig. 3b) 0.68 mm, height 0.36 mm, convexity 0.35 mm.

Remarks.—The species is variable in the strength of surface ornamental features, ranging from nearly smooth to deeply reticulate. The details of internal structure, especially the width of the zone of concrecence and the muscle scar pattern are also variable.

Occurrence.—Rare to common in all samples of Waccamaw Formation studied. The species has been recorded previously throughout the Miocene of the Middle Atlantic region from the upper Miocene Choctawhat-

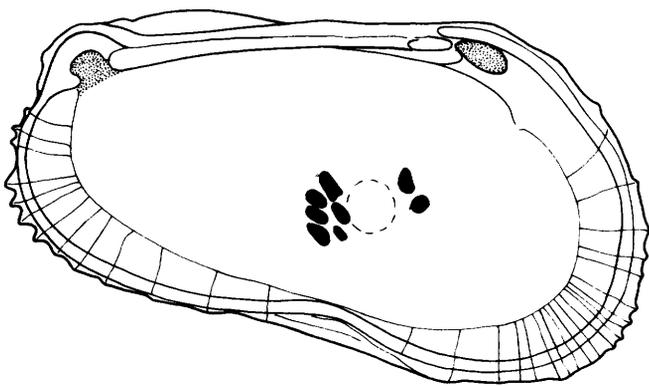


FIGURE 15.—*Muellerina lienenklausi* (Ulrich and Bassler). Interior of left valve; locality NC-5.

chee Formation (of former usage) of Florida, and from the Recent.

Specimens studied.—Sixty-nine.

Figured specimens.—USNM 649900–649913.

Genus **MURRAYINA** Puri, 1953

Type species.—*M. howei* Puri, Miocene.

Murrayina? sp.

Plate 3, figures 5a, b

Shell elongate-subelliptical in side view, highest near anterior end; dorsal margin slightly convex, straightened posteromedially; ventral margin concave medially; anterior margin broadly curved, extended medially. LV slightly larger than RV, overreaching RV ventrally and anterodorsally, valves moderately convex, greatest convexity posteromedian; posterior marginal zone compressed.

General surface of valves with elongate pits and intervening discontinuous ridges; these features are more or less concentrically arranged in marginal zone of shell and longitudinally arranged in midpart; a smoothed rounded patch slightly anteromedian in position.

Hinge not clearly seen but apparently consists in RV of anterior tooth and posterojacent socket, interterminal groove and posterior tooth; inner lamellae of moderate width, radial canals numerous and closely spaced; adductor scar a median vertical row of three or four spots and one or two more anterior spots.

Length of shell 0.80 mm, height 0.36 mm, convexity 0.37 mm.

Remarks.—This form is similar to *Bensonocythere whitei* (Swain) from the subsurface Miocene of North Carolina, but the surface pits in that species are not elongated, there are more distinct marginal ridges than in the present forms, and the muscle scar pattern is not typical of that genus in that the main adductor scars appear to be undivided.

Occurrence.—Rare in Waccamaw formation at locality NC-1, Columbus County, N.C.

Specimens studied.—One.

Figured specimen.—USNM 49914.

Genus **OCCULTOCYHEREIS** Howe, 1951

Elongate-subquadrate, small, compressed, eye tubercle, anteromedian node, anterior spinose rim, pointed posterior end; surface smooth or with rugose ridges, amphidont hinge, broad inner limellae, no vestibule, branching radial canals, adductor muscle scar an undivided anteromedian row of four spots and a more anterior V-shaped spot. Upper Cretaceous(?), Paleocene to Recent.

Type species.—*O. delumbata* Howe, Eocene.

Oocultocythereis sp.
Plate 5, figure 2

Shell small, elongate-subquadrate in lateral view, highest one-fourth from anterior end; dorsal margin nearly straight, cardinal angles broadly obtuse; ventral margin nearly straight, converging slightly toward dorsum posteriorly; anterior margin broadly curved, somewhat extended below; posterior margin narrowly curved, strongly extended above. Valves subequal, compressed; LV slightly larger than an overreaching RV.

Surface with a median longitudinal narrow groove, dorsal to which are three or four short subvertical ridges extending toward dorsal margin, and a dorso-adjacent irregular longitudinal ridge; variously sized pits ornament general surface. Internal shell structure not seen.

Length of figured specimen 0.35 mm, height 0.29 mm, convexity 0.13 mm.

Remarks.—This species is similar to *Leptocythere cranekeyensis* Puri (1954) in size, general form, and surface ornamentation but is less concave ventrally and has a different pattern of surface ridges from that species.

Occurrence.—Rare in Waccamaw Formation, locality NC-1, Columbus County, N.C.

Specimens studied.—One.

Figured specimen.—USNM 649955.

Genus *PURIANA* Coryell and Fields, 1953

Favella Coryell and Fields, 1937, Am. Mus. Novitates, no. 956, p. 8 (not Jørgensen, 1925).

Subquadrate, medium size, spinose anterior marginal rim, eye tubercle; posterior end compressed, coarsely spinose, anteromedian tubercle, rugose ridges on surface, amphidont hinge, crenulate median element, inner lamellae fairly broad, vestibule well developed or nearly absent, radial canals moderate in number, line of concrescence smooth or scalloped owing to funnel-shaped inner terminations of pore canals; adductor muscle scar a median row of spots and more anterior spot(s), one of which typically V-shaped. Oligocene to Recent.

Type species.—*Favella puella* Coryell and Fields, Miocene.

Puriana rugipunctata (Ulrich and Bassler)
Plate 5, figures 8a-c; plate 7, figure 4; text figures 16, 17

Cythere rugipunctata Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 118, pl. 38, figs. 16, 17.

Cythereis rugipunctata (Ulrich and Bassler). Howe and others, 1935, Florida Dept. Conserv. Geol. Bull. 13, p. 23, pl. 1, figs. 18, 20-22; pl. 4, figs. 22, 23.

Favella rugipunctata (Ulrich and Bassler). Edwards, 1944, Jour. Paleontology, v. 18, p. 524, pl. 88, figs. 5, 6. van den Bold, 1946, Contr. Study Ostracoda, Amsterdam, p. 100, pl. 10,

fig. 3. van den Bold 1950, Jour. Paleontology, v. 24, p. 86. Malkin, 1953, Jour. Paleontology, v. 27, p. 797, pl. 83, fig. 24. *Trachyleberis? rugipunctata* (Ulrich and Bassler). Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 38, pl. 6, fig. 8. *Puriana rugipunctata* (Ulrich and Bassler). Puri, 1953, Jour. Paleontology, v. 27, p. 751. Puri, 1954, Florida Geol. Survey Bull. 36, p. 257, pl. 12, figs. 16, 19, text fig. 8h. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 89, pl. 11, figs. 5a-d. Brown, 1958, North Carolina Dept. Conserv. and Devel. Bull. 72, p. 63, pl. 4, fig. 10. Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropods, Art. 8, p. 61, pl. 17, figs. 4-7. 9. Hulings and Puri, 1965, Pub. Staz. Zool., v. 33, supp., p. 321, fig. 12.

Diagnosis.—Subquadrate, medium-sized, highest one-fourth from anterior end; dorsum sinuous, anterior cardinal angle more obtuse than posterior; venter slightly concave; anterior broadly curved, extended and sparsely spinose below; posterior extended and coarsely spinose below, notched above and with triangular ridge-like extension near posterior cardinal angle. Moderately convex, LV slightly larger. Surface with broad anterior submarginal rim, narrow marginal rim along free border; large anteromedian node; anterodorsal eye tubercle, slightly oblique dorsoventrally elongate nodes or short ridges, closely spaced, posterior to median node; posterior end compressed, submarginal ventral longitudinal ridge.

RV hinge an anterior high-pointed tooth, postero-adjacent deep oval socket, interterminal narrow groove and posterior large rounded, slightly crenulate tooth; other internal features are as shown in text figure 16.

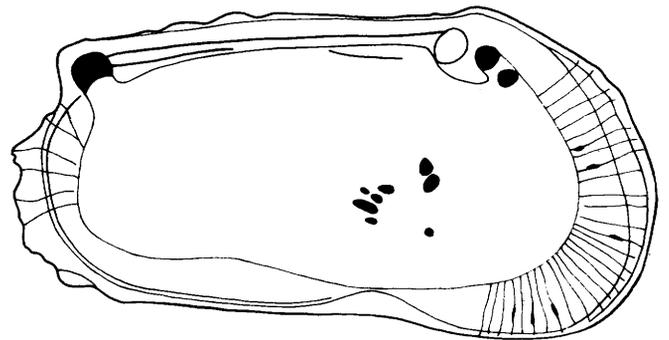


FIGURE 16.—*Puriana rugipunctata* (Ulrich and Bassler). Interior of left valve; locality NC-1.

Length of figured specimen (pl. 5, fig. 8a) 0.60 mm, height 0.35 mm, convexity 0.33 mm.

Occurrence.—The species is rare to common at nearly all localities of Waccamaw Formation studied. It also occurs in the Yorktown Formation of the Middle Atlantic region, more commonly in the upper than in the lower part; in the Duplin Marl of North Carolina; in the Alum Bluff Group and the Choctawhatchee Formation (of former usage) of Florida; in the Miocene of

Cuba, Guatemala, and British Honduras; and lives off the west coast of Florida.

Specimens studied.—Fifty-eight.

Figured specimens.—USNM 649973–649975, 650014.

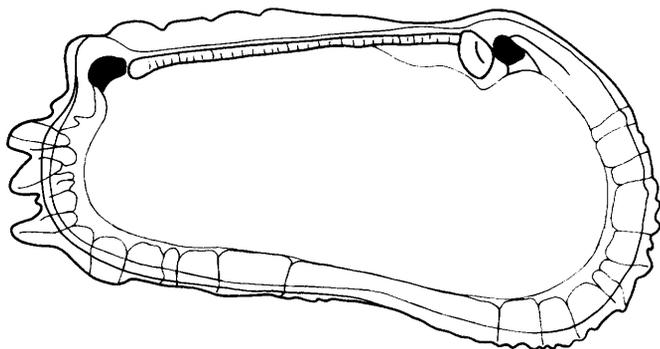


FIGURE 17.—*Puriana rugipunctata* (Ulrich and Bassler). Interior of immature left valve; locality SC-3.

***Puriana mesicostalis* (Edwards)**

Plate 4, figure 13; plate 5, figure 13

Favella mesicostalis Edwards, 1944, Jour. Paleontology, v. 18, no. 6, p. 524, pl. 88, figs. 1–4.

Diagnosis.—Shell elongate-subquadrate; dorsal and ventral margins subparallel, venter slightly concave medially; anterior margin broadly rounded, slightly extended below; posterior margin truncate, bearing three to four short spines below; concave above; valves subequal, moderately convex, greatest convexity in posterior third.

Anterior marginal zone with narrow submarginal ridge, anterior two-thirds of venter with similar but disconnected submarginal ridge, a narrow vertical ridge extending downward from posterocardinal margin; anteromedian node consists of a cluster of small curved ridges; a short ridge extends anteriorly from node and a long median ridge extends posteriorly from it; several short subvertical ridges extend from dorsal margin, and a series of small grooves and short ridges lie ventral of median longitudinal ridge. Internal features not seen in specimens at hand.

Length of figured specimen 0.71 mm, height 0.35 mm, convexity 0.33 mm.

Remarks.—*P. mesicostalis* differs from *P. rugipunctata* in having much weaker posteromedian transverse ridges than typical *rugipunctata* and in having a median longitudinal ridge that is absent in that species.

Occurrence.—The species was originally described from the Duplin Marl, upper Miocene, at Lumberton, N.C.; in the present Waccamaw collection it occurs at locality SC-1, Horry County, S.C.

Specimens studied.—Three.

Figured specimen.—USNM 649981.

Family BRACHYCYTHERIDAE Puri, 1954

Genus PTERYGOCYTHEREIS Blake, 1933

Fimbria Neviani, 1928, Pontificia Acad. delle Sci., Rome Mém. Sec. 2, v. 11, p. 72 [not Bohadsch, 1761, nor Megerle, 1811, nor Risso, 1826, nor Cobb, 1894, nor Belon, 1896].

Pterigocythereis Bold, 1946, Contr. to study of Ostracoda, Amsterdam, J. H. De Bussy, p. 29 (error).

Subquadrate, smooth to strongly spinose marginally, venter with pronounced alar expansion, posterior compressed, spinose, and extended below, truncate or concave above, surface smooth, reticulate tuberculate or spinose; hinge amphidont, in some species with crenulate median element; inner lamellae of narrow to medium width, radial canals moderate in number, vestibule narrow to absent; adductor muscle scars a median vertical row of four spots the middle two larger and an anterior V-shaped spot plus other spot(s). Upper Cretaceous (?) to Recent.

Type species.—*Cythereis jonesii* Baird, Recent.

Digmoipteron Hill and *Alatacythere* Murray and Hussey are also placed in synonymy with *Pterigocythereis* by van Morkhoven (1963, p. 215), but Howe (in Moore and others, 1961, p. 260–263) considers them to be distinct genera on basis of hinge structure.

***Pterigocythereis* sp. aff. *P. americana* (Ulrich and Bassler)**

Plate 2, figures 7a–d; text figure 18

?*Pterigocythereis* sp. aff. *P. americana* (Ulrich and Bassler). Benson and Coleman, 1963, Kansas Univ. Paleont. Contr., Arthropoda, Art. 2, p. 22, pl. 5, figs. 2, 3.

Diagnosis.—Shell subquadrate to subtrapezoidal, dorsum nearly straight, venter sinuous, converging posteriorly with dorsum, obtuse cardinal angles, anterior broadly curved, extended and coarsely spinose below; posterior narrow, extended medially, coarsely spinose below, truncate to slightly concave above, dorsum with narrow rim and expanded anterior eye tubercle. Venter strongly convex, flattened, with submarginal alaform ridge, highest posteriorly; posterior fifth of shell com-

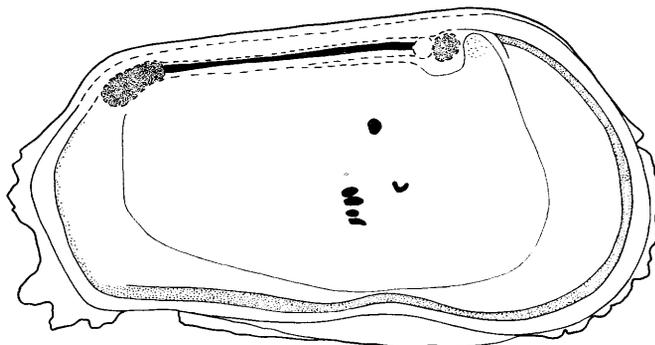


FIGURE 18.—*Pterigocythereis* sp. aff. *P. americana* (Ulrich and Bassler). Interior of imperfect left valve; locality NC-2.

pressed; venter with marginal ridge. Internal shell structures not seen in present specimens.

Length of figured specimen (pl. 2, fig. 7a) 0.86 mm, height 0.46 mm, convexity 0.48 mm.

Remarks.—This form is similar to the uncrested specimens described by Benson and Coleman (1963, p. 22) now living off the Florida coast, except that the Recent specimens have longer alar spines.

Occurrence.—Rare in Waccamaw Formation, locality NC-2, Columbus County, N.C. A similar species has been recorded living in the eastern Gulf of Mexico.

Specimens studied.—Three.

Figured specimen.—USNM 649806.

Family BYTHOCYTHERIDAE Sars, 1926

Genus JONESIA Brady, 1866

Macrocythere Sars, 1926, An account of the Crustacea of Norway, Bergen Mus., pts 18 and 19, p. 240 (obj. syn. of *Jonesia* as they both have the same type species).

Luvula Coryell and Fields, 1937, Am. Mus. Novitates, no. 956, p. 13.

Macrocytherina Coryell and Fields, 1937, Am. Mus. Novitates, no. 956, p. 16.

Elongate-lanceolate, anterior rounded, posterior acuminate, compressed; valves in general compressed, smooth; hinge lophodont to nearly adont; inner lamellae broad anteriorly, zone of concrescence narrow; adductor muscle scar an anteromedian obliquely subvertical row of several spots. Miocene to Recent.

Type species.—*Cythere simplex* Norman, Recent.

***Jonesia howei* (Puri)**

Plate 4, figure 11

Luvula howei Puri, 1954, Florida Geol. Survey Bull. 36, p. 239, pl. 15, fig. 11; text fig. 13b.

Diagnosis.—Shell elongate-sublanceolate; dorsal and ventral margins gently convex; anterior margin rounded, posterior margin acuminate, extended medially. LV slightly larger than RV; valves rather compressed; most convex posteromedially; posterior caudate area compressed; anterior narrow marginal area compressed; median small node with postjacent pit. General surface smooth. Internal features of shell not seen.

Length of figured specimen 0.42 mm, height 0.18 mm, convexity 0.15 mm.

Remarks.—Because of the similarity in external and in known internal shell features of *Jonesia* and *Luvula* Puri, the present writer follows Moore and others (1961, p. 268) in placing the latter genus in synonymy.

Occurrence.—Rare in Waccamaw Formation, locality SC-1b, Horry County, S.C.; elsewhere the species occurs in the Choctawatchee Formation (of former

usage) of Florida and the middle part of the Yorktown Formation of Virginia.

Specimens studied.—One.

Figured specimen.—USNM 649950.

Family CYTHERETTIDAE Triebel, 1952

Genus CYTHERETTA Müller, 1894

Pseudocytheretta Cushman, 1906, Boston Soc. Nat. History Proc., v. 32, p. 382.

Cylindrus Neviani, 1928, Pontificia Acad. delle Sci., Rome Mém., Sec. 2, v. 11, p. 72, 106 [not Deshayes, 1824, nor Fittinger, 1833, nor Herrmannsenn 1852].

Prionocytheretta Mehes, 1941, Geol. Hungarica, Ser. Paleont., pt. 16, p. 60.

Subquadrate, ends rounded, valves strongly convex, LV larger and higher than RV, surface pitted, ridged, reticulate or nearly smooth, hinge holamphidont with large teeth and sockets; inner lamellae broad, especially ventrally, no vestibule; radial canals numerous, long and sinuous, irregularly spaced, in part branching and with bulbous expansions; adductor muscle scars an anteromedian vertical row of four spots and a more anterior crescentic or V-shaped spot. Eocene to Recent.

Type species.—*C. rubra* Müller, Recent.

***Cytheretta* cf. *C. calhounensis* Smith**

Plate 6, figure 14

Cytheretta calhounensis Smith, 1941, Am. Assoc. Petroleum Geologists Bull., v. 25, p. 283, pl. 1, figs. 12, 13; pl. 3, figs. 2, 15. Puri, 1954, Florida Geol. Survey Bull. 36, p. 283, pl. 7, figs. 8, 9.

Diagnosis.—Elongate-subquadrate; dorsal and ventral margins nearly straight and about three-fourths of shell length; terminal margins broadly curved, anterior slightly extended below, posterior slightly extended above. LV larger than RV, extending beyond it ventrally and in cardinal areas. Valves moderately convex; greatest convexity posteromedian. Median two-thirds of valve surfaces bear rather broad low longitudinal ridges, in part bifurcate; closely spaced. Internal shell features not observed.

Length of figured specimen 1.20 mm, height 0.58 mm, convexity 0.55 mm.

Occurrence.—Locality SC-5, Horry County, S.C.; previously described only from the Miocene Chipola Formation of Florida. The specimen illustrated is weathered in appearance and may have been reworked.

Specimens studied.—One.

Figured specimen.—USNM 649503.

Family HEMICYTHERIDAE Puri, 1953

Genus ORIONINA Puri, 1953

Subquadrate, anterior rounded, posterior extended below, truncate or concave above, surface more or less

strongly reticulate, typically with one or more oblique longitudinal ridges, eye tubercle, spinose anterior marginal rim, hinge holamphidont, inner lamellae moderately broad, vestibule may or may not occur, line of concrescence straight to highly sinuous, radial canals numerous; on interior surface rounded pillarlike shell growths may occur anteriorly both in zone of concrescence and beyond edge of inner margin; adductor muscle scar a vertical row of four spots anteriorly from middle two of which two more spots are split off and additional more anterior spots. Miocene to Recent.

Type species.—*Cythere vaughani* Ulrich and Bassler, Miocene.

Jugosocythereis Puri has been placed in synonymy with *Orionina* by Sylvester-Bradley (in Moore and others, 1961, p. 339) but the type of *Jugosocythereis*, *Cythereis bicarinata* Swain has entirely different shell features in the present writer's opinion.

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

Plate 4, figures 4a-e; text figure 19

Cythere vaughani (Ulrich and Bassler), 1904, Maryland Geol. Survey, Miocene volume, p. 109, pl. 38, figs. 25-27.

Cythereis vaughani (Ulrich and Bassler) Howe and others, 1935, Florida Geol. Survey Bull. 13, p. 25, pl. 3, figs. 24, 25; pl. 4, fig. 13. Coryell and Fields, 1937, Am. Mus. Novitates, no. 956, p. 9, fig. 10a. Edwards, 1944, Jour. Paleontology, v. 18, p. 522, pl. 87, figs. 27, 28. van den Bold, 1946, Contr. Study Ostracoda, p. 88, pl. 10, fig. 1. van den Bold, 1950, Jour. Paleontology, v. 20, p. 83.

Trachyleberis vaughani (Ulrich and Bassler). Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 37, pl. 6, figs. 6, 7. Malkin, 1953, Jour. Paleontology, v. 27, p. 794, pl. 82, fig. 14.

Orionina vaughani (Ulrich and Bassler). Puri, 1954, Florida Geol. Survey Bull. 36, p. 254, pl. 12, figs. 15, 16; text figs. 8a-c. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 88, pl. 11, figs. 6a, b. van den Bold, 1963a, Jour. Paleontology, v. 37, p. 44, pl. 4, figs. 1-6; text fig. 5, 6-8. van den Bold, 1963b, Micropaleontology, v. 9, p. 386, pl. 6, fig. 7.

Diagnosis.—Subquadrate, highest anteriorly, dorsum nearly straight, venter slightly concave medially, anterior broadly curved, extended below; posterior narrower, strongly extended, rounded and coarsely spinose below, concave above; LV slightly larger than RV, valves compressed; free margins with narrow rim; three principal longitudinal ridges, the ventral bifurcate and double anteriorly; anterodorsal short subvertical ridge containing eye tubercle; two posterior short subvertical ridges at ends of longitudinal ridges; general surface with deep pits and intervening short ridges; anterior valve margins finely spinose; venter flattened by expansion of ventral ridge and with narrow submarginal ridges.

Hinge of RV with anterior rounded tooth, posterojacent socket, interterminal crenulate groove and posterior notched tooth; inner lamellae of moderate width,

anteriorly, with three to four rounded pillars near inner margin; radial canals numerous and closely spaced; muscle scar with vertical row of four spots; two more spots split off from middle two, and additional two or three more anterior antennal spots.

Length of figured specimen (pl. 4, fig. 4a) 0.70 mm, height 0.39 mm, convexity 0.33 mm.

Occurrence.—Frequent to common in Waccamaw Formation at localities SC-2, SC-3, and SC-4, Horry County, S.C.; rare at locality NC-1, Columbus County, N.C.; frequent at locality NC-3, Columbus County, N.C. The species occurs widely in the Yorktown Formation of the middle Atlantic Coastal Plain, the Duplin Marl of North Carolina, and the Choctawhatchee Formation (of former usage) of Florida, upper Miocene.

Specimens studied.—Thirty-five.

Figured specimens.—USNM 649932-649936.

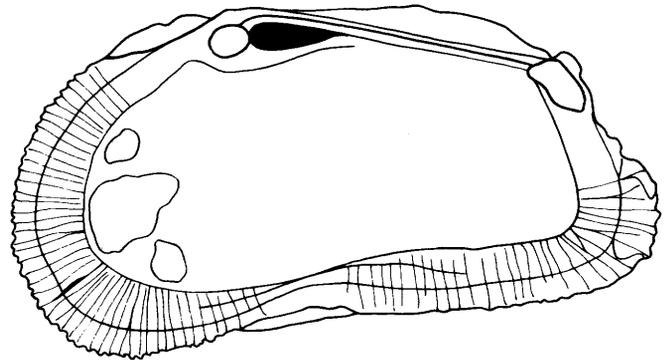


FIGURE 19.—*Orionina vaughani* (Ulrich and Bassler). Interior of right valve; locality NC-1.

Genus *MUTILUS* Neviani 1928

Subquadrate, short and high, anterior rounded, posterior narrower, truncate or concave above, posteriorly ridgelike shell surface projects above dorsal margin in side view, small ventral alae, posterior compressed; surface coarsely reticulate; median swelling obscured by ornamentation, venter flattened; hinge holamphidont; inner lamellae fairly broad, vestibule narrow to absent, radial canals fairly numerous; adductor muscle scars a median vertical row of four with the second from top paired and additional more anterior spots. Miocene to Recent.

Type species.—*Cythereis (Mutilus) laticancellata* Neviani, Pliocene.

***Mutilus confragosa* (Edwards)**

Plate 4, figures 8a-e; plate 5, figures 5a-c; plate 7, figures 3a-c. *Hemicythere confragosa* Edwards, 1944, Jour. Paleontology, v. 18, p. 518, pl. 86, figs. 23-26. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 43, pl. 6, figs. 13, 14. Puri, 1953, Washington Acad. Sci. Jour., v. 43, p. 176, pl. 1, figs. 4-6. Puri, 1954, Florida Geol. Survey Bull. 36, p. 266, pl. 11, figs. 10a-12. van den Bold, 1958, Micropaleontology, v. 4, p.

71. Brown, 1958, North Carolina Dept. Conserv. and Devel. Bull. 72, p. 66, pl. 7, fig. 1.

Mutilus confragosa (Edwards). Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans., v. 10, p. 130. Swain, 1967, Geol. Soc. America Mem. 101.

Aurila confragosa (Edwards). van den Bold, 1963b, Micropaleontology, v. 9, p. 385, pl. 8, fig. 1.

Diagnosis.—Shell, medium sized, subrhomboidal, highest one-third to one-fourth from anterior end, dorsum nearly straight, almost half shell length, cardinal angles obtuse, venter slightly sinuous; anterior broadly curved, extended below; posterior end narrower, sharply extended below, concave above. LV larger than, and overreaches, RV in dorsal half; valves moderately convex; greatest convexity ventromedian. Rim along free margins; ventral surface with alaform longitudinal ridge that produces flat venter; anterodorsal eye tubercle and adjacent irregular submarginal furrow; posterior fifth sharply compressed; general surface with large pits and reticulating ridges; several of latter are strongest in longitudinal direction; posterodorsal cardinal area with angulated ridge that extends forward and downward for a third or more of shell length.

Hinge of RV an anterior rounded tooth, postjacent socket, interterminal groove, broadened at posterior end and posterior reniform tooth; inner lamellae moderately broad, narrow vestibule, radial canals fairly numerous and closely spaced; muscle scar not seen clearly.

Length of figured specimen (pl. 4, fig. 8c) 0.56 mm, height 0.35 mm, convexity 0.31 mm.

Remarks.—The shape, surface ornamentation, and internal structure of this species are closer to *Mutilus* than to other genera to which it has been assigned. The form from the Miocene of Trinidad assigned to the species by Bold is much less strongly ornamented than the specimen from the Middle Atlantic States and may be another species.

Occurrence.—The species is rare to abundant at nearly all of the Waccamaw locations sampled, except locality SC-1, Horry County, S.C. The species was described from the Duplin Marl and is also in the upper part of the Yorktown Formation in several localities in North Carolina and in the Choctawhatchee Formation (of former usage), upper Miocene, and in Recent deposits of Florida and Gulf of California.

Specimens studied.—One hundred and fifty-six.

Figured specimens.—USNM 649943-649947, 649959, 649961.

Genus CAUDITES Coryell and Fields, 1937

Subtrapezoidal, anterior rounded; posterior compressed, with narrow caudate extension below, concave or truncate above; LV larger than RV, small eye tubercles, dimorphic, males more elongate, anterior marginal rim, discontinuous dorsal submarginal ridges, median and ventral longitudinal ridges, posterior

median subvertical ridge(s), anteromedian swelling or tubercles; holamphidont hinge, inner lamellae moderately broad, vestibule anteriorly and very small one posteriorly, radial canals numerous, anteriorly several rounded pillarlike growths on interior surface, adductor muscle scar an anteromedian divided row of four spots, the middle two paired, and more anterior spots. Eocene to Recent.

Type species.—*C. medialis* Coryell and Fields, Miocene.

Caudites sellardsi (Howe and Neill)

Plate 6, figures 12a, b

Hemicythere sellardsi Howe and Neill, 1935, Florida Geol. Survey Bull. 13, p. 29, pl. 2, figs. 6, 10.

Caudites sellardsi (Howe and Neill). Puri, 1953, Washington Acad. Sci. Jour., v. 43, p. 176, pl. 2, fig. b. Puri, 1954, Florida Geol. Survey Bull. 36, p. 265, pl. 11, fig. 17. van den Bold, 1958, Micropaleontology, v. 4, table 1. [part].

not *C. sellardsi* (Howe and Neill). van den Bold, 1957, Micropaleontology, v. 3, p. 239, pl. 3, fig. 8 [fide van den Bold, 1963, Micropaleontology, v. 9, p. 386].

Diagnosis.—Subquadrate-subtrapezoidal in side view, highest one-fourth from anterior end; dorsum nearly straight, anterior cardinal angle elevated; venter slightly concave medially, anterior broadly curved, slightly extended below; posterior margin caudate, strongly extended below, concave above; valves compressed, LV slightly larger than RV and overlaps it in cardinal areas. Free margins with smooth slightly elevated rim; anterodorsal rounded, elevated eye tubercle; vertical ridge from posterocardinal angle to near venter, where it makes right-angle bend forward to midlength. Internal shell characters not seen in present specimens but were described by Howe and Neill.

Length of figured shell (pl. 6, fig. 12a) 0.63 mm, height 0.35 mm, convexity 0.18 mm.

Occurrence.—The species is rare in the Waccamaw Formation at locality NC-3, Columbus County, N.C.; rare at locality NC-1, Columbus County, N.C.; rare at locality NC-4, Columbus County, N.C. The species also occurs in the *Arca* zone of the Choctawhatchee Formation (of former usage) of Florida, and has been reported in lower to upper Miocene beds of Trinidad.

Specimens studied.—Four.

Figured specimen.—USNM 649501.

Caudites? sp.

Plate 5, figures 6a, b; plate 6, figure 13; plate 7, figures 8a-c

Diagnosis.—Subquadrate-subreniform, highest one-fourth from anterior end, dorsum slightly convex, cardinal angles broadly obtuse; venter concave medially, anterior broadly curved, extended below; posterior narrower, angulated medially, truncate above and below; valves subequal, LV slightly the larger. Free margins with narrow submarginal rim; anterodorsally an

oblique eye tubercle; general median surface nearly smooth, although somewhat irregular; posterior end compressed. In dorsal view LV margin extends over RV in cardinal area.

Hinge of RV an anterior high pointed tooth, postero-jacent rounded socket, interterminal bar and subjacent rabbit groove formed in valve edge, and posterior pointed tooth; inner lamellae of moderate width, vestibule present but narrow; radial canals very numerous and closely spaced; three large pillars anteriorly, adjacent to inner margin; muscle scar not clearly seen but apparently consists of a median vertical row of spots, and two more anterior spots.

Length of figured specimen 0.52 mm, height 0.28 mm, convexity 0.22 mm.

Remarks.—The general outline, surface ornamentation, and hingement of this species are like *Caudites*, but the posterior outline is less caudate than typical for the genus.

Occurrence.—Rare in Waccamaw Formation at localities NC-3, Columbus County, and NC-5, Brunswick County, N.C., also in the Duplin Marl at Walkers Bluff, N.C.

Specimens studied.—Three.

Figured specimens.—USNM 649962, 649502.

Genus *AURILA* Pokorný, 1955

Auris Neviani, 1928, Pontificia Acad. delle Sci., Rome, Mém., Sec. 2, v. 11, p. 72, 94 [not Spix, 1827].

Mutilus (*Aurila*) Pokorný, van Morkhoven, 1963, Post-Palaeozoic Ostracoda, Elsevier, Amsterdam, p. 138.

Subovate, almond shaped, anterior rounded, extended below, posterior more or less pointed, also extended below, dorsum strongly arched, surface reticulate, pitted, ridged concentrically in terminal areas, eye tubercle, hinge holamphidont, inner lamellae moderately broad, radial canals numerous and closely spaced, vestibule narrow or absent, adductor muscle scars an anteromedian row of four spots the middle two or upper middle spots paired, and more anterior spots. Oligocene to Recent.

Type species.—*Cythere convexa* Baird, Recent.

Although van Morkhoven refers to *Aurila* as a subgenus of *Mutilus*, the latter is a differently constructed shell especially in its posterior compression and ridging. He apparently depended heavily on similar muscle scars to relate the two genera.

Aurila conradi conradi (Howe and McGuirt)

Plate 5, figures 7a-i; text figure 20

Hemicythere conradi Howe and McGuirt, 1935, Florida Geol. Survey Bull. 13, p. 27, pl. 3, figs. 31-34; pl. 4, fig. 17. Edwards, 1944, Jour. Paleontology, v. 18, p. 518, pl. 86, figs. 17-18. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 42, pl. 6, figs. 9-12. Puri, 1953, Washington Acad. Sci.

Jour., v. 43, p. 176, pl. 2, figs. 1, 2; Puri, 1954, Florida Geol. Survey Bull. 36, p. 206. Swain, 1955, Jour. Paleontology, v. 29, p. 635, pl. 62, figs. 3a-c.

Aurila conradi (Howe and McGuirt). McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 94, pl. 11, figs. 7a, b.

Aurila conradi (Howe and McGuirt). Puri, 1960, Gulf Coast Assoc. Geol. Soc. Trans., v. 10, p. 129, pl. 3, figs. 9, 10. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, suppl., p. 323, fig. 12A.

Aurila conradi conradi (Howe and McGuirt), Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropoda, Art. 8, p. 48, pl. 17, figs. 1, 2, 12, 13.

Diagnosis.—Almond shaped, dimorphic, highest medially in females, anteromedially in more elongate males; dorsum moderately to strongly arched, venter gently curved to slightly sinuous; anterior rounded, strongly extended below; posterior narrowly rounded, strongly extended ventromedially. LV larger than RV; valves moderately convex, greatest convexity median to posteromedian. Surface ornamentation consists of anterior and ventral submarginal ridge, an inner ventral ridge, posterior and posterodorsal submarginal ridge, anterodorsal oblique eye tubercle and subjacent furrow; general surface coarsely and deeply reticulate.

Hinge of RV with anterior knoblike tooth, postero-jacent triangular socket, interterminal groove broadened at ends, and posterior reniform tooth; inner lamellae of moderate width, narrow vestibule, numerous closely spaced radial canals; muscle scar a curved row of four spots, of which middle two are subdivided, and two or more additional anterior spots.

Length of figured female shell (pl. 5, fig. 7e) 0.70 mm, height 0.48 mm, convexity 0.40 mm; length of male shell (pl. 5, fig. 7d) 0.66 mm, height 0.41 mm, convexity 0.36 mm.

Occurrence.—The species occurs widely in the Choctawhatchee Formation (of former usage), Duplin Marl, and upper part of the Yorktown Formation of the Atlantic Coastal Plain and Florida. Rare to common in

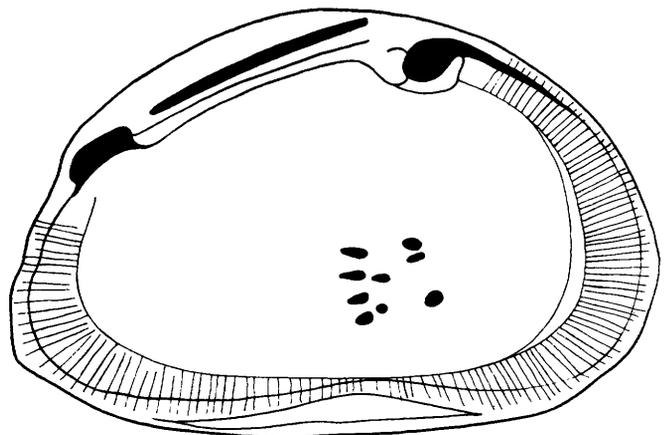


FIGURE 20.—*Aurila conradi* (Howe and McGuirt). Interior of left valve; locality NC-1.

the Waccamaw Formation at most of the localities studied, but was not found at locality SC-1, Horry County, S.C.

Specimens studied.—One hundred and eleven.

Figured specimens.—USNM 649964–649972.

***Aurila laevicula* (Edwards)**

Plate 5, figure 12

Hemicythere laevicula Edwards, 1944, Jour. Paleontology, v. 18, p. 518, pl. 86, figs. 27–30.

Diagnosis.—Elongate, almond shaped, highest medially; dorsum moderately arched, venter nearly straight, slightly sinuous; anterior margin rounded, extended below, truncate above. LV slightly larger than RV, overreaching dorsally; convexity of valves moderate. Surface densely and finely pitted; near free margins pits are arranged concentrically; ventrally there are one or two low narrow, submarginal ridges. Internal features not seen in present specimen, and were not described in detail by Edwards.

Length of figured specimen 0.58 mm, height 0.35 mm, convexity 0.27 mm.

Remarks.—The outline, overlap relationships, and surface ornamentation of this species suggest that it should be placed in *Aurila* rather than in *Hemicythere*.

Occurrence.—Waccamaw Formation, locality SC-5, Horry County, S.C.; originally described as rare in Duplin Marl near Lumberton, N.C.

Specimens studied.—One.

Figured specimen.—USNM 649980.

Family LOXOCOONCHIDAE Sars, 1925

Genus LOXOCOONCHA Sars, 1866

Loxoleberis Sars, 1866, Oversigt af Norges marine Ostracoder, p. 130 [error].

Normania Brady, 1866, Zool. Soc. London Trans., v. 5, p. 382.

Subrhomboidal, ends rounded, posterior extended above, anterior extended below, surface reticulate, pitted, ridged, nodose or nearly smooth, eye tubercle, hinge gongyodont (yolked terminal teeth and sockets), interterminal bar and groove crenulate, inner lamellae fairly broad, terminal vestibules, few radial canals, adductor muscle scars a median vertical row of four unpaired spots and more anterior and anteroventral spots, upper one typically crescentic. Cretaceous to Recent.

Type species.—*Cythere rhomboidea* Fischer, 1855, Recent.

***Loxococoncha wilberti* Puri**

Plate 3, figures 6a–c; plate 7, figure 6; text figures 21A, B

Loxococoncha wilberti Puri, 1954, Florida Geol. Survey Bull. 36, p. 274, pl. 10, figs. 1, 2; text figs. 10a, b.

Diagnosis.—Shell oblong, dorsum straight, venter nearly straight, subparallel to dorsum; terminal mar-

gins broadly curved, anterior extended below, posterior extended above; surface with coarse reticulate ridge pattern, concentrically arranged in marginal areas; posteriorly and posteroventrally concentric ridges are more prominent; free margins with narrow compressed rim. LV hinge with yolklike anterior socket and beadlike tooth, interterminal faintly crenulate groove and posterior yolklike lobed tooth and small socket, inner lamellae broad anteriorly, with vestibule; about 12 anterior radial canals with funneled inner ends; muscle scar a vertical row of four spots and two more anterior spots, the upper one crescentic.

Length of figured specimen (pl. 3, fig. 6a) 0.65 mm, height 0.40 mm, convexity 0.33 mm.

Occurrence.—Rare in Waccamaw Formation, locality NC-5, Brunswick County, N.C.; and at locality NC-1, Columbus County, N.C. The species was previously de-

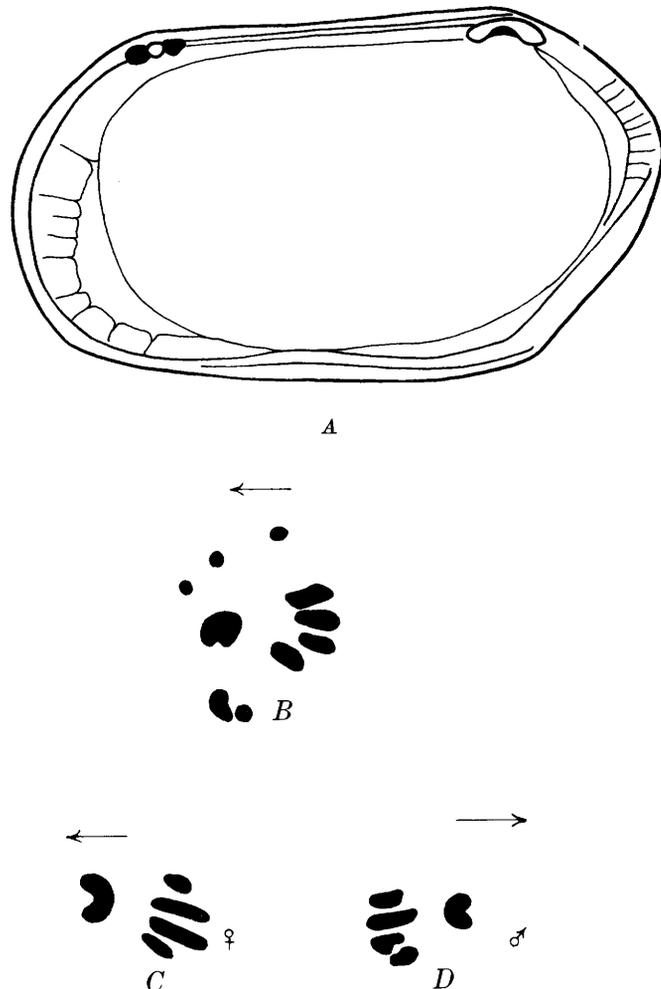


FIGURE 21.—*Loxococoncha wilberti* Puri. A, Interior of right valve. B, Adductor muscle scar; locality NC-1. C, D, *Loxococoncha purisubrhomboidea* Edwards, muscle scars of female and male shells; locality SC-4.

scribed from the Choctawhatchee Formation (of former usage), upper Miocene of Florida.

Specimens studied.—Three.

Figured specimens.—USNM 649915–649917.

***Loxoconcha purisubrhomboidea* Edwards**

Plate 3, figures 7a–e; plate 7, figure 7; text figures 21C, D

Loxoconcha subrhomboidea Edwards, 1944 [not Brady, 1880], Jour. Paleontology, v. 18, p. 527, pl. 88, figs. 28–32. Swain, 1952, U.S. Geol. Survey Prof. Paper 234–A, p. 25, pl. 2, figs. 18, 19. Malkin, 1953, Jour. Paleontology, v. 27, p. 787.

Loxoconcha purisubrhomboidea Edwards, new name, in Puri, 1953, Jour. Paleontology, v. 27, p. 270. Puri, 1954, Florida Geol. Survey Bull. 36, p. 274, pl. 10, fig. 8; text fig. 10h. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 71, pl. 7, figs. 4a–e.

Diagnosis.—Subquadrate-ovate (female) to subelliptical-ovate (male), highest medially; dorsum gently convex to nearly straight, venter sinuous, slightly concave anteromedially; terminal margins rounded, anterior broader than posterior and extended below; posterior extended above. Valves equal, moderately convex, greatest convexity median to posteromedian. Surface finely pitted; margins with narrow rim. Hinge and marginal structures are as shown in text figures 21C, D; muscle scar a median subvertical crescentic row of four spots; two more anterior spots, the dorsal one curved.

Length of figured female specimen (pl. 3, fig. 7e) 0.64 mm, height 0.36 mm, convexity 0.31 mm.

Occurrence.—Frequent to common in the Waccamaw at localities SC–2, SC–3, SC–4, and SC–5, Horry County, S.C. Rare in Waccamaw Formation at locality NC–3, Columbus County, N.C.; frequent at locality NC–5, Brunswick County, N.C. Rare in Pleistocene, Longs, S.C. The species was described from the Duplin Marl, upper Miocene of North Carolina, and occurs throughout the Miocene of the Atlantic Coastal region.

Specimens studied.—Forty-four.

Figured specimens.—USNM 649918–649920, 650015.

***Loxoconcha reticularis* Edwards**

Plate 4, figures 2a–f, 3; text figure 22

Loxoconcha reticularis Edwards, 1944, Jour. Paleontology, v. 18, p. 527, pl. 88, figs. 26, 27. Puri, 1954, Florida Geol. Survey Bull. 36, p. 274, pl. 10, fig. 7; text fig. 10e. Malkin, 1953, Jour. Paleontology, v. 27, p. 786, pl. 80, figs. 13–17. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 72, pl. 7, figs. 5a–b.

Loxoconcha cf. *L. reticularis* Edwards. Swain, 1952, U.S. Geol. Survey Prof. Paper 234–A, p. 26.

Diagnosis.—Subquadrate-subovate, highest one-third from anterior end, dorsum slightly sinuous, venter gently convex in males to nearly straight and subparallel to dorsum in females. Valves subequal, LV slightly larger; valves strongly convex; greatest convexity

ventromedian; surface with deeply reticulate pattern of pits and ridges; ridges markedly concentric in arrangement terminally and ventrally; margins bear a smooth narrow rim; terminal and posteroventral marginal areas compressed. Internal shell structure is shown in text figure 22.

Length of figured female specimen (pl. 4, fig. 2a) 0.51 mm, height 0.31 mm, convexity 0.28 mm. Length of figured male specimen (pl. 4, fig. 2c) 0.49 mm, height 0.28 mm, convexity 0.24 mm.

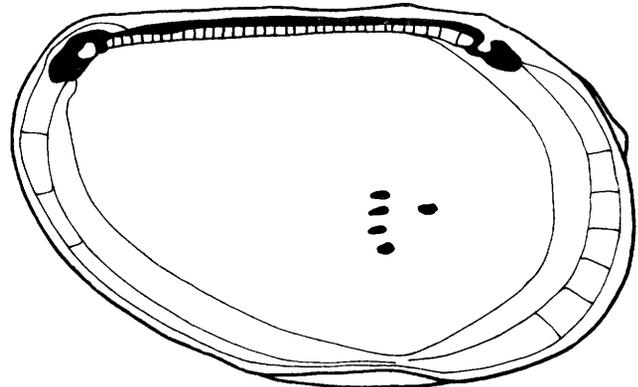


FIGURE 22.—*Loxoconcha reticularis* Edwards. Interior of left valve; locality SC-4.

Occurrence.—Rare to frequent in Waccamaw Formation at localities SC–2, SC–4, and SC–5, Horry County, S.C. Rare in Waccamaw Formation at locality NC–3, Columbus County, N.C.; rare at locality NC–5, Brunswick County, N.C.; frequent at locality NC–1, Columbus County. The species was described from the Duplin Marl, upper Miocene of North Carolina, and occurs throughout the Miocene of the Atlantic Coastal region.

Specimens studied.—Twenty-two.

Figured specimens.—USNM 649925–649931.

Genus PTEROLOXA Swain, 1963

Small, subquadrate, posterior narrower than anterior, LV slightly larger than RV, moderately convex, surface pitted or reticulate and with low ventral alate expansion, hinge gongyloidont, inner lamellae narrow to moderate in width, radial canals few, vestibule narrow or absent, adductor muscle scars a vertical row of three or four spots and additional more anterior spot(s). Pliocene (?), Pleistocene to Recent.

Type species.—*P. venipuncta* Swain, Pleistocene.

***Pteroloxa?* sp.**

Plate 4, figure 9

Diagnosis.—Shell small, subquadrate, highest anteromedially; dorsal margin straight and three-fourths of shell length; anterior cardinal angle slightly more obtuse than posterior; ventral margin slightly convex,

subparallel to dorsum; anterior margin broadly curved, slightly extended below, truncate above; posterior margin with dorsomedian small projection, subtruncate below and above. Valves subequal, moderately convex, greatest convexity posteromedian; valves compressed behind.

A narrow rim extends around free margins; posteroventral submarginal zone with narrow ridge; oblique longitudinal ridge slightly dorsal of midheight; several additional short oblique ridges in anterodorsal area; remainder of valve surface with short irregular ridges as illustrated. Internal shell features not observed.

Length of shell 0.33 mm, height 0.18 mm, convexity 0.17 mm.

Remarks.—This species has a low posteroventral alaform ridge like that typical of *Pteroloxa* but is of questionable generic position because of the lack of knowledge of its internal shell features. It somewhat resembles *Pteroloxa guaymanensis* Swain (1967) from the Recent of the Gulf of California, but has a different pattern of surface ornamentation.

Occurrence.—Rare in Waccamaw Formation, locality SC-3, Horry County, S.C.

Specimens studied.—One.

Figured specimen.—USNM 649948.

Genus CYTHEROMORPHA Hirschmann 1909

Subovate, subreniform or subquadrate, small, compressed, anterior margin extended below, broader than posterior, venter concave or sinuous, surface smooth, finely pitted, or finely reticulate, hinge gongyodont, crenulate interterminal bar and groove, inner lamellae of moderate width, vestibules present, radial canals few, line of concrescence scalloped owing to funnel-shaped opening of radial canals, adductor muscle scars a median vertical row of four spots and more anterior spots, upper one curved. Paleocene. Recent.

Type species.—*C. albula* Hirschmann, Recent.

***Cytheromorpha curta* Edwards**

Plate 5, figures 9a, b

Cytheromorpha curta Edwards, 1944, Jour. Paleontology, v. 18, p. 516, pl. 86, figs. 19-22. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 49, pl. 7, fig. 22.

Diagnosis.—Shell small, subovate, almond shaped in side view, highest anteromedially, dorsum moderately convex, truncated to slightly notched posteriorly; venter sinuous, concave anteromedially; terminal margins broadly curved, the anterior somewhat extended below, the posterior extended above. Valves subequal, the LV slightly larger; valves compressed, greatest convexity median. Surface densely and finely pitted; interspaces

equal to or exceeding diameter of pits. Middorsally, pits are arranged in two anteriorly curved subparallel rows possibly representing an incipient median sulcus; margins of valves with smooth narrow rim. Internal features not observed in present specimens but were described by Edwards (1944).

Length of figured specimen 0.37 mm, height 0.27 mm, convexity 0.18 mm.

Occurrence.—Rare in Waccamaw Formation at localities SC-1 and SC-4, Horry County, S.C. The species ranges upward from the St. Marys Formation, middle Miocene in the Middle Atlantic region. It is living in Pamlico Sound.

Specimens studied.—Two.

Figured specimens.—USNM 649976, 649977.

Genus LOXOCORNICULUM Benson and Coleman, 1963

Similar in nearly all shell features to *Loxoconcha* but has posterodorsal nodes on both valves. Miocene to Recent.

Type species.—*Cythere fischeri* Brady, Recent.

The present writer believes this genus represents ecologic variants of species of *Loxoconcha*, but is using the name until someone has made a detailed study of the problem.

***Loxocorniculum* sp.**

Plate 3, figures 8a, b; plate 4, figure 1

Shell subovate, highest medially, dorsal margin gently convex, passing with only slight, very obtuse angulation into terminal margins; ventral margin slightly concave anteromedially; anterior margins rounded, extended below, subtruncate above; posterior margin rounded, strongly extended above. Terminal and posteroventral margins with narrow low rims; anterior fourth of valve surface weakly and finely pitted; posterodorsal large, low, rounded node; anterodorsal smaller and lower eye tubercle. Internal shell structure not observed.

Length of figured specimen 0.50 mm, height 0.31 mm, convexity 0.24 mm.

Remarks.—The shape of this form is very much like that of *Loxoconcha rhomboidea* (Fischer), but the posterodorsal node is indicative of *Loxocorniculum* of Benson and Coleman. Too few specimens are available in the present collection to enable adequate comparisons to be made with described species.

Occurrence.—Rare in Waccamaw Formation, locality SC-5, Horry County, S.C. The species was also obtained from the Pleistocene, Longs, S.C.

Specimens studied.—Three.

Figured specimens.—USNM 649921, 649922, 649924.

Family **CAMPYLOCYTHERIDAE** Puri, 1960 (from
CAMPYLOCYTHERINAE Puri, 1960)

Inclusion of genera listed here in Hemicytheridae (Puri, 1960; Hazel, 1967) is not followed because that family typically has divided adductor muscle scars.

Genus **BASSLERITES** Howe, 1937

Basslerella Howe, 1935, Florida Geol. Survey Bull. 13, p. 30 [not Kellett, 1935].

Ovate-elliptical, ends rounded, LV larger than RV; surface smooth, wrinkled, or with posterior thlipsuroid lobate depression of surface; hinge holamphidont, heavily developed for size of shell; inner lamellae narrow, vestibule narrow or absent, a few to moderate number of radial canals in part anastomosing toward shell interior, adductor muscle scar an anteromedian vertical row of four spots and additional more anterior spot(s), upper one crescentic. Miocene to Recent.

Type species.—*Basslerella miocenica* Howe, Miocene.

Basslerites giganticus Edwards

Plate 4, figure 6; text figure 23

Basslerites giganticus Edwards, 1944, Jour. Paleontology, v. 18, p. 521, pl. 87, figs. 19–23. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 47, text figs. 3c–g.

Basslerites cf. *B. giganticus* Edwards. Puri, 1954, Florida Geol. Survey Bull. 36, p. 280, pl. 8, figs. 10, 11; text fig. 11k.

Diagnosis.—Large, subquadrate, dorsum nearly straight with cardinal areas slightly elevated, about three-fourths shell length; venter nearly straight, very slightly concave medially; anterior and posterior margins broadly and nearly uniformly rounded, the posterior narrower. LV larger than RV, convexity moderate, greatest posteromedially. Surface with weak pits more or less longitudinally arranged; shallow cardinal notches. Hinge of immature? LV with terminal small sockets and interterminal faintly crenulate bar formed of slightly extended valve edge; inner lamellae narrow, vestibule not developed; adductor scars a vertical row of four spots and two more anterior spots, the upper one crescentic; scars lie in anteromedian depression on interior of valve; about six muscle scars lie dorsally,

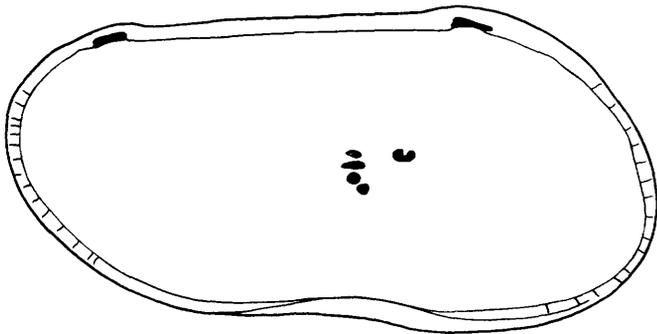


FIGURE 23.—*Basslerites giganticus* Edwards. Interior of immature left valve in which hinge and marginal zone are only weakly developed; locality NC-1.

three of which are in longitudinal row just below dorsum.

Length of figured specimen 0.96 mm, height 0.50 mm, convexity 0.15 mm.

Occurrence.—Rare in Waccamaw Formation at locality NC-1, Columbus County, N.C. The species was described from the Duplin Marl, upper Miocene of North Carolina, and also occurs in the Choctawhatchee Formation (of former usage) of Florida and the Yorktown Formation of the Middle Atlantic region.

Specimens studied.—One.

Figured specimens.—USNM 649939.

Genus **CAMPYLOCYTHERE** Edwards, 1944

Acuticythereis Edwards, 1944, Jour. Paleontology, v. 18, p. 519.

Elongate-ovate to elliptical, posterior narrower than anterior, LV slightly larger than RV, rather compressed; surface smooth, pitted, or reticulate; hinge holamphidont, inner lamellae moderate to narrow in width, vestibule present, radial canals fairly numerous, in part bunched along line of concrescence, adductor muscle scars a median vertical row of four spots and more anterior spots. Miocene to Recent.

Type species.—*C. laeva* Edwards, Miocene.

Campylocythere laevisissima (Edwards)

Plate 6, figures 1a, b, 2a–b, 3, 6, 8; plate 7, figures 9a, b; text figures 24, 25A, B

Acuticythereis laevisissima Edwards, 1944, Jour. Paleontology, v. 18, p. 519, pl. 87, figs. 4–11. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 42. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli; v. 33, supp., p. 323, fig. 12A.

Acuticythereis laevisissima punctata Edwards, 1944, Jour. Paleontology, v. 18, p. 520, pl. 87, figs. 12, 13.

Campylocythere laevisissima (Edwards). Malkin, 1953, Jour. Paleontology, v. 27, p. 785, pl. 80, figs. 4–6.

Diagnosis.—Subquadrate to subtrapezoidal, highest one-fourth from anterior end; dorsum nearly straight, anterior cardinal angle more obtuse than posterior; venter gently convex, converging strongly with dorsum toward posterior, anterior broadly curved, extended

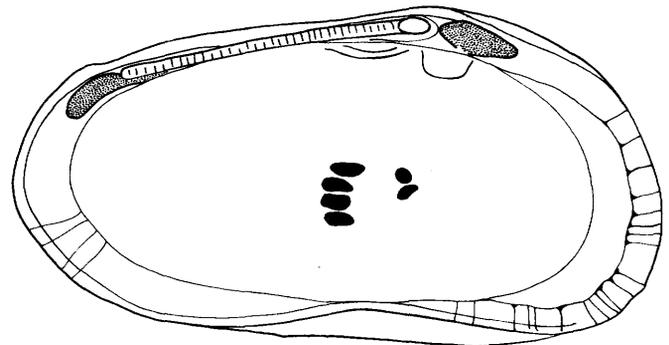
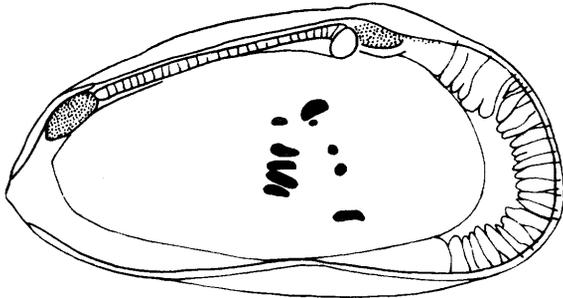
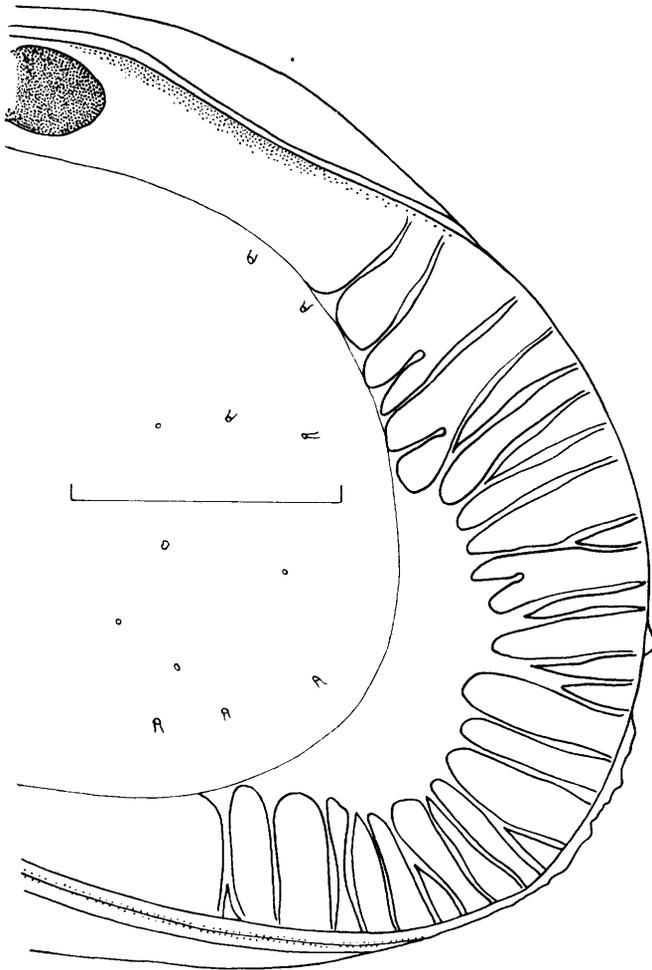


FIGURE 24.—*Campylocythere laevisissima* (Edwards). Interior of left valve; locality NC-5.

below, subtruncate above; posterior much narrower in male dimorphs, broader in females, extended to sharply angulated medially, subtruncate above; LV larger than RV, overreaching along free margins; valves moderately convex, greatest convexity postero-medial. Weak eye tubercle and subjacent oblique furrow anterodorsally; median and posteromedian valve surface of some specimens weakly and finely to coarsely



A



B

FIGURE 25.—*Campylocythere laevissima punctata* (Edwards).
A, Interior of left valve. B, Anterior marginal zone; locality NC-1.

pitted, other specimens are smooth. Posterior marginal zone compressed.

Hinge of RV consists of low anterior pyramidal tooth, posterojacent small open socket, interterminal crenulate furrow and posterior lobate tooth. Inner lamellae narrow, vestibule present, radial canals fairly numerous anteriorly, in part bunched at indentations on line of concrescence. Muscle scar, a vertical row of four and two more anterior spots.

Length of figured male specimens (pl. 6, fig. 2a) 0.68 mm, height 0.35 mm, convexity 0.33 mm. Length of a female shell (pl. 6, fig. 6) 0.78 mm, height 0.40 mm, convexity 0.36 mm.

Occurrence.—The species is frequent in Waccamaw Formation at locality NC-3, Columbus County, N.C.; rare at locality NC-1, Columbus County, N.C.; rare at locality NC-5, Brunswick County, N.C.; rare at locality NC-4, Columbus County, N.C.; rare at locality SC-2, Horry County, S.C. The species also occurs in the Duplin Marl of North Carolina and the upper part of the St. Marys and Yorktown Formations of North Carolina and Virginia.

Specimens studied.—Seventeen.

Figured specimens.—USNM 649982-649985, 649989, 649992, 650017.

***Campylocythere multipunctata* (Edwards)**

Plate 6, figures 5a-d; text figure 26

Acuticythereis multipunctata Edwards, 1944, Jour. Paleontology, v. 18, p. 520, pl. 87, figs. 14-16. Swain, 1952, U.S. Geol. Survey Prof. Paper 234-A, p. 42, text fig. 3m, n.

Diagnosis.—Subquadrangle to sublanceolate, highest one-third from anterior end, dorsum slightly convex with broadly obtuse, poorly defined cardinal angles. Venter nearly straight to slightly convex, converging strongly with dorsum toward posterior; anterior broadly curved, extended below; posterior narrow, strongly extended to subacuminate medially. LV larger than RV, overreaching along venter; convexity mod-

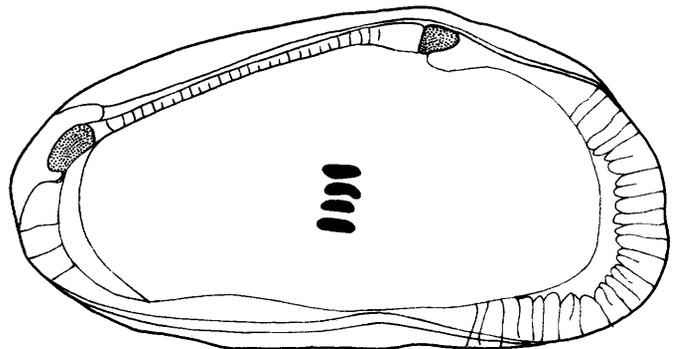


FIGURE 26.—*Campylocythere multipunctata* (Edwards). Interior of left valve; Duplin Formation, Walkers Bluff, N.C.

erate, greatest convexity posteromedian; posterior end compressed. Surface coarsely and deeply reticulate; in part, ridges are prominent longitudinally.

Hingement and other internal features similar to preceding species, but elements somewhat weaker, and reversal of hinge features from RV to LV observed by Edwards.

Length of figured specimen (pl. 6, fig. 5a) 0.60 mm, height 0.30 mm, convexity 0.28 mm.

Occurrence.—Rare in Duplin Marl, at Walkers Bluff on southern bank of Cape Fear River 9 miles below Elizabethtown, Bladen County, N.C. The species was described from the Duplin Marl and apparently does not range outside the Duplin. It is listed here to provide a comparison with other *Campylocythere* in the Waccamaw.

Specimens studied.—Two.

Figured specimens.—USNM 649987, 649988.

***Campylocythere laeva* Edwards**

Plate 2, figures 3a, b; plate 6, figures 7a–c; text figure 27

Campylocythere laeva Edwards, 1944, Jour. Paleontology, v. 18, p. 514, pl. 86, figs. 8–14. Malkin, 1953, Jour. Paleontology, v. 27, p. 784, pl. 80, figs. 1–3. Hulings and Puri, 1965, Pub. Staz. Zool., Napoli, v. 33, supp., p. 323, fig. 12a.

Diagnosis.—Subquadrate to subelliptical, highest medially to anteromedially, dorsum gently convex, venter slightly sinuous; anterior rounded, extended below; posterior more narrowly curved in males, broadly curved in females, extended medially. LV larger than RV, overreaching ventrally; valves moderately convex; greatest convexity median to posteromedian. Surface smooth. Hinge and other internal features are shown in text figure 27.

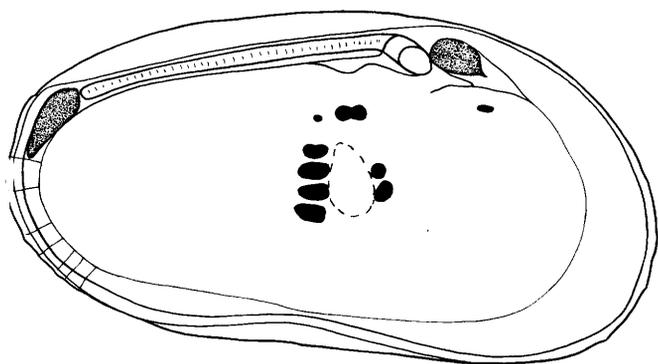


FIGURE 27.—*Campylocythere laeva* Edwards. Interior of left valve; locality NC-2.

Length of figured shell (pl. 6, fig. 7a) 0.77 mm, height 0.40 mm, convexity 0.37 mm.

Occurrence.—Rare in Waccamaw Formation locality SC-4, Horry County, S.C.; at localities NC-2 and NC-3, Columbus County, N.C.; and at locality NC-5, Brunswick County, N.C. The species was described from the Duplin Marl of North Carolina and ranges throughout the Yorktown Formation, upper Miocene of Virginia and North Carolina. It lives off the west coast of Florida, where it is found on clean sand bottom in euhaline shallow water (Hulings and Puri, 1965).

Specimens studied.—Six.

Figured specimens.—USNM 649990, 649991.

Genus BENSONOCY THERE Hazel, 1967

For diagnosis see Hazel (1967, p. 27). Oligocene (?), Miocene to Recent.

Type species.—*Leguminocythereis whitei* Swain.

***Bensonocythere whitei* (Swain)**

Plate 5, figures 4a, b; text figure 28

Leguminocythereis whitei Swain, 1952, U.S. Geol. Survey Prof.

Paper 234-A, p. 43, pl. 3, figs. 14, 16–18; pl. 4, fig. 1. Malkin, 1953, Jour. Paleontology, v. 27, p. 785–788, pl. 80, figs. 7–12.

Leguminocythereis (?) *whitei* Swain. McLean, 1957, Bull. Am. Paleontology, v. 38, no. 167, p. 80, pl. 9, figs. 4a–b.

Triginglymus whitei (Swain) Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropoda, Art. 8, p. 36, pl. 15, figs. 2, 5, 6, 8, 9.

Bensonocythere whitei (Swain), Hazel, 1967, U.S. Geol. Survey Prof. Paper 564, p. 27, pl. 5, figs. 2, 3, 8–10; pl. 10, figs. 1–8; pl. 11, figs. 1, 2.

Diagnosis.—Elliptical to elongate-ovate, highest one-fourth from anterior end; dorsum nearly straight, about four-fifths of shell length; venter slightly sinuous; anterior more broadly curved than posterior; LV larger than RV; female dimorphs less elongate and more convex posteromedially than males. Narrow ridge parallel to and just within free margins; a second ridge lies within first; a third anterodorsal ridge; other irregular ridges over general surface in some specimens form a roughly reticulate pattern, in others vertical elements are dominant. Hinge of RV an anterior oblique smooth tooth, posterojacent shallow socket, narrow interterminal smooth groove, anteromedian “antislip tooth” projection, and posterior elongate subreniform tooth. Muscle scar with one or both of middle spots of vertical row subdivided into two spots; inner lamellae of moderate width; little or no vestibule; radial canals most numerous anteroventrally.

Length of figured specimen 0.65 mm, height 0.38 mm, convexity 0.35 mm.

Remarks.—Hazel (1967) has recently reviewed the problems of classification of this species.

Occurrence.—Rare in Waccamaw Formation at localities NC-1 and NC-3, Columbus County, N.C., and at localities SC-1, and SC-2, Horry County, S.C. Elsewhere in the Atlantic Coastal Plain the species has been recorded from the lower part of the Choptank Formation to the top of the upper Miocene section. It was recorded in the subsurface lower Miocene or Oligocene of North Carolina (Swain, 1952, p. 44), but that occurrence is somewhat questionable. It is living in the Atlantic Ocean.

Specimens studied.—Two.

Figured specimens.—USNM 649958.

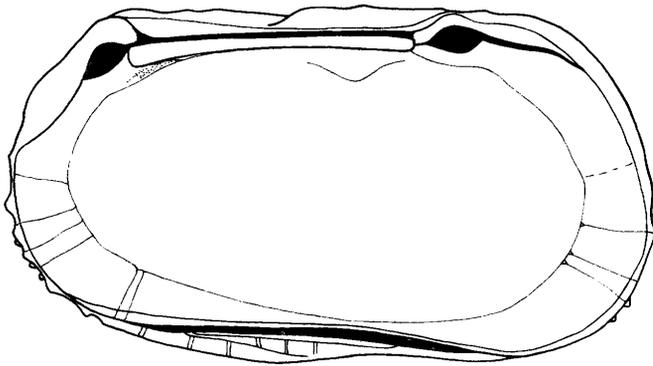


FIGURE 28.—*Bensonocythere whitei* (Swain). Interior of left valve; locality NC-1.

Family PECTOCYTHERIDAE Hanai, 1957

Genus MUNSEYELLA van den Bold, 1957

Toulminia Munsey, 1953, Jour. Paleontology, v. 27, p. 6 [not Zittel, 1878].

Small, subquadrate, posterior narrower than anterior, narrow marginal rim, other ridges on surface variably distributed, hinge of LV with anterior and posterior rounded teeth, small sockets behind and in front of teeth, respectively, and interterminal crenulate groove, converse in RV, inner lamellae fairly broad, vestibule present, line of concrescence sinuous, strongly so anteriorly, radial canals few, adductor muscle scars a vertical undivided row of four with additional more anterior scar(s). Paleocene to Recent.

Type species.—*Toulminia hyalokystis* Munsey, Paleocene.

Munseyella subminuta (Puri)

Plate 5, figures 3a-d; text figure 29

Cytheromorpha subminuta Puri, 1954, Florida Geol. Survey Bull. 36, p. 267, p. 6, figs. 9, 10.

Munseyella subminuta (Puri) van den Bold, 1958, Micropaleontology, v. 4, pl. 5, fig. 3. van den Bold 1963b, Micropaleontology, v. 9, p. 379, pls. 5, 6, fig. 3. Pooser, 1965, Kansas Univ. Paleont. Contr., Arthropoda, Art. 8, p. 52, pl. 11, figs. 1, 2, 4.

Diagnosis.—Small, sublanceolate-subquadrate, highest anteriorly, dorsum and venter nearly straight and converge posteriorly; anterior broadly curved; posterior narrower. Valves subequal, compressed, greatest convexity posteromedian. Marginal smooth rim anteriorly and ventrally, less distinct dorsally and posteriorly; a sinuous discontinuous dorsal ridge extends beyond dorsal margin posterodorsally, and bends toward venter, a second sinuous longitudinal ridge midventrally; medially a short ridge, anteriorly a median small node, and a posterior larger swelling. Internal structures of a LV are as shown in text figure 29.

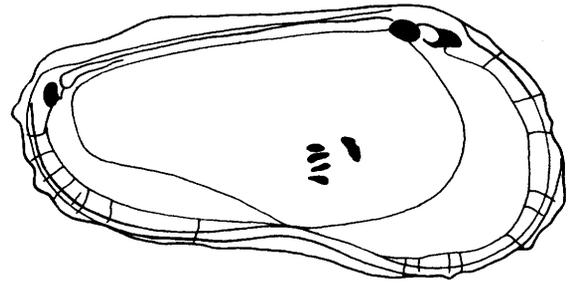


FIGURE 29.—*Munseyella subminuta* (Puri). Interior of left valve; locality SC-3.

Length of figured specimen 0.38 mm, height 0.20 mm, convexity 0.16 mm.

Occurrence.—Rare in Waccamaw Formation at locality NC-4, Columbus County, N.C.; localities SC-2 and SC-3, Horry County, S.C. The species was described from the Choctawhatchee Formation (of former usage) of Florida, *Arca*, *Ecphora*, and *Cancellaria* facies, and has also been recorded from the Miocene of Trinidad.

Specimens studied.—Four.

Figured specimens.—USNM 649956, 649957, 650018.

Family PROGONOCYTHERIDAE Sylvester-Bradley, 1948

Subfamily PROGONOCYTHERINAE Sylvester-Bradley, 1948

Genus XENOCYTHERE Sars, 1925

Elongate-sublanceolate, posterior end much narrower than anterior and extended below, wedge shaped in end view, venter flattened owing to expansion of ventral shell surface, valves subequal; surface smooth, pitted, or with closely spaced sinuous narrow ridges, hinge antimerodont, that of LV with terminal crenulate sockets and intervening crenulate bar, inner lamellae of moderate width, vestibule present at least anteriorly, radial canals few, adductor muscle scars a median vertical row of four spots with two more anterior antennal? spots above and one mandibular? spot below. Pliocene(?) to Recent.

Type species.—*Cythere cunieformis* Brady, Recent.

Length of figured specimen 1.44 mm, height 0.23 mm, convexity 0.27 mm.

Occurrence.—Rare in Waccamaw Formation at localities SC-2, SC-3, SC-4, and SC-5, Horry County, S.C. The species was described from the Choctawhatchee Formation (of former usage), upper Miocene of Florida.

Specimens studied.—Six.

Figured specimens.—USNM 649504, 649505.

Genus XIPHICHILUS Brady, 1870

Machaerina Brady and Norman, 1889. Royal Dublin Soc. Sci. Trans., ser. 2, v. 4, p. 237, (obj. syn. of *Xiphichilus* as they both have same type species).

Elongate bilanceolate, pointed at both ends, compressed, posterodorsal marginal sinuosity, surface smooth, hinge lophodont, inner lamellae and vestibule broad, continuous around venter, radial canals few, adductor muscle scars an anteromedian vertical row of four spots, may be paired to produce a double row, additional more anterior spots may occur. Pliocene to Recent.

Type species.—*Bythocythere tenuissima* Norman, Recent.

Xiphichilus? sp.

Plate 5, figure 11

Diagnosis.—Shell elongate-lanceolate in side view, highest medially; dorsal margin moderately convex, sloping uniformly on either side of position of greatest height; ventral margin slightly convex with weak posteromedian sinuosity; terminal margins narrowly rounded to subacuminate, the anterior slightly broader than posterior, both strongly extended below. Valves compressed, subequal; surface smooth. Internal shell features not observed.

Length of shell 0.42 mm, height 0.18 mm, convexity 0.13 mm.

Remarks.—The species is somewhat less acuminate terminally than most other species of *Xiphichilus*. The lack of information as to internal shell structures makes generic assignment uncertain.

Occurrence.—Rare in Waccamaw Formation, locality SC-5, Horry County, S.C.

Specimens studied.—One.

Figured specimen.—USNM 649979.

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Xenocythere? sp.

Plate 6, figures 9a, b

Diagnosis.—Shell elongate-subovate in side view, highest anteromedially; dorsum moderately convex, venter nearly straight; anterior margin broadly curved, somewhat extended below; posterior margin much more narrowly curved, extended below. LV slightly larger than RV, valves moderately convex, greatest convexity ventro-median where ventral valve surface is slightly expanded posteromedially; venter has two compressed areas in front of and behind expanded area. Surface ornamented with weak narrow irregular longitudinal ridges in ventral half and is obscurely pustulose in dorsal half.

Most internal shell features obscured by recrystallization in specimen at hand; muscle scars consist of a median vertical row of four spots and two more anterior spots of which upper is crescentic.

Length of shell (pl. 6, fig. 9a) 0.78 mm, height 0.38 mm, convexity 0.35 mm.

Remarks.—The shape, flattened venter, surface ornamentation, and musculature of this species furnish a relationship to *Xenocythere* Sars. The details of surface ornamentation especially the lesser strength of longitudinal ribbing are different from *X. cunieformis* (Brady), the type species.

Occurrence.—Rare in Waccamaw Formation at locality NC-5, Brunswick County, N.C.

Specimens studied.—Two.

Figured specimens.—USNM 649993, 649994.

Family XESTOLEBERIDIDAE Sars, 1928**Genus XESTOLEBERIS Sars, 1866**

Ovate-subreniform, strongly convex, venter flattened owing to expansion of ventral shell surface, LV larger than RV, surface smooth, finely pitted or striate ventrally, hinge antimerodont, LV with terminal crenulate sockets and intervening crenulate bar, zone of concrecence narrow, inner lamellae and vestibule broad anteriorly, radial canals short, fairly numerous, adductor muscle scars an anteromedian row of four spots, a more anterior trilobate antennal? spot above, and two mandibular? spots below. Cretaceous to Recent.

Type species.—*Cythere aurantia* Baird, Recent.

***Xestoleberis choctawhatcheensis* Puri**

Plate 6, figures 10a-c

Xestoleberis choctawhatcheensis Puri, 1954, Florida Geol. Survey Bull. 36, p. 297, pl. 16, fig. 6; text figs. f, g.

Diagnosis.—Subovate-subtriangular, highest medially, dorsum moderately convex, venter nearly straight; ends rounded, extended below; posterior truncated above. Valves strongly convex, inflated, and overhanging valve margin ventrally; most convex in posterior

half; LV larger than RV, overreaching it dorsally and anteriorly. Surface smooth except for faint ridges along venter; normal canals numerous, arranged in longitudinal rows ventrally. Hinge of RV with terminal elongate, weakly crenulate tooth flanges and an interterminal very faintly crenulate furrow; muscle scar a median vertical row of four spots and at least one, more anterior spot; inner lamellae narrow, vestibule present, radial canals short and numerous.

Length of figured specimen (pl. 6, fig. 10b) 0.48 mm, height 0.28 mm, convexity 0.28 mm.

Remarks.—This species is similar to *X. ventrostriata* Swain, but is somewhat more elongate and has weaker ventral striae.

Occurrence.—Rare in Waccamaw Formation at locality NC-3, Columbus County, N.C.; rare at locality NC-1, Columbus County, N.C.; rare at locality NC-5, Brunswick County, N.C.; rare at localities SC-1, SC-2, and SC-3, Horry County, S.C. The species was previously recorded from the *Ephora* and *Cancellaria* beds of the Choctawhatchee Formation (of former usage), upper Miocene of Florida.

Specimens studied.—Ten.

Figured specimens.—USNM 649995-649997.

***Xestoleberis howei* Puri**

Plate 6, figures 15a, b; plate 7, figure 5; text figure 30

Xestoleberis triangularis Puri, 1954, Florida Geol. Survey Bull. 36, p. 208, pl. 16, figs. 1-4; text figs. 13h, i [not Weber, 1937, or Mandelstam, 1960].

Xestoleberis howei Puri, 1964, Jour. Paleontology, v. 38, p. 787.

Diagnosis.—Shell elongate-subtriangular in side view; dorsal margin strongly convex; ventral margin nearly straight; anterior margin rounded, extended below; posterior margin more narrowly rounded, also extended below; valves subequal, the LV slightly larger; valves strongly convex, greatest convexity median and ventral in position. Surface smooth. Internal shell features not seen in present specimens; they were partially described by Puri.

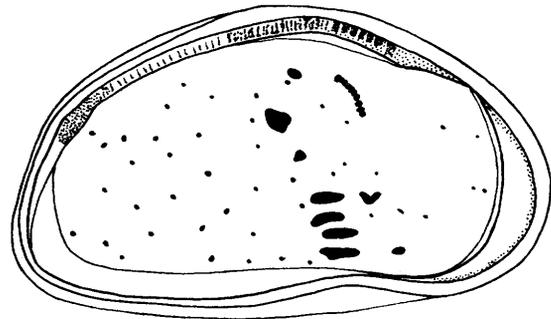


FIGURE 30—*Xestoleberis howei* Puri. Interior of left valve; locality SC-4.

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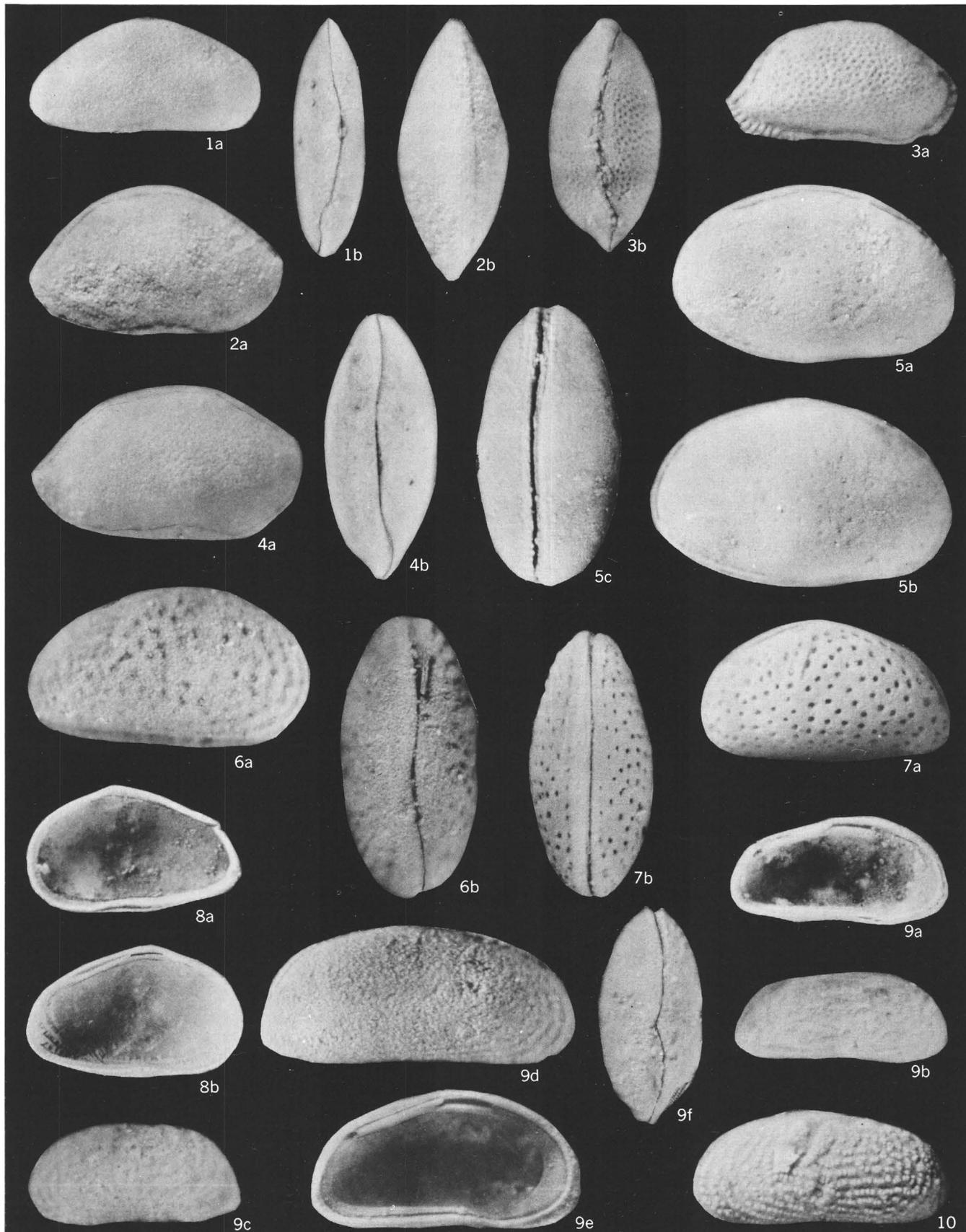
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PLATES 1-7

PLATE 1

[All magnifications $\times 60$]

- FIGURES 1a, b. *Bythocypris wicomicoensis* Swain (p. D5). Right side and dorsal views of shell, loc. NC-1, upper zone.
- 2a, b. *Bairdoppilata triangulata* Edwards (p. D6). Right side and dorsal views of shell, loc. NC-1, upper zone.
- 3a, b. *Bairdia* cf. *B. tuberculata* Brady (p. D6). Right side and dorsal views of shell, loc. NC-5.
- 4a, b. *Bairdia laevicula* Edwards (p. D7). Right side and dorsal views of shell, loc. NC-2, upper zone.
- 5a-c. *Haplocytheridea setipunctata* (Brady) (p. D7). a, b, Right side of two female shells. c, Ventral view of female shell. All from loc. NC-3, upper zone.
- 6a, b. *Haplocytheridea* sp. aff. *H. blanpiedi* (Stephenson) (p. D8). Right side and dorsal views of shell, loc. NC-5.
- 7a, b. *Haplocytheridea bradyi* (Stephenson) (p. D8). Left side and ventral views of shell, Duplin Marl, Walkers Bluff locality on southern bank of Cape Fear River, 9 miles below Elizabethtown, Bladen County, N.C., lower zone.
- 8a, b. *Haplocytheridea bradyi* (Stephenson) (p. D8). Interior views of immature right and left valves, Duplin Marl, Walkers Bluff locality, North Carolina, lower zone.
- 9a-f. *Pontocythere* cf. *P. wilberti* (Puri) (p. D9). a, Interior of immature left valve, loc. NC-2. b, Exterior of immature right valve, same locality. c, Exterior of immature left valve, same locality. d, Right side of male shell, loc. NC-3, upper zone. e, Interior of female left valve, loc. NC-2. f, Dorsal view of immature shell, same locality.
10. *Pontocythere rugipustulosa* (Edwards) (p. D9). Exterior of left valve, Duplin Marl, Walkers Bluff on southern bank of Cape Fear River, 9 miles below Elizabethtown, Bladen County, N.C., upper zone.

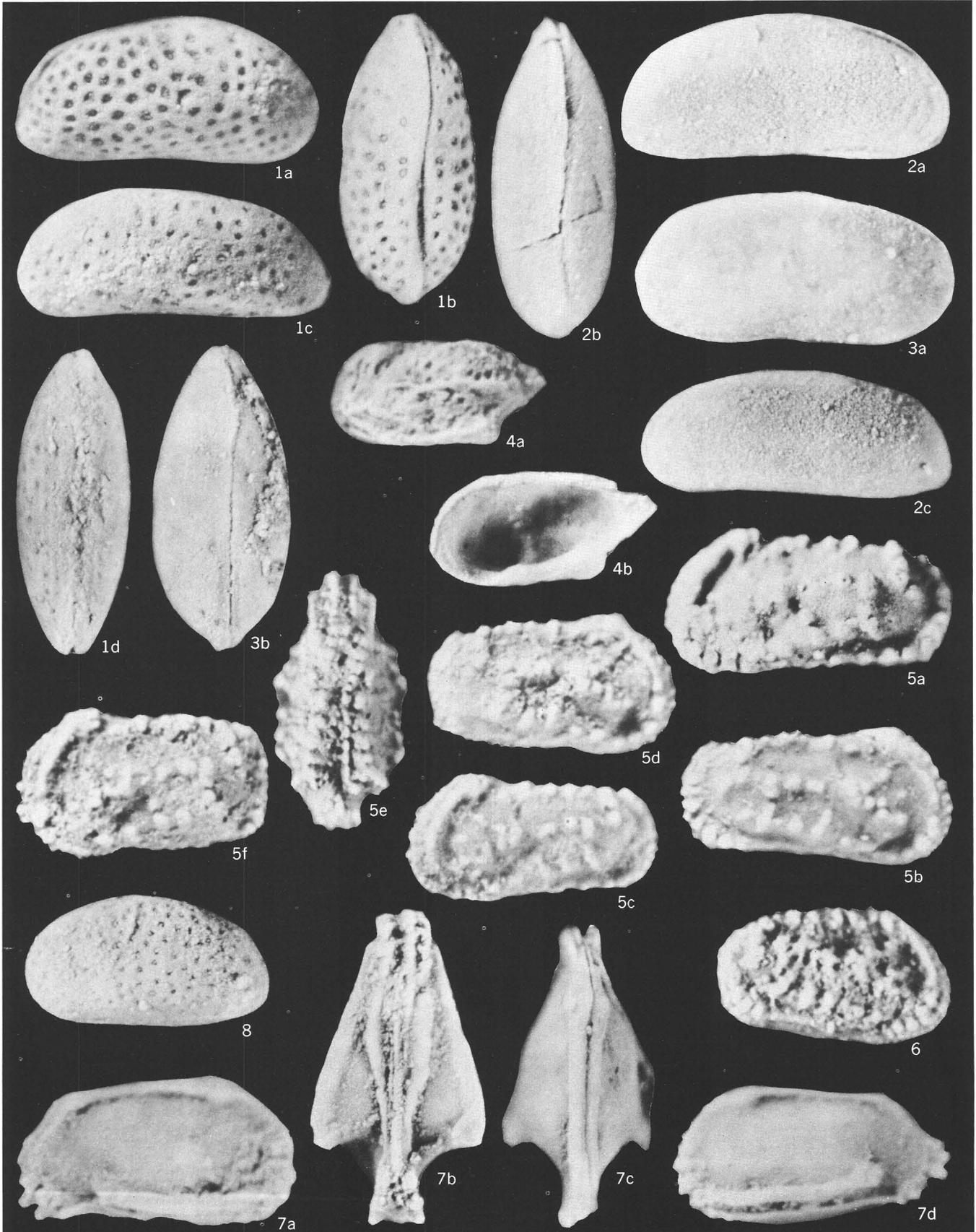


OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 2

[All magnifications $\times 60$]

- FIGURES 1a-d. *Pontocythere ashermanni* (Ulrich and Bassler) (p. D10). a, Right side of female shell, loc. NC-3, upper zone. b, Dorsal view of female shell, same locality. c, Left side of male shell, same locality. d, Ventral view of male shell, same locality.
- 2a-c. *Pontocythere* cf. *P. wilberti* (Puri) (p. D9). a, Right side of male shell. b, Dorsal view of shell. c, Left side of male shell, loc. NC-3, upper zone.
- 3a, b. *Campylocythere laeva* Edwards (p. D29). Right side and dorsal views of shell, loc. NC-3, upper zone.
- 4a, b. *Paracytheridea* cf. *P. vandenboldi* Puri (p. D11). a, Exterior of left valve. b, Interior of right valve, loc. NC-2.
- 5a-f. *Actinocythereis exanthemata* (Ulrich and Bassler) (p. D14). a, Left side of male shell, loc. NC-3. b, Right side of female shell, same locality. c, Left side of male shell, loc. NC-3. d, Right side of female shell, loc. NC-5. e, Dorsal view of female shell, same locality. f, Left side of female shell, same locality.
6. *Cletocythereis? mundorffi* (Swain) (p. D15). Right side of shell, loc. NC-5.
- 7a-d. *Pterygocythereis* sp. aff. *P. americana* (Ulrich and Bassler) (p. D19). a, Right side of shell, loc. NC-2. b, Ventral view of shell, same locality. c, Dorsal view of shell, same locality. d, Left side of shell, same locality.
8. *Haplocytheridea bradyi* (Stephenson) (p. D8). Left side of shell, Waccamaw Formation, loc. SC-5.

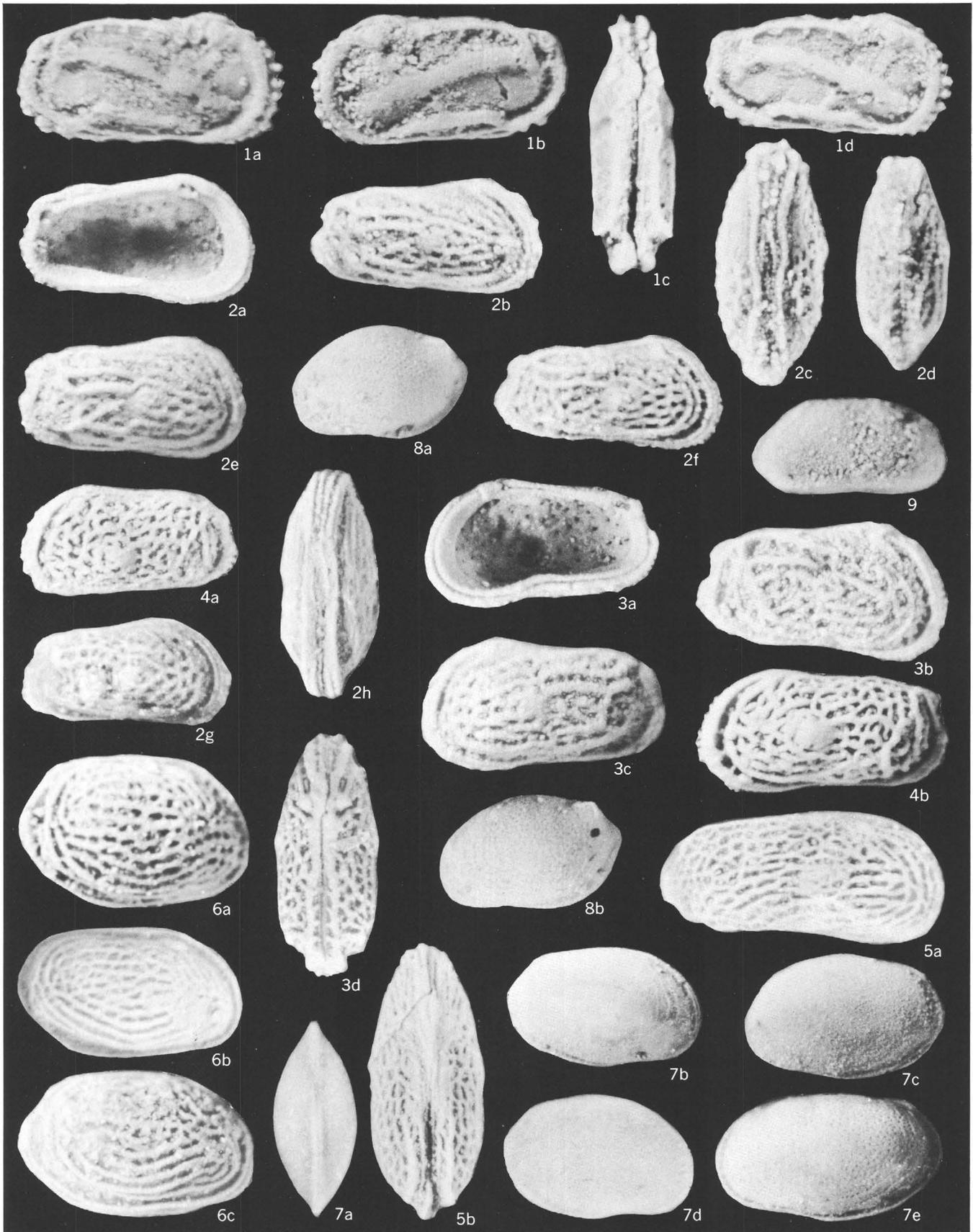


OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 3

[All magnifications $\times 60$]

- FIGURES 1a-d. *Neocaudites triplistriata* (Edwards) (p. D16). a, Right side of shell. b, Left side of shell. c, Dorsal view of shell. d, Right side of shell. All are from loc. NC-3, upper zone.
- 2a-h. *Muellerina lienenklausi* (Ulrich and Bassler) (p. D16). a, Interior of left valve loc. NC-5. b, Right side of immature shell, same locality. c, Dorsal view of shell, loc. NC-3. d, Dorsal view of immature shell, same locality. e, Right side of shell, loc. NC-5. f, g, Right sides of immature shells, loc. NC-3. h, Dorsal view of shell, Pliocene strata, Pierce quarry locality, North Carolina.
- 3a-d. *Muellerina lienenklausi* (Ulrich and Bassler). (p. D16). a, Interior of right valve, loc. NC-5. b, Right side of shell, same locality. c, Left side of shell, same locality. d, Dorsal view of shell, same locality.
- 4a, b. *Muellerina lienenklausi* (Ulrich and Bassler). (p. D16). a, Left side of immature shell, loc. NC-5. b, Left side of shell, same locality.
- 5a, b. *Murrayina?* sp. (p. D17). a, Right side and dorsal views of shell, loc. NC-1, upper zone.
- 6a-c. *Loxoconcha wilberti* Puri. (p. D24). a, Right side of shell, loc. NC-5. b, Exterior of right valve, locality NC-1. c, Right side of shell, loc. NC-5.
- 7a-c. *Loxoconcha purisubrhomboidea* Edwards. (p. D25). a, Ventral view of shell, Pleistocene, Longs, S.C. b, Right side of immature shell, loc. NC-5. c, Left side of shell, same locality. d, Right side of immature shell, Pleistocene beds, Longs, S.C. e, Left side of female shell, loc. NC-5.
- 8a, b. *Loxocorniculum* sp. (p. D26). Left sides of two shells, male? and female?, respectively, Waccamaw Formation, loc. SC-5.
9. *Cytheropteron choctawhatcheensis* Puri, (p. D13). Right side of a shell, Waccamaw Formation, loc. SC-1b.

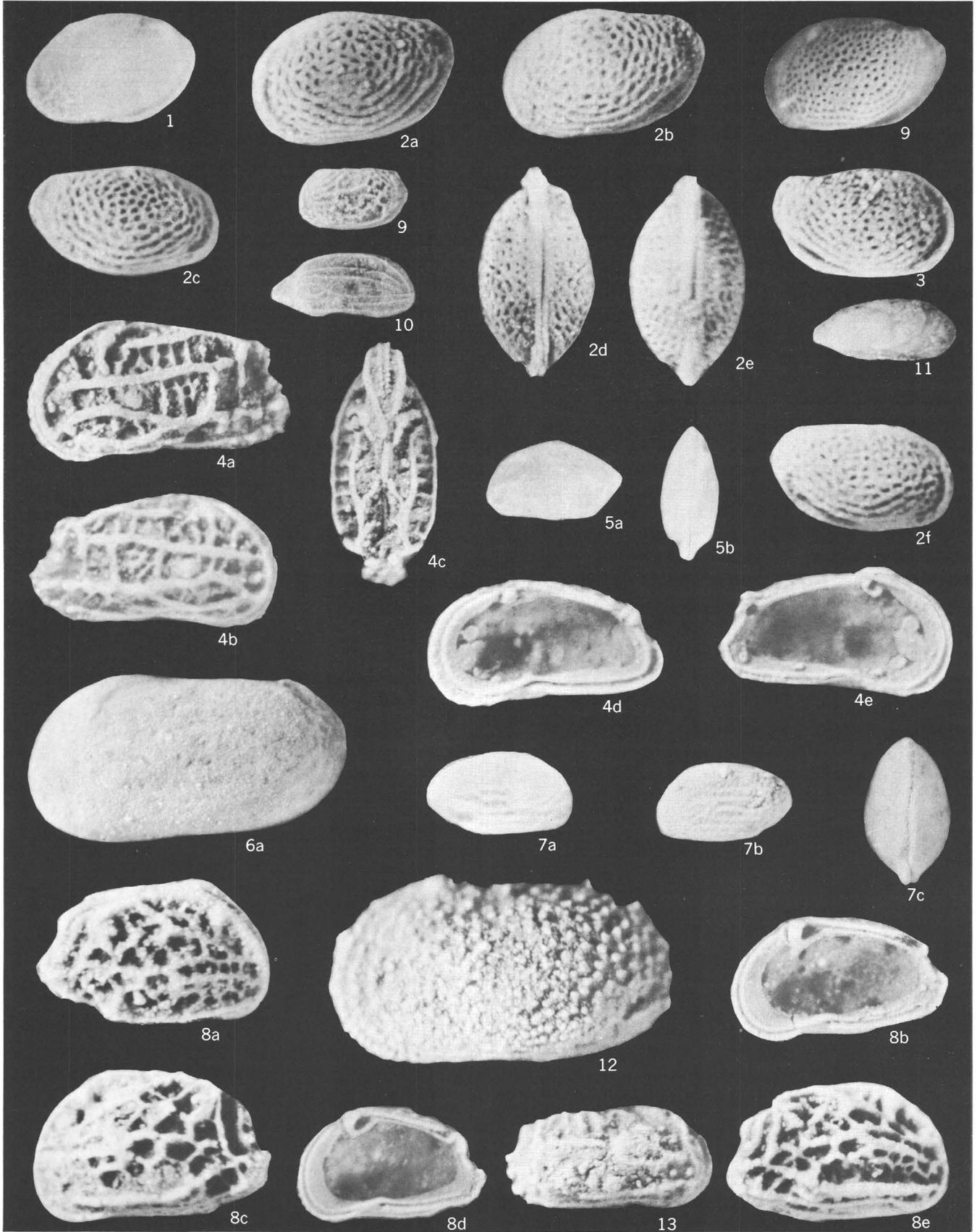


OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 4

[All magnifications $\times 60$]

- FIGURES 1. *Lozocorniculum* sp. (p. D26). Left side of shell, Pleistocene beds, Longs, S.C.
- 2a-f. *Loxoconcha reticularis* Edwards (p. D25). a, Left side of female shell, loc. NC-3. b, Left side of female shell, loc. NC-5. c, Right side of male shell, same locality. d, e, Dorsal views of two shells, loc. NC-3. f, Right side of female shell, loc. NC-5.
3. *Loxoconcha reticularis* Edwards (p. D25). Right side of shell, loc. NC-1, a specimen with unusually sinuous dorsal margin.
- 4a-e. *Orionina vaughani* (Ulrich and Bassler) (p. D21). a, Left side of shell, loc. NC-3, upper zone. b, Right side of shell, loc. NC-1. c, Ventral view of shell, loc. NC-3, upper zone. d, e, Interior of right and left valves, loc. NC-1.
- 5a, b. *Hemicytherura howei* (Puri) (p. D11). Left side and dorsal views of shell, Duplin Marl, Walkers Bluff locality, on southern bank of Cape Fear River, 9 miles downstream from Elizabethtown, Bladen County, N.C., upper zone.
6. *Basslerites giganticus* Edwards (p. D27). Exterior view of left valve, loc. NC-1, upper zone.
- 7a-c. *Cytheropteron yorktownensis* (Malkin) (p. D13). a, Right side of shell, loc. NC-2. b, Left side of shell, same locality. c, Dorsal view of shell, same locality.
- 8a-e. *Mutilus confragosa* (Edwards) (p. D21). a, Right side of shell, loc. NC-1, upper zone. b, Interior of right valve, same locality. c, Left side of shell, same locality. d, Interior view of right valve, same locality. e, Right side of shell, same locality, upper zone. 8c is a female shell; the others are either immature or male shells.
9. *Pteroloxa?* sp. (p. D 25). Left side of shell, loc. SC-3.
10. *Cytherura* cf. *C. costata* Müller (p. D12). Right side of shell, loc. SC-3.
11. *Jonesia howei* (Puri) (p. D20). Right side of shell, loc. SC-1b.
12. *Echinocythereis garretti* (Howe and McGuirt) (p. D15). Left side of shell, loc. SC-2.
13. *Puriana mesicostalis* (Edwards) (p. D19). Right side of shell, loc. SC-1.

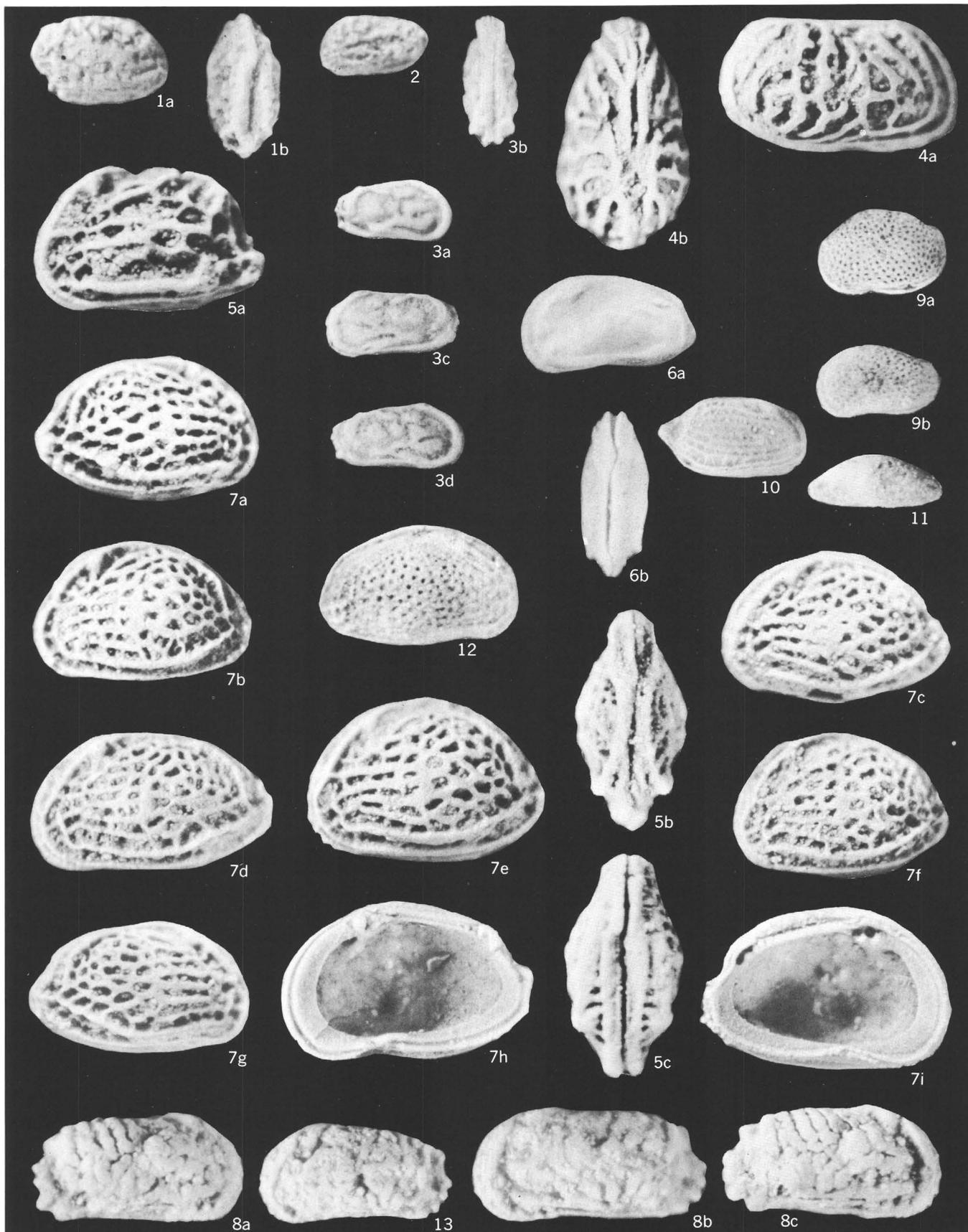


OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 5

[All magnifications $\times 60$]

- FIGURES 1a, b. *Eucytherura* sp. (p. D13). Right side and dorsal views of shell, loc. NC-4, North Carolina.
2. *Occultocythereis* sp. (p. D18). Left side of shell, loc. NC-1.
- 3a-d. *Munseyella subminuta* (Puri) (p. D30). a, b, Right side and dorsal views of shell, loc. NC-4. c, d, Left and right sides of two shells, loc. SC-2.
- 4a, b. *Bensonocythere whitei* (Swain) (p. D29). Right side and dorsal views of shell, loc. NC-3, upper zone.
- 5a-c. *Mutilus confragosa* (Edwards) (p. D21). a, Left side of a shell, loc. NC-1, upper zone. b, c, Dorsal and ventral views of shells, same locality.
- 6a, b. *Caudites?* sp. (p. D22). Duplin Marl, Walkers Bluff locality, southern bank of Cape Fear River, 9 miles below Elizabethtown, Bladen County, N.C., lower zone.
- 7a-i. *Aurila conradi conradi* (Howe and McGuirt) (p. D23). a, Right side of shell, loc. NC-3, upper zone. b-f, Left sides of several shells, same locality. g, Right side of shell, same locality. h, i, Interior views of right and left valves of a shell, same locality. 7e, h, and i are mature females; 7d and g are males; the others are immature? females.
- 8a-c. *Puriana rugipunctata* (Ulrich and Bassler) (p. D18). a, Right side of shell, loc. NC-3, upper zone. b, Left side of shell, same locality. c, Right side of shell, same locality.
- 9a, b. *Cytheromorpha curta* Edwards (p. D26). Left valve views of male? and female? shells, loc. SC-4 and SC-1 respectively.
10. *Cytherura forulata* Edwards (p. D12). Right side of shell, loc. SC-3.
11. *Xiphichilus?* sp. (p. D32). Right side of shell, loc. SC-5.
12. *Aurila laevicula* (Edwards) (p. D24). Right side of carapace, loc. SC-5.
13. *Puriana mesicostalis* (Edwards) (p. D19). Left side of carapace, loc. SC-1.

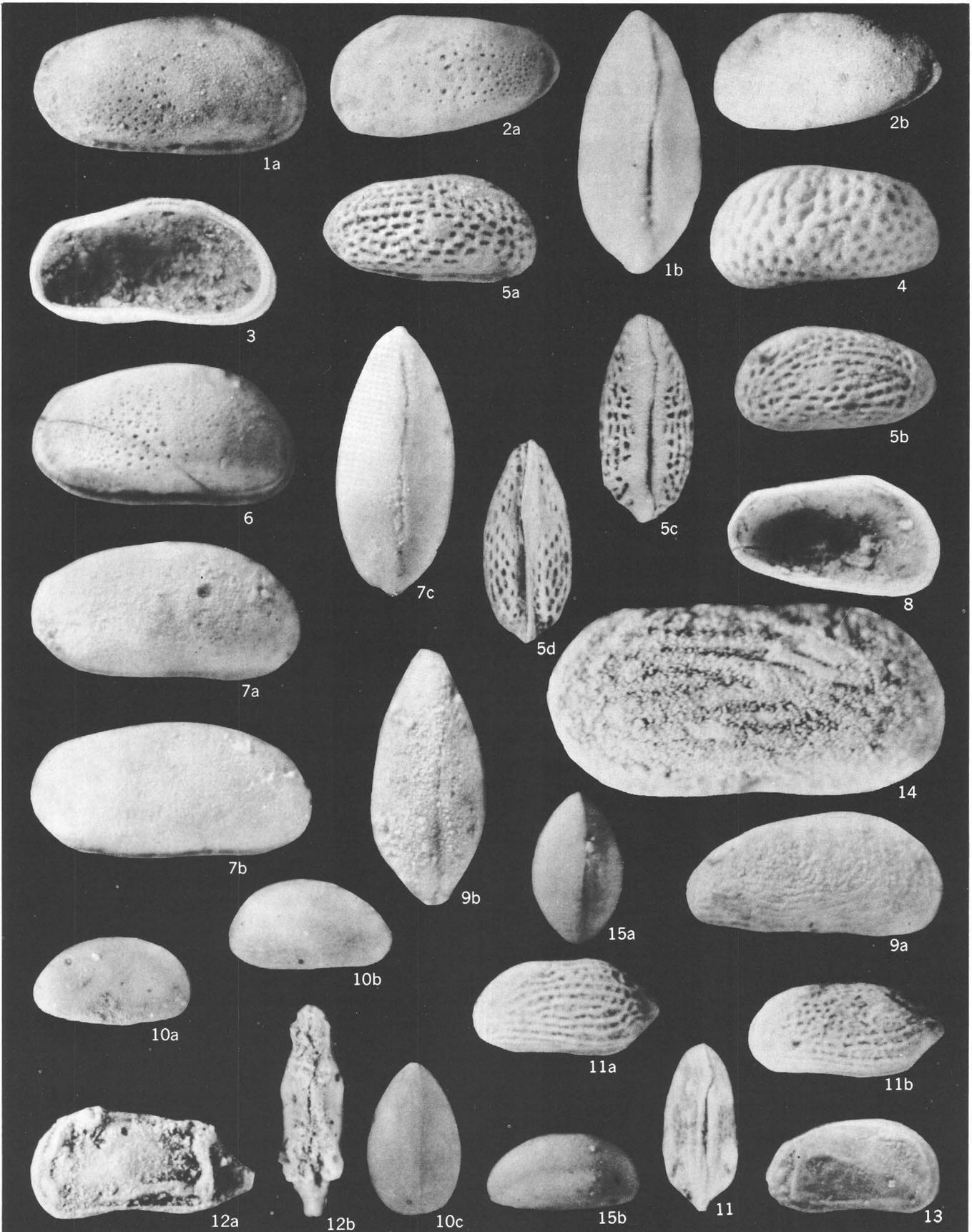


OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 6

[All magnifications $\times 60$]

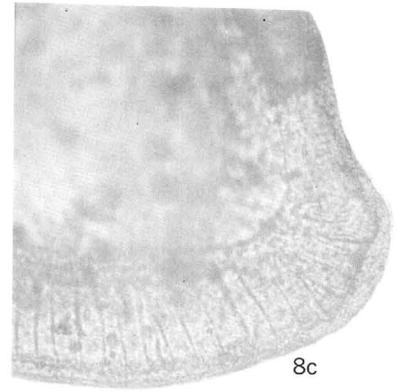
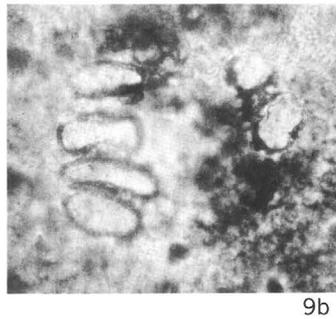
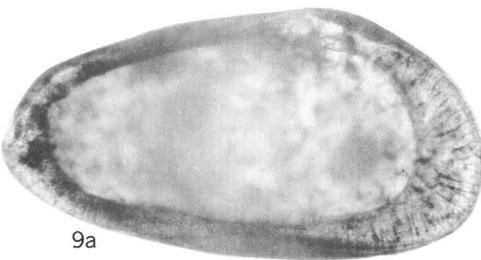
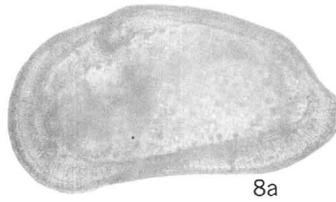
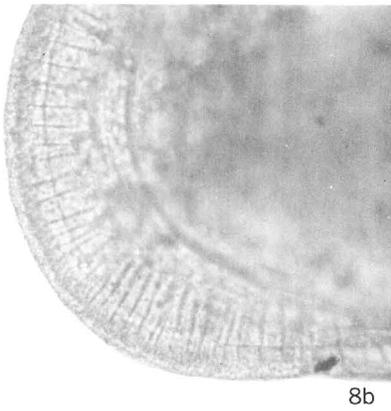
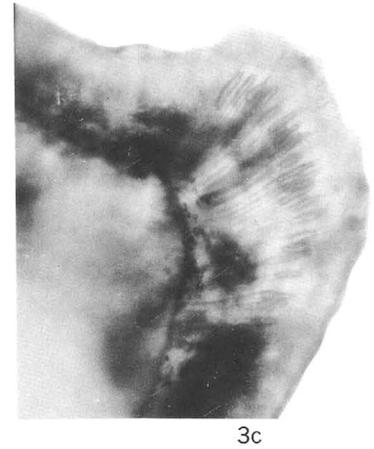
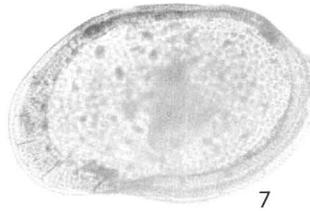
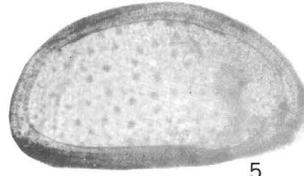
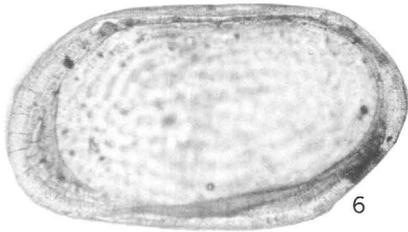
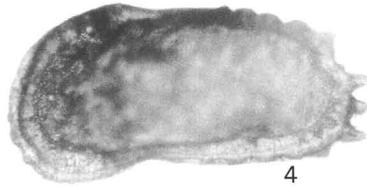
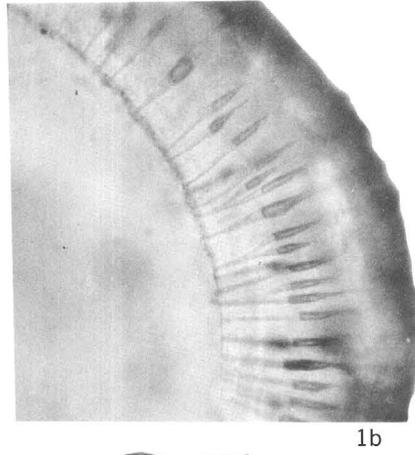
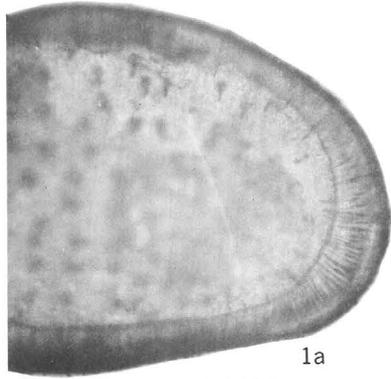
- FIGURES 1a, b. *Campylocythere laevissima* (Edwards) (p. D27) Right side and dorsal views of female shell, loc. NC-5.
- 2a, b. *Campylocythere laevissima* (Edwards) (p. D27) Left sides of two male shells, loc. NC-3, upper zone.
3. *Campylocythere laevissima* (Edwards) (p. D27) Interior of female? left valve, loc. NC-1, North Carolina.
4. *Pontocythere ashermani* (Ulrich and Bassler) (p. D10). Left side of shell, Duplin Marl, Walkers Bluff locality, southern bank of Cape Fear River, 9 miles below Elizabethtown, Bladen County, N.C., lower zone.
- 5a-d. *Campylocythere multipunctata* (Edwards) (p. D28). a, Right side of shell, Duplin Marl, Walkers Bluff locality, North Carolina, lower zone. b, Left side of shell, same locality. c, Dorsal view of shell, same locality. d, Ventral view of shell, same locality.
6. *Campylocythere laevissima* (Edwards) (p. D27). Right side of shell, loc. NC-3, upper zone.
- 7a-c. *Campylocythere laeva* Edwards (p. D29). a, Right side of female shell, loc. NC-2. b, Right side of female shell, loc. NC-3, upper zone. c, Dorsal view of 7a.
8. *Campylocythere laevissima* (Edwards) (p. D27). Interior of immature left valve, loc. NC-1.
- 9a, b. *Xenocythere?* sp. (p. D31). Right side and dorsal views of shell, loc. NC-5.
- 10a-c. *Xestoleberis choctawhatcheensis* Puri (p. D31). a Left side of shell, loc. NC-3. b, Right side of shell, same locality. c, Dorsal view of b.
- 11a-c. *Cytherura elongata* Edwards (p. D12). a, b, Left sides of a female and a male shell, Duplin Marl, Walkers Bluff, southern bank of Cape Fear River, 9 miles below Elizabethtown, Bladen County, N.C., lower zone. c, Dorsal view of male? shell, Duplin Marl, Walkers Bluff locality, North Carolina, lower zone.
- 12a, b. *Caudites sellardsi* (Howe and Neill) (p. D22). Left side and dorsal view of shell, loc. NC-3, upper zone.
13. *Caudites?* sp. (p. D22). Right side of shell, loc. NC-5.
14. *Cytherella* cf. *C. calhounensis* Smith (p. D20). Right side of poorly preserved shell, loc. SC-5.
- 15a, b. *Xestoleberis howei* Puri (p. D31). Dorsal view and left side of two shells, loc. SC-4.



OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

PLATE 7

- FIGURES 1a, b. *Haplocytheridea setipunctata* (Brady) (p. D17). a, Anterior half of left valve, from interior, in transmitted light, loc. NC-1, \times 95. b, Enlargement of part of anterior margin showing radial canals, \times 325.
2. *Bairdia laevicula* Edwards (p. D7). Interior of left valve by transmitted light, loc. SC-2, \times 78.
- 3a-c. *Mutilus confragosa* (Edwards) (p. D21). a, Interior of right valve by transmitted light, loc. NC-1, \times 78. b, Enlargement of part of anterior margin showing radial canals, \times 325. c, Enlargement of part of posterior margin, \times 325.
4. *Puriana rugipunctata* (Ulrich and Bassler) (p. D18). Interior of right valve by transmitted light, loc. SC-3, \times 78.
5. *Xestoleberis howei* Puri (p. D31). Interior of left valve by transmitted light, loc. SC-4, \times 95.
6. *Loxoconcha wilberti* Puri (p. D24). Interior of right valve by transmitted light, loc. NC-1, \times 78.
7. *Loxoconcha purisubrhomboidea* Edwards (p. D25). Interior of right valve by transmitted light, loc. SC-4, \times 78.
- 8a-c. *Caudites?* sp. (p. D22). a, Interior of right valve by transmitted light, Duplin Marl, Walkers Bluff, N.C., \times 45. b, Enlargement of part of anterior margin showing radial canals, \times 325. c, Enlargement of part of posterior margin showing radial canals, \times 325.
- 9a, b. *Campylocythere laevissima punctata* (Edwards) (p. D27). a, Interior of left valve by transmitted light, loc. NC-1 \times 95. b, Enlargement of muscle scar, \times 325.



OSTRACODA FROM THE WACCAMAW FORMATION, NORTH CAROLINA AND SOUTH CAROLINA

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STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

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- (C) Fusulinidae from the Graford Formation and Winchell Limestone, Canyon Group, Upper Pennsylvanian, in Brown County, Texas, by Donald A. Myers.
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