Ostracoda from Wells in North Carolina

Part 1, Cenozoic Ostracoda

GEOLOGICAL SURVEY PROFESSIONAL PAPER 234-A

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By FREDERICK M. SWAIN

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Descriptions, illustrations, geographic distribution, and stratigraphic ranges of microfossils.

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PART 1, CENOZOIC OSTRACODA

By FREDERICK M. SWAIN

ABSTRACT

Cenozoic Ostracoda obtained from wells and surface exposures in North Carolina are described. Eight of the species are new. This work provides our first knowledge of the pre-Miocene Cenozoic Ostracoda in North Carolina. The names of the surface Cenozoic formations are not applied to the subsurface units in this paper because of uncertainties in correlation; instead, the more general terms Paleocene (?), lower Eocene, middle Eocene, Oligocene or lower Miocene, lower Miocene, middle Miocene, upper Miocene, Pliocene, Pleistocene, and Recent are used.

The Paleocene (?) rocks consist of fine-grained, sandy, glauconitic shale and marl, and contain tiny benthonic Foraminifera. The unit is 277 feet thick beneath Cape Hatteras and thins abruptly westward. Its tentative assignment to Paleocene is based on stratigraphic position and on the fact that it differs markedly in lithologic character and fauna from the adjoining units.

The lower Eocene consists of as much as 485 feet of fine-grained glauconitic sandstone and sandy limestone in which, from Cape Hatteras southwestward, many layers are highly siliceous. *Brachycythere marylandica* (Ulrich), *Bythocypris parilis* Ulrich, *Cytherelloidea howei* Swain, *Haplocytheridea hopkinsi*, (Howe and Garrett), *Trachyleberis?* sp. aff. *T.? communis aquia* (Schmidt), and *Xestoleberis* cf. *X. longissima* Schmidt are ostracodes characteristic of the lower Eocene.

The middle Eocene rocks are coarse-grained, glauconitic, sandy limestones and calcareous sandstones with a maximum total thickness of 647 feet. This zone contains abundant ostracodes of which many are indicative of Claiborne age. The species that are restricted to the unit are: *Buntonia howei* (Stephenson), *Clithrocytheridea* cf. *C. smithvillensis* Stephenson, *Cytheretta darensis* Swain, n. sp., *Cytheromorpha* cf. *C. eocenica* Stephenson, *Cytheropteron* cf. *C. variosum* Martin, *Cytherura* sp. aff. *C. washburni* Stephenson, *Haplocytheridea* cf. *H. goochi* Stephenson, *H.* cf. *H. nowotnyi* Stephenson, *Loxoconcha* sp. aff. *L. claibornensis* Murray, *L.* cf. *L. mcbeanensis* Murray, *L.* cf. *L. surreala* Murray, *Monoceratina* cf. *M. harrisi* Stephenson, *Pterygocythereis washingtonensis* Swain, n. sp., *T.? rukasi* (Gooch), and *T. smithvillensis* (Sutton and Williams).

The upper Eocene rocks, if present in the subsurface of eastern North Carolina, do not contain a distinctive ostracode fauna.

A unit of sandstone, glauconitic shale, and sandy limestone beds totalling as much as 258 feet thick overlying the middle Eocene in the two deep Esso Standard Oil Co. wells, Dare County, is here referred to the Oligocene or lower Miocene.

The lower Miocene apparently occurs in two facies in eastern North Carolina. At Cape Hatteras and southwestward the lower Miocene is represented by as much as 485 feet of sandy, mostly nonglauconitic limestone and sand, probably representing the Trent marl of surface exposures. North of Cape Hatteras there is a facies change to gray diatomaceous shale.

The middle Miocene beds may represent the St. Marys formation of surface exposures; it consists of fossiliferous shaly sands and sandy clay as much as 340 feet thick. *Paracytheridea? weatherelli* (Jones) and *Trachylebris rosetta* Swain, n. sp. were found only in the unit. The highest occurrence of *Trachyleberis evax* (Ulrich and Bassler) was used in selecting the upper boundary of the middle Miocene.

The upper Miocene consists of a maximum of 560 feet of unconsolidated sand and shell beds that probably represent the Yorktown formation and the Duplin marl of surface exposures. The following ostracodes are restricted to the upper Miocene: *Acuticythereis laevissima punctata* Edwards, *A.* cf. *A. multipunctata* Edwards, *Basslerites* cf. *B. giganticus* Edwards, *Cytheromorpha curta* Edwards, *Cytherura* cf. *C. reticulata* Edwards, *Favella mesicostalis* Edwards, *Hemicythere confragosa* Edwards, *Loxoconcha edentonensis* Swain, n. sp. *Paracytheridea* cf. *P. rugosa* Edwards, *Pellucistoma* cf. *P. magniventra* Edwards, *Trachyleberis? triplistriata* Edwards, *Xestoleberis? ventrostriata* Swain, n. sp.

The Pliocene, Pleistocene, and Recent are not clearly distinguishable lithologically in the wells.

The Tertiary ostracode fauna of the North Carolina wells is strikingly similar to those of the Gulf region but several problems of correlation and facies relationships remain unsolved.

INTRODUCTION

Several collections of Mesozoic and Cenozoic Ostracoda from water wells and exploratory oil wells in the coastal plain of eastern North Carolina (Fig. 1) have been furnished to the Geological Survey. The species of Cenozoic ostracodes obtained from 13 wells are recorded in this paper, and a second paper will discuss the Cretaceous species. The only published study on the North Carolina Cenozoic ostracodes is that by Edwards (1944), who provided excellent descriptions of the upper Miocene Duplin marl species. McLean (1947) listed several species from the Miocene and Oligocene occurring in a water well at Camp Lejeune, Onslow County, N. C.

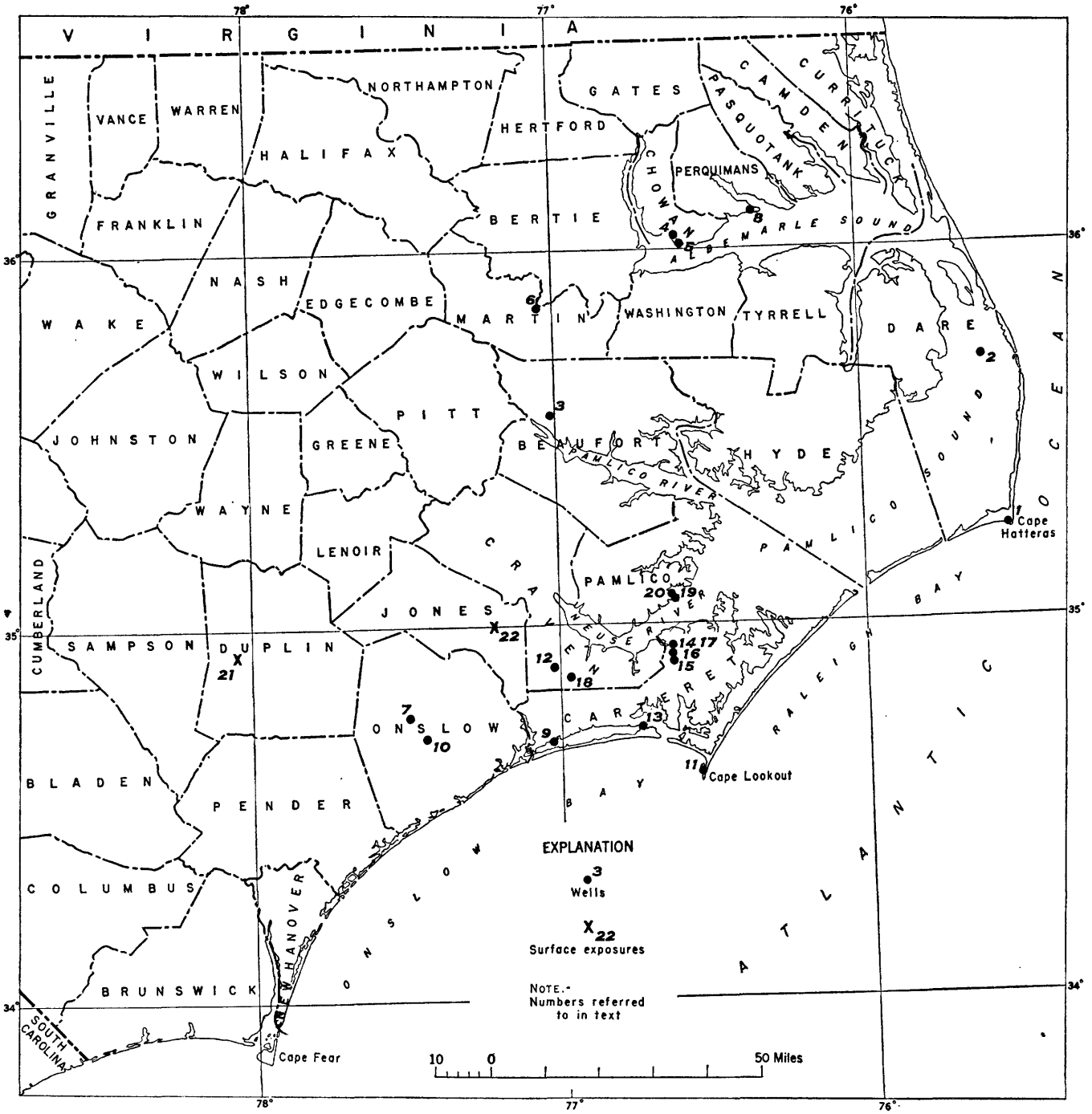

FIGURE 1.—Index map of eastern North Carolina showing localities studied.

The Cenozoic Foraminifera of surface exposures in North Carolina are better known (Cushman, 1918, 1935; Cushman and Cahill, 1933). McLean (1947) and Cushman (unpublished report dated April 24, 1946) recorded Miocene, Oligocene, and Eocene species of Foraminifera from some water wells. Cushman's unpublished report deals with several of the water wells involved in the present study. A large collection of Foraminifera was obtained from the Hatteras Light well no. 1, located on Cape Hatteras, but study of the material has not been completed by the Geological Survey.

Because it seems inadvisable to apply the names of the surface Cenozoic formations to units occurring in the wells, only a generalized stratigraphic classification is used, as follows:

Quaternary system
- Recent series
- Pleistocene series

Tertiary system
- Pliocene series
- Miocene series
  - Upper Miocene
  - Middle Miocene
  - Lower Miocene
- Lower part of Miocene series or Oligocene
- Eocene series
  - Middle Eocene
- Lower Eocene
- Paleocene (?) series

The stratigraphy of these units and their ostracode faunas are briefly described. The ranges of some species recorded from the water wells may be inaccurate due to the caving of walls during drilling; in picking specimens from the exploratory oil well samples an attempt was made to eliminate specimens that might have been displaced by caving, but some inaccuracies may remain.

A recent informative paper by Spangler (1950) gives data on the subsurface stratigraphy in eastern North Carolina. According to Spangler (1950, pp. 120, 121) the Cenozoic rocks in the Esso Standard Oil Co., Hatteras Light well no. 1 can be subdivided as follows: Recent and Pleistocene 0–110 feet, Pliocene 110–320 feet, upper Miocene (Yorktown) 320–750 feet, middle Miocene (Calvert) 750–994 feet, lower Miocene (Trent) 994–1,480 feet, Eocene, 1,480–2440 feet; the top of the Cretaceous (Peedee formation) is placed at 2,440 feet.

Spangler's subdivisions of the Cenozoic in the Esso Standard Oil Co., North Carolina Esso well no. 2 are: Recent, Pleistocene, and Pliocene 0–300 feet, Miocene 300–1,265 feet, Eocene 1,265–1,750 feet; the top of the Cretaceous was placed at 1,750 feet.

Presumably, Spangler's correlations of these two wells were based on study of the drill-cuttings, cores, electrical logs and Foraminifera. Concerning the top of the Cretaceous in the two wells Spangler (1950, pp. 130, 131) states: "No foraminiferal fauna by which the true age of the Peedee could be determined was found in the North Carolina Esso no. 2 and Hatteras no. 1 and correlations were made on electric-log characteristics." The present author placed the top of the Cretaceous in both wells at a lower level on the basis of the ostracodes, as hereinafter stated.

Acknowledgments. The writer appreciates material and information received from K. D. White and W. B. Spangler of the Esso Standard Oil Co., W. S. Pike and Doris Malkin of the Shell Oil Co., Inc., and M. J. Mundorff, J. B. Reeside, Jr., J. A. Cushman, Julia Gardner, and F. Stearns MacNeil of the U. S. Geological Survey. L. E. Monley, L. M. Perry, J. A. Peterson, and W. D. Quinlivan of the U. S. Geological Survey, assisted in various ways. The bibliographic work and some of the laboratory work were done by Richard E. Hadley and Robert H. Cress, supported by a grant-in-aid from the Graduate School, University of Minnesota.

LIST OF WELLS

In the following list asterisks (*) indicate wells from which ostracodes were obtained. Information from the other wells helped work out stratigraphic relationships. The kinds of information concerning each well is indicated. The well numbers are used in the faunal table (pp. 12–14) to identify the wells in which the various ostracode species are found.

*1. Esso Standard Oil Co. Hatteras Light well[1] no. 1; Long. 75°31′4″ W., Lat. 35°15′0.5″ N., Cape Hatteras, Dare County, N. C.; derrick floor altitude 24 feet; depth 10,054 feet; drill-cuttings, cores, electrical log, drilling time log; report by Julia Gardner on macrofossils; stratigraphy briefly described by Swain (1947).

*2. Esso Standard Oil Co., North Carolina Esso well no. 2; Long. 75°33′54″ W., Lat. 35°42′12″ N., Pamlico Sound, Dare County, N. C.; drive bushing altitude 21 feet; depth 6,410 feet; drill cuttings, electrical log; stratigraphy summarized by Swain (1947).

*3. Naval Auxiliary Air Station well; Washington, Beaufort County, N. C., about 2½ miles northeast of city; altitude about 33 feet; depth 215 feet; ostracodes, unpublished report by Cushman on Foraminifera.

*4. Edenton Naval Air Base well no. 1; Chowan County, N. C., 3 miles southeast of center of Edenton; altitude 15 feet; depth 55 feet; ostracodes, unpublished report by Cushman on Foraminifera.

*5. Edenton Naval Air Base well no. 4; one mile southeast of preceding; altitude 10 feet; depth 88 feet; ostracodes.

[1] These two wells were originally termed (Swain, 1947) the Standard Oil Company (N. J.) North Carolina Esso no. 1 and North Carolina Esso no 2 wells. The exploration section of the company has since been renamed the Esso Standard Oil Company and the name of the no. 1 well has been changed to Hatteras Light well no. 1.

*6. Williamston test well no. 2; Martin County, N. C.; about ½ mile east of center of town; altitude about 60 feet; depth about 220 feet; ostracodes.

*7. Jacksonville Tent Camp well no. 2; Onslow County, N. C.; 2 miles S. 45° W. of town; altitude 20.3 feet; depth 184 feet; ostracodes.

*8. Harvey Neck water well; Perquimans County, N. C., on Harvey Point, 1¾ miles from tip of point, ½ mile southeast of Perquimans River; altitude about 8 feet; depth 77 feet; ostracodes.

*9. Bogue water well no. 65; Carteret County, N. C., at Bogue, about 6 miles east of Swansboro; altitude 18½ feet; depth 260 feet; ostracodes.

*10. Layne Housing project water well; Jacksonville, N. C., 5¾ miles S. 20° E. of Jacksonville; altitude 32.2 feet; depth 125 feet; ostracodes, unpublished report by Cushman on Foraminifera.

*11. Cape Lookout water well; Carteret County, N. C., about 10.5 miles southeast of Beaufort; altitude not known, probably 5 to 10 feet above sea level; depth 435 feet; ostracodes, unpublished report by Cushman on Foraminifera.

*12. Great Lakes Drilling Co. well; 5 miles west of Havelock, Craven County, N. C. altitude about 30 feet; depth 2,531 feet; drill-cuttings, unpublished report by Doris L. Malkin of Shell Oil Co.; log of well published (Mansfield, 1927, Mundorff, 1944).

*13. F. L. Karsten, Laughton no. 1 well; Morehead City, Carteret County, N. C.; altitude 17 feet; depth 4,044 feet; drill-cuttings, electrical log, summarized log published (Richards, 1948, p. 59).

14. Carolina Petroleum Co., O. L. Phillips-State of N. C. no. 1 well, 1½ miles north of Merrimon, Carteret Co., N. C.; altitude 10 feet, estimated; depth 3,964 feet; electrical log.

15. Carolina Petroleum Co., Nita Carraway no. 1 well, 2 miles south of Merrimon, Carteret Co., N. C.; altitude 10 feet, estimated; depth 4,126 feet; electrical log.

16. Carolina Petroleum Co., Guy M. Carraway no. 1 well, at Merrimon, Carteret Co., N. C.; altitude 8 feet; depth 4,069 feet; electrical log.

17. Carolina Petroleum Co., H. B. Salter no. 1 well, 1¼ miles north of Merrimon, Carteret Co., N. C.; altitude 8 feet; depth 3,963 feet; electrical log.

18. Carolina Petroleum Co., Charles Bryan no 1 well; 1 mile east of Ellis Lake, Craven Co., N. C.; altitude 15 feet, estimated; depth 2,435 feet; electrical log.

19. Carolina Petroleum Co., N. C. Pulpwood no. 1 well; 1 mile southwest of Pamlico, Pamlico Co., N. C.; altitude 4 feet; total depth 3,666 feet; electrical log.

Correlation of Tertiary strata in North Carolina wells

[Correlations of the Carolina Petroleum Co. wells are based on electrical logs obtained from the Riley Blueprint Co., Jackson, Miss. All figures are depths in feet below surface]

	Top of Pleistocene	Top of Pliocene	Top of upper Miocene	Top of middle Miocene	Top of lower Miocene	Top of lower Miocene or Oligocene	Top of middle Eocene	Top of lower Eocene	Top of Paleocene (?)	Top of upper Cretaceous	Depth of well	Oldest rock penetrated
1. *Esso Standard Oil Company, Hatteras Light well no. 1, Dare County.	50±	120±	160±	720±	995	1,480	1,738	2,385	2,870±	3,033	10,054	Precambrian granite.
2. *Esso Standard Oil Company, North Carolina Esso well no. 2, Dare County.	------	------	130±	460?	800	1,265	1,425	1,735	2,036±	2,225	6,410	Lower Cretaceous.
3. *Naval Auxiliary Air Station well, Washington, North Carolina.	------	------	60±	------	------	------	90	175	------	------	215	Lower Eocene (?).
4. *Edenton Naval Air Base well no. 1, Chowan County.	------	------	30±	50±	------	------	------	------	------	------	55	Middle Miocene.
5. *Edenton Naval Air Base well no. 4, Chowan County.	------	------	45±	70±	------	------	------	------	------	------	88	Middle Miocene.
6. *Williamston test well no. 2, Martin County.	------	------	------	90±	------	------	------	------	------	------	220±	(?).
7. *Jacksonville Tent Camp well no. 2, Onslow County.	------	------	------	------	10	------	105	------	------	------	184	(?).
8. *Harvey Neck well, Perquimans County.	------	------	43?	46	------	------	------	------	------	------	77	Middle Miocene.
9. *Bogue well no. 65, Carteret County.	------	------	130?	------	------	------	------	------	------	------	260	Upper Miocene (?).
10. *Layne Housing Project well, Onslow County.	------	------	34±	63±	------	425?	------	------	------	------	427?	Oligocene (?).
11. *Cape Lookout well, Carteret County.	------	------	------	75±	------	------	385±	------	------	------	435	Middle Eocene (?).
12. *Great Lakes Drilling Co. well, Craven County.	------	------	55	60?	120?	165?	325	560±	685±	740	2,351	Precambrian granite.
13. *F. L. Karsten, Laughton no. 1, Carteret County.	------	------	------	------	336±	------	950	1,080	1,333	1,440	4,044	" "
14. Caroline Petroleum Company, Phillips-State of North Carolina no. 1, Carteret County.	------	------	------	------	------	------	740	912	1,152	1,278	3,964	" "
15. Carolina Petroleum Company, Nita Carraway no. 1, Carteret County.	------	------	------	------	------	------	927	1,065	1,255	1,402	4,126	" "
16. Carolina Petroleum Company, G. M. Carraway no. 1, Carteret County.	------	------	------	------	------	------	835	997	1,204	1,345	4,069	" "
17. Carolina Petroleum Company, H. B. Salter no. 1, Carteret County.	------	------	------	------	------	------	787	960	1,175	1,300	3,963	" "
18. Carolina Petroleum Company, C. Bryan no. 1, Craven County.	------	------	------	------	------	------	754	850?	930	1,010	2,435	" "
19. Carolina Petroleum Company, North Carolina Pulpwood no. 1, Pamlico County.	------	------	------	------	------	------	855	956	1,150	1,195	3,666	" "
20. Carolina Petroleum Company, Atlas Plywood no. 1, Pamlico County.	------	------	------	------	------	------	830	910	1,090	1,118	3,425	" "

* Ostracode specimens used in present study obtained from this well. Stratigraphic ranges of species are indicated in table on p. 12.

20. Carolina Petroleum Co., Atlas Plywood no. 1 well; 1½ miles northwest of preceding; altitude 8 feet; depth 3,425 feet; electrical log.

Mr. Mundorff supplied ostracodes from the following surface exposures:

*21. Natural Well, 1½ miles north of Magnolia, Duplin County, N. C.; Duplin marl; ostracodes; Edwards (1944) described several species from this locality.

*22. Railroad station pit at Pollacksville, Jones County, N. C.; Castle Hayne marl; ostracodes.

STRATIGRAPHIC SUMMARY

The first table (p. 4), lists the wells from which information was obtained, and when known, the Cenozoic subdivisions, the top of the Cretaceous, the total depth of the well and the oldest rock penetrated. The table on pages 12–14 summarizes the ranges of the ostracode species and their occurrence in the wells. The generalized stratigraphic relationships of the Cenozoic rocks in the Esso Standard Oil Company's Hatteras Light well no. 1, and the North Carolina Esso well no. 2 are shown in Figure 2.

PALEOCENE (?) SERIES

The strata here assigned tentatively to the Paleocene occur only in the deep wells bordering Pamlico Sound, and samples of the material were seen only from two wells, the Hatteras Light no. 1 and the North Carolina Esso no. 2 (Fig. 2). The Paleocene (?) is 277 feet thick in the North Carolina Esso no. 1 well at Cape Hatteras; it thins to 28 feet on the west side of Pamlico Sound in Carolina Petroleum Co.'s no. 1 Atlas Plywood well, and was not observed in the records of wells farther updip. Paleocene deposits have not been recognized at the surface in North Carolina or in neighboring States.

The assignment to the Paleocene (?) is based on the lithologic similarity to the Clayton formation of Georgia (Cooke, 1943, pp. 39–47) and not on paleontologic evidence. The sequence in the Hatteras Light well no. 1 and North Carolina Esso well no. 2 consists of fine-grained light gray, glauconitic, highly siliceous, sandy shale and marl below, and fine-grained sandstone above. Montmorillonite is the principal clay constituent of core samples from the unit according to Dr. S. S. Goldich (personal communication) who kindly examined the samples.

The underlying Upper Cretaceous rocks also are highly siliceous, but coarser-grained, with more coarse-grained glauconite, and contain a distinctive Later Cretaceous fauna.

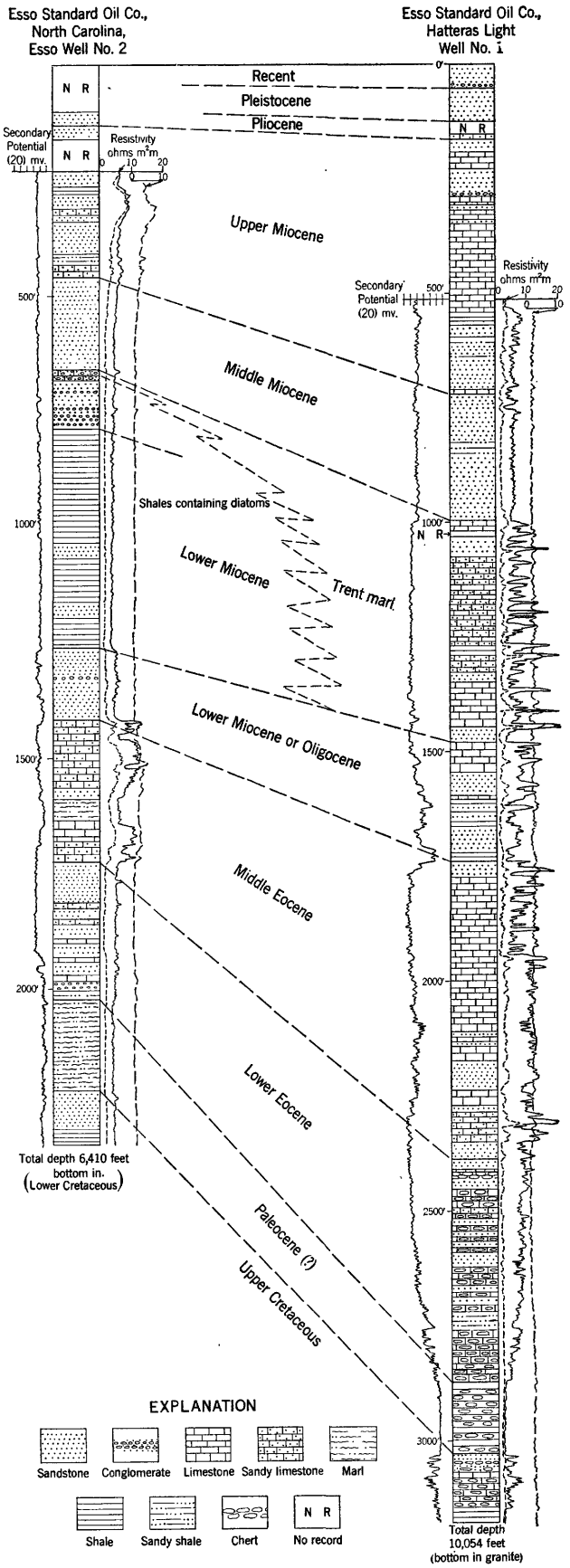

FIGURE 2.—Stratigraphic relationships of Cenozoic rocks in Esso Standard Oil Company Hatteras Light well no. 1 and North Carolina Esso well no. 2, eastern Dare County, N. C.

Brachycythere cf. *B. hadleyi* Stephenson is the only species of ostracode obtained from the Paleocene (?), and the specimens may have fallen from higher levels. Other fossils are scarce; there are tiny *Globigerina* and calcareous, benthonic Foraminifera in core samples from the unit. A radiolarian and a possible diatom were seen in thin section.

Rocks assigned to the Paleocene (?) in the Hatteras Light well no. 1, and the North Carolina Esso well no. 2 are described on pages 11 and 12.

EOCENE SERIES

LOWER EOCENE

The lower Eocene is 485 feet thick in the Hatteras Light well no. 1, 301 feet thick in the North Carolina Esso well no. 2, and 80 to 253 feet thick in the deep wells on the west side of Pamlico Sound.

The lower part of the subsurface Eocene at Cape Hatteras and southwestward to Carteret County consists of fine-grained glauconitic sandstone and sandy limestone in which many of the layers are highly silicified. Beds of glauconitic, light-gray, translucent chert occur at several levels. In the North Carolina Esso no. 2 well, 32 miles north of Cape Hatteras, only the lower beds of the equivalent unit are highly silicified; the remainder consists of brownish-gray, argillaceous, fine and medium grained sandstones and fossiliferous limestones. Coarse grained conglomeratic sandstone with pebbles of amethyst and other varieties of quartz occurs at the base of the unit in the North Carolina Esso well no. 2.

The lower Eocene of this paper perhaps is a correlative of the Black Mingo formation of South Carolina and of the Aquia formation of Maryland, Delaware, and Virginia both of Wilcox age, but from Cape Hatteras southwestward, in the wells studied here, lithologically it resembles the McBean formation of South Carolina which is of Claiborne age.

Most of the ostracode species, however, provide a correlation with the Wilcox group of the Gulf region or with the Aquia formation of the middle Atlantic states (Howe and Garrett, 1934, Schmidt, 1948). *Trachyleberis davidwhitei* and *Brachycythere hadleyi* have heretofore been reported only from the Claiborne group (Stephenson, 1946, pp. 333, 336, 340, and Howe and Chambers, 1935).

The ostracodes of the Black Mingo formation are unknown to the writer. Detailed descriptions of the lower Eocene in the Hatteras Light well no. 1, and the North Carilina Esso well no. 2, are given on pages 11 and 12.

MIDDLE EOCENE (AND UPPER EOCENE (?))

The coarse, porous, fossiliferous, sandy, glauconitic limestones and calcareous sandstones that overlie the lower Eocene in the subsurface of eastern North Carolina contain many species of ostracodes that are characteristic of the Claiborne group.

The unit is 647 feet thick in the Hatteras Light well no. 1 at Cape Hatteras; it thins to 80 feet on the west side of Pamlico Sound in North Carolina Petroleum Co. no. 1 Atlas Plywood well.

The middle Eocene of this paper probably represents the beds that were recorded by Mundorff (1944) as Castle Hayne marl in various water wells in eastern North Carolina. The Castle Hayne of surface exposures is basal upper Eocene and is correlated with the Ocala limestone of Florida (Kellum, 1926). The strong Claiborne aspect of the ostracodes in the subsurface unit and the lack of knowledge of ostracodes in the surface exposures, prevent a correlation with the surface Castle Hayne but suggest correlation with the McBean formation of Georgia and South Carolina. Martin (1939) described species of *Cytheropteron* from the McBean that occur in the Claiborne group of the central Gulf region. A sample from the so-called McBean at Orangeburg, S. C. yielded a few specimens of *Haplocytheridea montgomeryensis* (Howe and Chambers). This species ranges from the middle Eocene (Claiborne) to Oligocene (Vicksburg) in the Gulf region, but has not been found in lower Eocene rocks. The only ostracodes from surface exposures of the Castle Hayne in the writer's possession are specimens of *Leguminocythereis scarabaeus* Howe and Law, obtained by Mr. Mundorff from Pollacksville, N. C. This species has been recorded previously only from the Vicksburg group, Oligocene of Louisiana (Howe and Law, 1936, p. 64).

The author found no ostracode faunas of late Eocene age in the samples from eastern North Carolina wells. Available evidence indicates that the middle and upper Eocene are not distinguishable on the basis of the ostracode faunas, at least in this area.

No definite conclusions concerning the stratigraphic relationships of the various subsurface early and middle Tertiary ostracodes are possible until the faunas of surface rocks are better known.

OLIGOCENE OR LOWER PART OF MIOCENE SERIES

Overlying the middle (or upper?) Eocene in the Hatteras Light well no. 1, and the North Carolina Esso well no. 2 is a sequence of sandstone, glauconitic shale, and porous sandy limestone, of undetermined but apparently postmiddle Eocene age. The unit is 258 feet

thick in the Hatteras light well no. 1 and 160 feet thick in the North Carolina Esso well no. 2. It has not been definitely identified in the other wells studied.

An Oligocene age for part or all of the unit is indicated by the presence of *Cytheretta howei* Swain (1946, p. 380), a species that occurs in the subsurface Oligocene of Florida.[2] *Haplocytheridea israelskyi* Stephenson, to which one of the species is related, occurs in the subsurface middle Tertiary of Texas (Stephenson, 1944a, pp. 156–161) in beds which are possibly of Oligocene age, but ranges into the Miocene judging from an occurrence in the subsurface of Maryland (Swain, 1948, p. 210). The other species indicate a Miocene age for the containing strata.

MIOCENE SERIES

Lower part.—Strata tentatively identified as lower Miocene are present in the wells at Cape Hatteras and southwest. They are porous, sandy, nonglauconitic limestone and cleanly washed, water-polished sand up to 485 feet thick. On the basis of lithology, this unit is believed to represent the Trent marl as exposed at the surface in North Carolina.[3] North of Cape Hatteras a facies change takes place and in the North Carolina Esso well no. 2 what is apparently the same stratigraphic interval is occupied by soft, light-gray, sandy shale, 465 feet thick, which contains diatoms. The shale has not been identified in the surface exposures but is here considered to be at least partly equivalent in age to the Trent. Lithologically similar deposits occur in the Calvert formation of middle Miocene age, in the middle Atlantic states, and may in part be of the same age as the shales under discussion.

Middle part.—The fine grained, argillaceous, fossiliferous sands and sandy clays that overlie the Trent marl in the Hatteras Light well no. 1 are here placed in the middle part of the Miocene. The ostracode *Trachyleberis evax* (Ulrich and Bassler) does not range into the overlying strata in this well, and in other parts of the region has not been found in the upper Miocene. In Maryland it occurs in the Calvert formation of middle Miocene age. In the Hatteras Light well no. 1 the unit is 250 feet thick; in the Esso no. 2 well it is 340 feet thick, contains abundant shell fragments, and its sands are coarser grained than in the Hatteras Light well no. 1. The St. Marys formation of surface exposures in North Carolina probably is equivalent to the subsurface middle Miocene of this paper, but the exact correlation is uncertain.

Upper part.—The upper Miocene in the Hatteras Light well no. 1, and the North Carolina Esso well no. 2 consists of poorly cemented sand and shell beds. The upper part of the unit consists of shell beds and probably represents a thick deposit of the Duplin marl. The upper Miocene of the wells is probably the equivalent of the Yorktown formation as exposed at the surface in the North Carolina coastal plain. In the Hatteras Light well no. 1 the unit is 560 feet thick,[4] and in the no. 2 well, 230 feet thick. Upper Miocene mollusks from beds at depths of 160 to 640 feet in the no. 1 well were identified by Julia Gardner.

PLIOCENE SERIES

Only Hatteras Light no. 1 well furnishes information on the subsurface Pliocene. The mollusks occurring at depths of 120 to 160 feet suggest a Pliocene age, according to Gardner (1948). The drill cuttings from this unit are mostly casing cement but at depths of 130 to 140 feet loose sand and abundant mollusk fragments were obtained, but no ostracodes.

PLEISTOCENE SERIES

Miss Gardner suggested (1948) that the beds 40 to 120 feet below the surface in the Hatteras Light well no. 1 may be of Pleistocene age. The deposits are fine- to coarse-grained, unconsolidated sand, contain shell fragments, and are conglomeratic in the lower 40 feet. Pleistocene deposits were not recognized in the other wells.

Nearly all of the ostracodes from 60 to 110 feet depth in the Hatteras Light well no. 1 are of species previously found only in the Miocene, and may represent reworked specimens.

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[2] C. W. Cooke questions assignment of the unit to the Oligocene, because (written communication, August 8, 1949) "No Oligocene deposits are known at the surface east of the valley of Savannah River." F. S. MacNeil (written communication, February 17, 1950) agrees as to the possibility that the Oligocene is represented by sedimentary deposits in the subsurface of eastern North Carolina. Both Cooke and MacNeil suggest that the unit in question may be equivalent to the Trent marl of early Miocene age.

[3] C. W. Cooke (written communication, August 8, 1949) states: "I suspect that the upper part of this interval is middle Miocene, equivalent to part of the Chesapeake group of Maryland. No lower Miocene affinities are suggested by the fauna, but the presence of pebbles between 1,120 and 1,180 feet in the Hatteras Light no. 1 suggests the base of a formation. Perhaps the Trent (lower Miocene) extends only up to 1,180 feet." The coarse deposits indicate a local change in sedimentologic conditions but no widespread or important environmental change. The pebbly unit cannot be distinguished from the adjacent units by electrical characteristics (see fig. 2), and it would be difficult to justify placing a stratigraphic boundary at 1,180 feet.

[4] C. W. Cooke (written communication, August 8, 1949), believes that the base of the upper Miocene in the Hatteras Light well, no. 1 is at 290 feet because there is a gravel bed above that horizon and because he feels that the molluscan evidence suggesting late Miocene age below that level is "very inconclusive." Julia Gardner (written communication, March 26, 1948) identified *Mulinia congesta* Conrad from a depth of 570–580 feet in the Hatteras Light well no. 1 and stated that it "is highly characteristic of a certain zone in the upper Miocene of Virginia and North Carolina."

RECENT SERIES

Forty to 50 feet of fine- to coarse-grained, unconsolidated sand at the top of the section in the Hatteras Light well no. 1 is of Recent age, according to Miss Gardner. No ostracodes were found in samples from this unit.

MOLLUSKS FROM THE ESSO STANDARD OIL CO. HATTERAS LIGHT WELL NO. 1

Julia A. Gardner kindly identified macrofossils from depths of 18 to 1,100 feet in the Hatteras Light well no. 1 near Cape Hatteras, N. C. Her report concerning the age relationships of the fauna follows.

"No fauna older than the upper Miocene is clearly recorded in the cuttings from Hatteras Light well no. 1.

"The uppermost 40′ yielded only a few fragments of echinoids and broken shells, for the most part *Mulinia*. Those upper sands may be Recent, Pleistocene, or even, though not probably, Pliocene. A slight change in the fauna at about 120′ is indicated by a greater diversity rather than by the appearance in the fauna of any Pliocene zone markers. It is possible that the upper 120′ may be Quaternary, and those from 120′ to 160′ may be referable to the Pliocene. The cuttings from 160′ to 170′ contain a more diversified fauna than any of those higher in the well, and among the species is *Crassinella* sp. cf. *C. dupliniana* Dall, a form not established in beds younger than the Miocene. The faunas between 160′ and 250′ are the richest in the section. They are closely allied to those from the Duplin surface outcrops, though they show no marked resemblance to those from the Havelock well. Below 250′ the faunas are rather meager, but no new significant forms appear. Limestone molds of small but undeterminate shells were recovered from 350′ to 360′, but *Astarte* (*Ashtarotha*) *concentrica* Conrad, present throughout the Miocene and Pliocene of Virginia and North Carolina though most abundant in the Yorktown, is unmistakably present and probably in place at 630′ to 640′. Below this depth nothing is found on which an age determination can be based."

STRATIGRAPHY OF WATER WELLS IN EASTERN NORTH CAROLINA

An unpublished report by Joseph A. Cushman, dated April 24, 1946, here summarized, provided the following information:

1. Edenton Naval Air Base well no. 1, Chowan County, N. C., 22–25 feet, Miocene.
2. Edenton Naval Air Base well no. 4, Chowan County, N. C., 40–88 feet, Miocene.
3. Williamson test well no. 2, Martin County, N. C., 88–95 feet, Miocene.
4. W. H. A. well no. 2, Wilmington, New Hanover County, N. C., 132–157 feet, specimens of Foraminifera few and poorly preserved, probably Miocene(?).
5. Bogue well no. 65, Carteret County, N. C., 30–230 feet, Miocene. 230–245 feet, very few specimens of Foraminifera, Eocene(?).
6. Layne Housing Project well, Jacksonville, Onslow County, N. C., 53–132 feet, specimens of Foraminifera few and poorly preserved, presumably Miocene.
7. Jacksonville Tent Camp well no. 2, Onslow County, N. C.
   - 10–20 feet, indeterminate.
   - 105–110 feet, Eocene(?).
   - 110–120 feet, indeterminate.
   - 120–130 feet, Eocene.
8. Winton well, Hartford County, N. C., 116–148 feet, probably Miocene. 160–162 feet, few but distinctive Foraminifera; probably Eocene, but not like the Eocene of the other wells.
9. Harvey Neck well, Perquimans County, N. C., 43–74 feet, probably Miocene.
10. Cape Lookout well, Carteret County, N. C.,
    - 75–101 feet, Miocene.
    - 101–125 feet, indeterminable.
    - 203–235 feet, apparently Eocene, Jackson group.
    - 408–415 feet, Eocene, Claiborne (?) group.
11. Naval Auxiliary Air Station well, Washington, Beaufort County, N. C.
    - 60–75 feet, Miocene.
    - 90 feet, Eocene: *Asterigerina* sp. *Textularia dibollensis*, *Cancris cubensis*.
    - 120 feet, Eocene.
    - 125 feet, Eocene, very few specimens of Foraminifera.
    - 130–165 feet, Eocene, some species similar to species of McBean or Lisbon age.
    - 190 feet, indeterminable.
    - 195 feet, a few species of Foraminifera present, related to Paleocene Midway group.

CENOZOIC ROCKS IN ESSO STANDARD OIL CO. HATTERAS LIGHT WELL NO. 1

Lithology	Depth (feet)	Thickness (feet)
Recent		
No record of cuttings	0–18	18
Sand, fine- to very coarse-grained, angular to sub-rounded, containing abundant shell fragments, conglomeratic in lower part	50	32
Pleistocene		
Sand, white, fine-grained at top, coarse and conglomeratic below, angular to subrounded, very fossiliferous, and with several shell beds in lower part	120	88

Lithology	Depth (feet)	Thickness (feet)
Pliocene		
No record of cuttings, a few mollusks of Pliocene age according to Miss Gardner	150	30
Shell bed, sandy, with abundant mollusks	160	10
Upper Miocene		
Sand, fine- to coarse-grained, angular to rounded, with abundant mollusks	185	25
Shell bed, and sand, containing mollusks and Foraminifera	225	40
Sand, fine- to coarse-grained, argillaceous in middle part, conglomeratic with ferruginous, varicolored quartz, sandstone, and quartzite pebbles in lower 30 feet; abundant Foraminifera, mollusks, and ostracodes [5]	290	65
Coquinoid limestone, white and light-gray, very porous, partly sandy, more consolidated than shell beds above, containing drusy cavities; fauna mostly mollusks	310	20
Sand, very fine- to medium-grained, angular to subrounded, cleanly washed, water polished	320	10
Foraminiferal coquina, white and light brown, partly argillaceous and sandy, porous	340	20
Sand, fine- to medium-grained, angular to subrounded, water polished	350	10
Coquinoid limestone, white and light-gray, partly sandy and argillaceous, with abundant mollusks, Foraminifera and echinoid fragments. Core 346–356 feet, recovered 4 inches of light-gray, very porous, sandy, coquinoid limestone. Core 480–490 feet, recovered 5 feet of light-gray to white, argillaceous, marly, fine- to coarse-grained sandstone; sp. gr. ranges from 1.86 to 2.03.[6] Core 540–550 feet, recovered 10 feet of light-gray and white, sandy marl and chalk; sp. gr. ranges from 1.81 to 1.88	555	205
Clay, light-gray and brown, with abundant Foraminifera	575	20
Sand, fine- to coarse-grained, partly argillaceous; contains mollusks, abundant Foraminifera and ostracodes. Core 600–610 feet, recovered 20 inches of light-gray, fine- to medium coarse-grained, very argillaceous, calcareous sand; sp. gr. 1.95. Core 650–660 feet, recovered 4 feet of gray, fine- to medium-grained, fairly porous, soft, argillaceous sand, with abundant disseminated pyrite; sp. gr. ranges from 1.74 to 1.79. Core 700–710 feet, recovered 20 inches of light-gray, fine- to medium coarse-grained, porous, argillaceous, silty, slightly glauconitic sand with dark chert or quartz grains; sp. gr. 1.70	710	135
Limestone, white and light-gray, coarsely crystalline, porous, argillaceous, containing abundant Foraminifera	720	10
Middle Miocene		
Sand, fine- to coarse-grained, calcareous, partly argillaceous, slightly glauconitic in upper part, containing abundant Foraminifera; *Trachyleberis evax* (Ulrich and Bassler) 730–740 feet	745	25
Sand, fine- to medium coarse-grained, very argillaceous, containing abundant *Globigerina*. Core 760–770 feet, recovered 3 feet 4 inches of light-gray, fine- to medium-grained, argillaceous, calcareous sand with abundant *Globigerina;* sp. gr. ranges from 1.82 to 1.86. Core 810–820 feet, recovered 6 feet of light-gray, soft, sandy marl and calcareous sand, with abundant *Globigerina;* sp. gr. range from 1.42 to 1.53	820	75
Clay, light gray-brown, slightly sandy, abundant *Globigerina*	850	30
Sand, very fine- to coarse-grained, scattered glauconite in middle part, more abundant glauconite in lower part. Core 880–890 feet, recovered 3 feet of light-gray, fine-grained, calcareous, fairly porous sand with abundant *Globigerina;* sp. gr. 1.66. Core 940–950 feet, recovered 10 feet of light-gray, firm, calcareous, porous sandstone with abundant *Globigerina;* sp. gr. ranges from 1.61 to 1.63	995	145
Lower Miocene		
Limestone, white, chalky to coarsely crystalline, porous, fossiliferous. Core 1,010–1,020 feet recovered 12 inches of light-gray and white chalky limestone and marl, containing abundant broken, recrystallized shell fragments and Foraminifera; sp. gr. 2.06	1,030	35
Sand, coarse-grained, rounded, water polished	1,070	40
Limestone, white, porous, partly recrystallized, with intercalated sand and claybeds, bryozoans	1,100	30
Sand, very fine- to coarse-grained, water polished, containing Foraminifera	1,120	20
Limestone, white and light-gray, finely to coarsely crystalline, in part coarsely sandy, fossiliferous; containing fragments of gray and brown chert and metamorphic rock; much of limestone presents a detrital appearance; *Globigerina* abundant at several horizons	1,180	60
Sand, fine- to coarse-grained, water polished	1,200	20
Limestone, light-gray and white, porous, recrystallized, possibly detrital, partly sandy, fossiliferous, with an abundance of flat shell fragments in lower part	1,270	70
Clay, light gray, sandy, containing abundant Foraminifera	1,290	20
Limestone, white and light-gray, porous, in large part detrital, partly sandy, fossiliferous, containing brown phosphatic pellets at top	1,330	40

[5] See footnote, p. 12.

[6] Specific gravity determinations of core samples were provided by the Esso Standard Oil Co.

Lithology	Depth (feet)	Thickness (feet)
Lower Miocene—Continued		
Sand, coarse-grained, clear, water-polished	1,350	20
Limestone, white and light-gray, coarsely crystalline, partly detrital, porous, sandy. Core 1,407–1,412 feet, recovered 10 inches of white sandy chalk, quartz grains well rounded	1,450	100
Sand, fine- to coarse-grained, water-polished, containing smoky, rose, and amethystine quartz, chert, and rock fragments. Core 1,465–1,475 feet, coarsely sandy white chalk, sp. gr. 2.28	1,480	30
Lower Miocene or Oligocene (possibly including upper Eocene equivalents in lower part)		
Limestone, white, and light-brown, porous, sandy, partly detrital. Core 1,525–1,535 feet, recovered 33 inches of white coarsely sandy chalk, quartz grains well rounded; sp. gr. 2.24	1,550	70
Sand, coarse-grained, angular to subrounded. Core 1,587–1,597 feet, recovered 26 inches of light-gray, fine- to coarse-grained, subrounded, calcareous, argillaceous, fairly porous, very glauconitic sand, partly speckled with spots of limonite; sp. gr. 2.10	1,600	50
Limestone, white, porous, recrystallized, abundantly fossiliferous	1,610	10
Clay, buff, sandy, glauconitic, with interbeds of coarse-grained glauconitic sand, and sandy limestone. Core 1,650–1,660 feet, recovered 40 inches; top 20 inches very light-gray, sandy, glauconitic marl with brown phosphatic pellets; bottom 20 inches fine- to coarse-grained angular to subrounded, calcareous, fairly porous greensand; sp. gr. 2.09. Core 1,680–1,690 feet, recovered 3 feet of green, very sandy glauconitic clay and argillaceous sandstone; sp. gr. 2.11	1,738	128
Middle Eocene (possibly including upper Eocene equivalents in upper part):		
Sandstone, fine-grained above, coarser below, angular, porous, calcareous, glauconitic, fossiliferous. Core 1,740–1,750 feet recovered 10 feet of very light-gray, firm, finely sandy siltstone; sp. gr. ranges from 2.05 to 2.14	1,780	42
Limestone, white and light-gray, sandy, porous, recrystallized, glauconitic, fossiliferous at several horizons. Core 1,800–1,810 feet, recovered 2 feet of white, porous, chalky, very fossiliferous, glauconitic limestone; sp. gr. 1.91. Core 1,860–1,870, recovered 4 inches of white, porous, sandy, coquinoid limestone. Core 1,920–1,930 feet, recovered 6 inches of white, soft, very sandy slightly porous chalk. Core 1,983–1,993 feet, recovered 14 inches of white, soft, very sandy chalk having low porosity; sp. gr. 2.20. Core 2,043–2,053 feet, recovered 6 inches of white, soft, sandy chalk, low porosity. Core 2,083–2,093 feet, recovered 3 feet of white, soft, slightly sandy chalk, low porosity; sp. gr. 1.91	2,120	340
Middle Eocene—Continued		
Sandstone, light-gray and white, fine-grained, argillaceous, and interbedded white, sandy, chalky limestone. Core 2,135–2,145 feet, recovered 6 feet of white, soft, sandy, glauconitic chalk; sp. gr. ranges from 1.92 to 2.04	2,150	30
Limestone, light gray and white, sandy	2,180	30
Sandstone, fine- to coarse-grained, calcareous and glauconitic in lower part. Core 2,196–2,206 feet, recovered 2 feet of light greenish-gray, porous, fine-grained, subangular, fossiliferous, glauconitic sandstone; sp. gr. 2.30	2,230	50
Limestone, white, coarsely crystalline, porous, sandy, fossiliferous, glauconitic; and interbedded sandstone. Core 2,257–2,267 feet, recovered 26 inches of light greenish-gray, fine-grained, calcareous, fossiliferous, glauconitic sandstone; sp. gr. 1.91. Core 2,309–2,319 feet, recovered 8 feet of white and greenish-gray, fine- to medium-grained, subangular to subrounded, fairly porous, very glauconitic, fossiliferous sandstone; sp. gr. ranges from 1.95 to 2.01	2,385	155
Lower Eocene		
Sandstone, fine- to coarse-grained, argillaceous, and interbedded light brown, argillaceous, sandy, fossiliferous limestone, containing phosphatic pellets, and nodules of gray chert. Core 2,380–2,390 feet, light-gray, fine- to medium-grained, subangular to subrounded, porous, glauconitic, silty, fossiliferous sandstone; sp. gr. 2.21. Core 2,441–2,451 feet, recovered 3 feet of very light-gray, very fine- to medium-grained, angular, silty, glauconitic sandstone with laminae of glauconitic chert; sp. gr. 1.84	2,460	75
Limestone, white, dense, sandy, glauconitic and interbedded white, sandy glauconitic chert. Core 2,460–2,470 feet, recovered 2 feet of white, siliceous, calcareous, slightly porous, glauconitic sandstone, and glauconitic chert; sp. gr. 1.96	2,500	40
Sandstone, white, fine-grained, calcareous, glauconitic, and interbedded glauconitic, sandy chert. Core 2,531–2,541 feet, recovered 5 feet of light greenish-gray, soft, very fine- to fine-grained, angular, micaceous, glauconitic, calcareous, soft, slightly porous sandstone; sp. gr. ranges from 1.73 to 1.74	2,560	60
Limestone, white, dense, sandy, glauconitic, interbedded with white glauconitic chert and fine-grained sandstone. Core 2,593–2,603 feet, recovered 18 inches of light-gray, very fine- to fine-grained, angular, micaceous, glauconitic, calcareous, soft, slightly porous sandstone; sp. gr. 1.67	2,610	50
Sandstone, white, fine-grained, calcareous, glauconitic, slightly argillaceous, and interbedded with white glauconitic chert	2,630	20

Lithology	Depth (feet)	Thickness (feet)
Lower Eocene—Continued		
Limestone, white, glauconitic, sandy, chalky, and interbedded white glauconitic chert. Core 2,653–2,663 feet, recovered 3 feet 6 inches of light gray, very fine- to fine-grained, angular, calcareous, glauconitic, micaceous, siliceous sandstone; sp. gr. 2.14	2,670	40
Sandstone, chert, and limestone, interbedded, white and light-gray, glauconitic. Core 2,714–2,724 feet, recovered 10 feet of light-gray, sandy, glauconitic, micaceous, slightly calcareous, highly siliceous shale; sp. gr. ranges from 1.76 to 1.91	2,730	60
Sandstone, light-gray and white, argillaceous, glauconitic, fairly porous	2,755	25
Limestone, white, partly chalky-textured, finely glauconitic, sandy, interbedded with light-gray and white, very siliceous, glauconitic shale and chert; lower part more shaly and apparently gradational with underlying unit. Core 2,775–2,785 feet, recovered 7 feet 8 inches of light-gray, compact finely glauconitic, micaceous, irregularly laminated, slightly calcareous, highly siliceous shale; sp. gr. ranges from 1.83 to 1.88. Core 2,835–2,845 feet, recovered 10 feet of white, slightly porous, slightly calcareous, finely sandy, glauconitic chert containing impressions of small pteropod? shells; sp. gr. ranges from 1.79 to 1.82	2,870	115
Paleocene(?)		
Shale, light-gray and white, highly siliceous, finely glauconitic, slightly calcareous. Core 2,897–2,907 feet, recovered 8 feet of very light-gray, compact, very finely glauconitic, micaceous, siliceous shale; sp. gr. ranges from 1.89 to 1.96. Core 2,950–2,960 feet, recovered 9 feet 6 inches of white, compact, slightly calcareous, finely glauconitic, micaceous, highly siliceous shale; sp. gr. ranges from 1.93 to 2.30	3,033	160
Upper Cretaceous (uppermost beds)		
Sandstone, white, fine-grained, slightly porous, in part indurated by siliceous cement, more coarsely glauconitic than overlying Paleocene?; interbeds of sandy, partly calcareous, siliceous shale and chert. Core 3,060–3,070 feet, recovered 30 inches of white, slightly calcareous, finely glauconitic, highly siliceous shale	3,080	47
Bottom of well in pre-cambrian granite	10,054	

TERTIARY ROCKS IN ESSO STANDARD OIL CO. NORTH CAROLINA ESSO WELL NO. 2

Lithology	Depth (feet)	Thickness (feet)
No record of drill-cuttings	0–100	100
Pliocene(?)		
Sand, fine- to coarse-grained, unconsolidated, argillaceous, slightly glauconitic; few Foraminifera	160	60
No record of drill-cuttings	230	70
Upper Miocene		
Sand, fine- to coarse-grained, unconsolidated, angular to subrounded, partly argillaceous and yellowish-brown, trace of glauconite in lower part; abundant mollusk shells throughout, Foraminifera in lower part	256	26
Clay, light-gray, soft; containing Foraminifera	280	24
Sand, fine- to coarse-grained, conglomeratic, clean, water-polished and glauconitic in lower part; abundant Foraminifera, mollusk shells and ostracodes [7]	310	30
Sand and molluscan shell beds, shells more chalky in texture (perhaps an effect of diagenesis) in lower part, abundant Foraminifera throughout	410	100
Shale, light-gray, very sandy, glauconitic, and fine- to medium-grained, soft, argillaceous sand; large thick-shelled mollusks in lower part	430	20
Limestone coquina, light-gray, partly sandy, very porous, largely composed of recrystallized fragments of mollusks	460	30
Middle Miocene		
Sand and shell beds, coarse grains of quartz, large mollusk fragments	490	30
Sand, fine- to medium-grained, partly well rounded and water-polished; fragmentary mollusk shells very abundant at several levels, large Foraminifera 540–550 feet	660	170
Gravel bed, quartz pebbles, containing mollusk shells	700	40
Limestone, light-brown, finely crystalline, sandy	720	20
Gravel beds and sand; well-rounded quartz pebbles; large, thick mollusk fragments, shark tooth	800	80
Lower Miocene?		
Shale, light-gray and brown, finely sandy, and interbedded fine- to coarse-grained, unconsolidated sands, diatoms at many levels, Foraminifera numerous below 1,070 feet	1,265	465
Oligocene or Lower Miocene (possibly including upper Eocene equivalents in lower part)		
Sand, fine- to coarse-grained, unconsolidated, subangular to subrounded; containing abundant brown phosphatic nodules and fish bones from 1,265–1,310 feet; a conglomeratic layer partly cemented by brown carbonate from 1,320–1,330 feet; abundant fine- to coarse-grained, dark-green glauconite from 1,350–1,380 feet; a few mollusks in lower part	1,380	115
Shale, soft, brown; and interbedded sand	1,425	45
Middle Eocene (possibly including upper Eocene beds in upper part)		
Limestone, white, porous, glauconitic, sandy; sand fine- to coarse-grained, rounded; mollusks, bryozoans, ostracodes, Foraminifera	1,580	155

[7] C. W. Cooke (written communication August 8, 1949) believes that the base of the Duplin marl may be at 310 feet.

Lithology	Depth (feet)	Thickness (feet)
Middle Eocene—Continued		
Sand, coarse-grained, unconsolidated, angular to subrounded	1,600	20
Marl, light-gray, soft, partly sandy, fossiliferous	1,625	25
Sand, fine-grained, cleanly washed, water-polished, subrounded, glauconitic	1,650	25
Limestone, white, fairly porous, chalky, and finely to coarsely crystalline, sandy, glauconitic; middle and lower parts contain very coarse sand grains	1,735	85
Lower Eocene		
Sandstone, fine- to coarse-grained, glauconitic and white, sandy, porous limestone	1,930	195
Sandstone, fine-grained, argillaceous, glauconitic, containing layers with siliceous cement below 1,940 feet	1,955	25
Limesone, light-tan, finely crystalline to chalky, glauconitic, partly siliceous	1,965	10
Conglomerate, slightly ferruginous, rounded quartz grains, some amethystine quartz	2,036	71
Paleocene(?)		
Shale, light-gray to white, siliceous, finely glauconitic, with layers of glauconitic chert; calcareous in upper and lower portions	2,225	189
Upper Cretaceous (uppermost beds)		
Sandstone, greenish-gray, coarse-grained, very argillaceous, coarsely glauconitic, sideritic	2,250	25
Bottom of well in Lower Cretaceous	6,410	----

Stratigraphic ranges of ostracode species from wells in North Carolina, and previously reported occurrences

[In this table the figures indicate the occurrence of the species in localities listed on p. 3 and × the occurrence of the species elsewhere. For example, *Prachycythere* cf. *B. hadleyi* is recorded from the Paleocene, Lower and Middle Eocene in well 2, and from the Middle Eocene in well 1]

	Paleocene	Eocene			Oligocene	Miocene			Pliocene	Pleistocene	Recent
		Lower	Middle	Upper		Lower	Middle	Upper			
Acuticythereis cf. *A. laevissima* Edwards							8			1	
laevissima punctata Edwards								9, ×			
cf. *A. multipunctata* Edwards								1, ×			
Bairdia sp			1								
cf. *B. laevicula* Edwards							5	×			
cf. *B. fortificata* Brady								4			×
Bairdoppilata cf. *B. delicatula* Jennings		1, ×	2								
Basslerites cf. *B. miocenicus* (Howe)							6, ×	×			
cf. *B. giganticus* Edwards								1, ×			
Brachycythere marylandica (Ulrich)		3, ×									
cf. *B. jessupensis* Howe and Garrett		×	3								
cf. *B. hadleyi* Stephenson	2	2	1, 2, ×								
cf. *B. martini* Murray and Hussey			2, ×	×							
sp								1			
Buntonia howei (Stephenson)			3, ×								
? *mcguirti* (Howe)			1		×				×		
? cf. *B.? lacunosa* (Jones)			3								×
? cf. *B.? garretti* (Howe and McGuirt)							1	2, ×			
? *planibasilis* (Ulrich and Bassler)							×	2			
Bythocypris cf. *B. parilis* Ulrich		13, ×									
? *wicomicoensis* Swain			1				×				
Caudites jacksonvillensis Swain, n. sp			7								
Clithrocytheridea sp		1									
cf. *C. broussardi* Howe and Garrett		×	3								
virginica Schmidt		×	3								
cf. *C. smithvillensis* Stephenson			2, ×								
cf. *C. caldwellensis* (Howe and Chambers).			1, ×	×							
Cytherella cf. *C. marlboroensis* Ulrich		13, ×									
sp			2								
cf. *C. hannai* Howe and Lea					×	1					
sp							1	1			
Cytherelloidea howei Swain		3, ×									
sp			1								
Cytheretta darensis Swain, n. sp			1								
cf. *C. alexanderi* Howe and Chambers			2, 3	×							
porcella (Ulrich and Bassler)						1	×				
karlana Howe and Pyeatt						×	8, ×	×			
cf. *C. bassleri* Howe							×	1			
inaequivalvis (Ulrich and Bassler)							×	1, 9			
cf. *C. plebeia* (Ulrich and Bassler)							×			1	
? sp. aff. *C. plebeia* (Ulrich and Bassler)								3			
Cytheridea sp			1								
? sp							1				

Stratigraphic ranges of ostracode species from wells in North Carolina, and previously reported occurrences—Continued

	Paleocene	Eocene			Oligocene	Miocene			Pliocene	Pleistocene	Recent
		Lower	Middle	Upper		Lower	Middle	Upper			
Cytherideis ashermani Ulrich and Bassler						1	11, ×	1		1	
longula Ulrich and Bassler							×	1			
rugipustulosa Edwards							1	2, ×		1	
Cytheromorpha cf. *C. eocenica* Stephenson			3, ×								
? sp			3								
warneri Howe and Spurgeon						×	×	3, ×			
curta Edwards								3, ×			
Cytheropteron cf. *C. variosum* Martin			3, ×								
cf. *C. subreticulatum* van den Bold						×	×	3, ×			
sp. (b)						1					
sp. (a)								1			
Cytherura sp. aff. *C. washburni* Stephenson			3, ×								
wardensis Howe and Brown							5, 11, ×	1			
elongata Edwards								1, 4, ×			
forulata Edwards								×		1	
reticulata Edwards								1, ×			
Eocytheropteron ? sp								2			
Eucythere cf. *E. chickasawhayensis* Howe					×			1			
sp								1			
Favella mesacostalis Edwards								1, ×			
Haplocytheridea? cf. *H.*? *hopkinsi* (Howe and Garrett)		1, ×									
cf. *H. veatchi* (Howe and Garrett)		×	1, ×								
cf. *H. wallacei* (Howe and Garrett)		2, ×	1, ×								
cf. *H. goochi* Stephenson			1, ×								
sp. aff. *H. hammondensis* (Swain)			3								
cf. *H. nowotnyi* Stephenson			1; 3, ×								
montgomeryensis (Howe and Chambers)		2, ×	1, 2, 3, ×	×							
sp. aff. *H. israelskyi* Stephenson					1, ×			3			
cf. *H. subovata* (Ulrich and Bassler)					1		×	9			
Hemicythere conradi Howe and McGuirt						1	5	1, 2, ×			
confragosa Edwards								3, ×			
sp. aff. *H. conradi* Howe and McGuirt										1	
Leguminocythereis scarabaeus Howe and Law				×	×						
whitei Swain, n. sp					2		5	2		1	
clarkana (Ulrich and Bassler)						13	1, ×	9			
Loxoconcha cf. *L. creolensis* Howe and Chambers		×	3	×							
sp. aff. *L. claibornensis* Murray			3, ×								
cf. *L. mcbeanensis* Murray			3, ×								
cf. *L. surreala* Murray			3, ×								
subrhomboidea Edwards						1	5	1, 3, ×			
cf. *L. reticularis* Edwards								1, ×			
edentonensis Swain, n. sp								1			
Monoceratina cf. *harrisi* Stephenson			3, ×								
Paracypris cf *P. franquesi* Howe and Chambers		1, ×	×	×	×						
Paracytheridea? *wetherellii* (Jones)			×				1, 2				
nodosa (Ulrich and Bassler)						×	4, ×	×			
cf. *P. rugosa* Edwards								1, ×			
Pellucistoma cf. *P. magniventra* Edwards								2, ×			
Pterygocythereis washingtonensis Swain, n. sp			3								
cornuta americana Ulrich and Bassler							×	2			
Trachyleberis? sp. aff. *T.*? *communis aquia* (Schmidt)		2, ×									
? *bassleri* (Ulrich)	×	×	2, 3, ×		×						
hilgardi (Howe and Garrett)		1, ×	3								
? *pellucinoda* (Swain)		×	3								
davidwhitei (Stadnichenko)		1	2, 3, ×								
stenzeli (Stephenson)		1	1, 3, ×								
mundorffi Swain, n. sp							4	3			
pidgeoni (Berry)			3								
? *rukasi* (Gooch)			3, ×								
smithvillensis (Sutton and Williams)		×	3, ×								

Stratigraphic ranges of ostracode species from wells in North Carolina, and previously reported occurrences—Continued

	Paleocene	Eocene			Oligocene	Miocene			Pliocene	Pleistocene	Recent
		Lower	Middle	Upper		Lower	Middle	Upper			
Trachyleberis—Continued.											
evax (Ulrich and Bassler)					1	1	1, ×				
exanthemata (Ulrich and Bassler)							8, ×	3, 4, 5, ×			
? *martini* (Ulrich and Bassler)						1	4, ×	1, 2, 4, 5			
? *rugipunctata* (Ulrich and Bassler)						1	11, ×	1, 2, 3, 4, 5, ×			
rosetta Swain, n. sp							1				
? cf. *T.*? *micula* (Ulrich and Bassler)							×	1			
vaughani (Ulrich and Bassler)							8, ×	1, 8, ×			
? cf. *T.*? *angulata* (Sars)							5			×	×
? cf. *T.*? *reesidei* (Swain)								8			
? cf. *T.*? *triplistriata* (Edwards)								4, ×			
Triebelina sp						1		1			
Xestoleberis cf. *X. longissima* Schmidt		1, ×									
? *ventrostriata* Swain, n. sp								1			
sp								2			

SYSTEMATIC DESCRIPTIONS

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

Cytherella cf. C. hannai Howe and Lea [8]

Plate 1, figure 1

Cytherella hannai Howe and Lea, Howe and Law, 1936, Louisiana Dept. Conserv. Geol. Bull. 7, p. 16, pl. 1, figs. 1–5.[9]

Shell subovate in side view; highest about one-third from posterior end; dorsal margin gently arched, nearly straight in anterior two-thirds; ventral margin nearly straight; anterior margin uniformly rounded; posterior margin broadly rounded, subtruncate above, and with a short flange-like extension below. Greatest convexity in posterior third of shell. Right valve larger than left, surface smooth.

Along hinge and entire free margin, rabbeted edge of left valve fits inside edge of right valve. Muscle scar obscured by matrix. Length of figured specimen a left valve: 0.92 mm., height 0.55 mm.

Remarks: In possession of a straight hinge associated with a tendency toward a posterior "swing" (caused by the post-ventral flange-like extension) this species resembles *C. hannai* Howe and Lea.

Occurrence: Esso Standard Oil Company Hatteras Light well no. 1, drill-cutting sample 1,160–1,170 feet, lower Miocene. U.S.N.M. 560595. Oligocene Vicksburg group and Red Bluff clay of Louisiana, Mississippi, and Alabama.

Cytherella cf. C. marlboroensis Ulrich

Cytherella marlboroensis Ulrich, 1901, Maryland Geol. Survey, Eocene, p. 117, pl. 16, figs. 9–13.

Occurrence: Lower Eocene, Karsten no. 1 Laughton well, 1,120–1,150 feet. U.S.N.M. 560724. Described from the Aquia formation, Upper Marlboro, Md.

Cytherella sp.

An imperfect right valve of a *Cytherella* (U.S.N.M. 560725) was obtained. The outline is ovoid, posterior portion swollen, surface recrystallized, but apparently smooth.

Occurrence: Middle Eocene, North Carolina Esso well no. 2, 1,430–1,440 feet.

Cytherella spp.

Text figures 3*a–c*

Two specimens, probably of two species of *Cytherella*, were obtained from the middle Miocene, Hatteras Light well no. 1, core 810–820 feet. One (text fig. 3A, U.S.N.M. 560726) is ovoid, smooth, with greatest convexity posterior. The other is smooth and subelliptical with a truncate anterodorsal margin. A specimen like the first example was found in the upper Miocene, Hatteras Light well no. 1, 280–290 feet.

[8] "Cf." in this paper means either that (a) the specimen(s) are not well preserved, but their observable features conform to those prescribed for the species and identity, although not proven, is strongly suggested; or (b), that descriptions and illustrations are insufficient for clear comparisons, but nevertheless concern forms to which my specimens may be referred. Both meanings are applicable to some species.

"Aff." means that the specimens probably belong to a related species, but available specimens are too poorly preserved or too few to warrant erection of a new species.

The writer believes that in a faunal study of this kind, it is more desirable and more useful to suggest tentative comparisons and possible similarities to or differences from species in other localities, by use of "cf." and "aff." than to imply identity by omitting "cf." or clear differences by introducing new specific names of doubtful validity.

[9] For species designated by "cf." a bibliography of the species is given in the form of, but not the literal intent of, a synonymy.

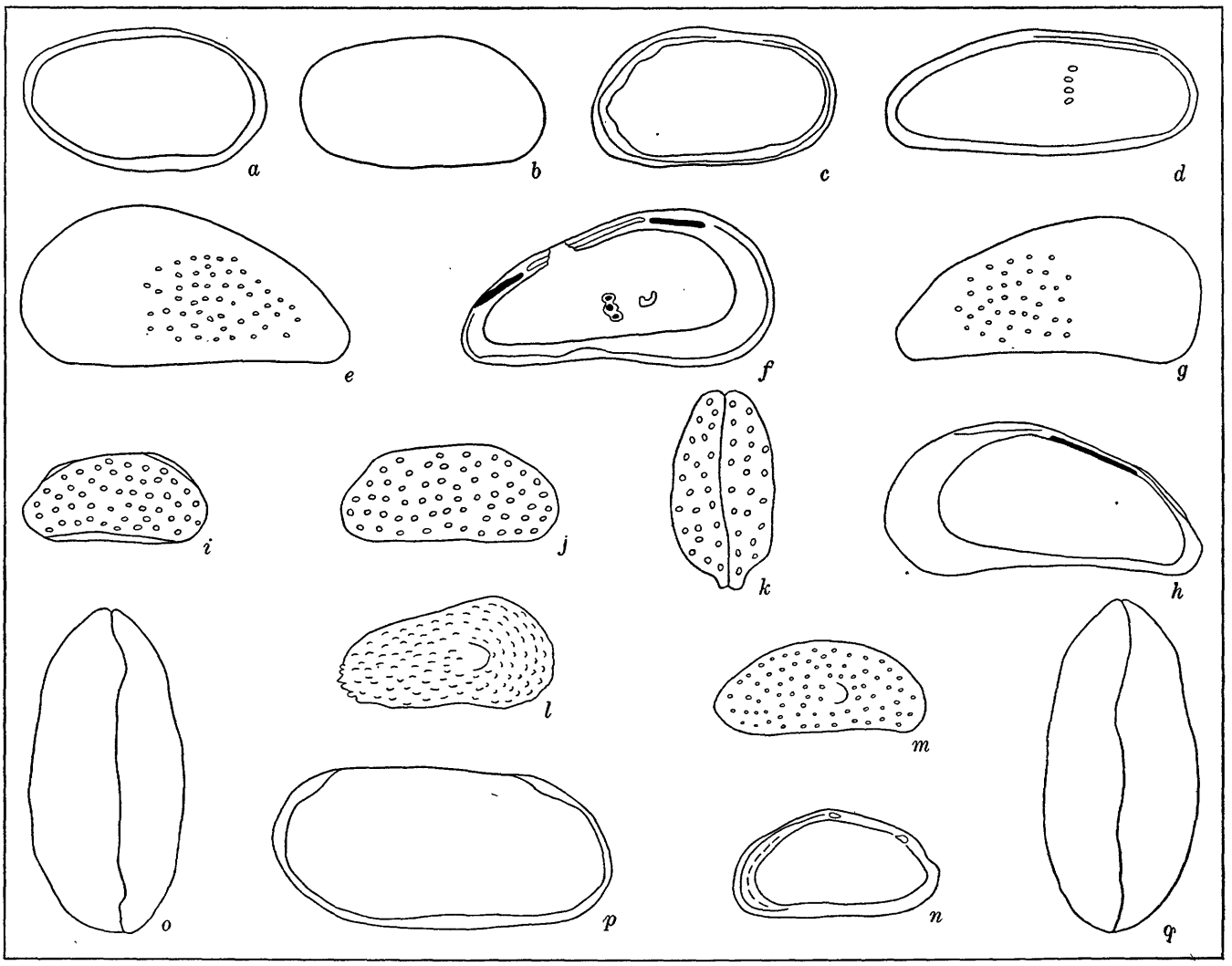

FIGURE 3.—Cytherellidae and Cytheridae.

		Page
a.	*Cytherella* sp. Left side of a complete shell. Length 0.80 mm. Esso Standard Oil Co., Hatteras Light well no. 1, 810–820 feet, middle Miocene, × 59. U.S.N.M. 560726	14
b, c.	*Cytherella* sp. Exterior and interior of a left valve. Length 0.87 mm. Esso Standard Oil Co., Hatteras Light well no. 1, 810–820 feet, middle Miocene, × 55. U.S.N.M. 560726	14
d.	*Xestoleberis* sp. Interior of a left valve. Length 0.58 mm. Esso Standard Oil Co., North Carolina Esso no. 2 well, 130–140 feet, upper Miocene, × 105. U.S.N.M. 560732	18
e–h.	*Eucythere* sp. Exterior and interior of left valve (× 114) and right valve (× 109) of a complete specimen. Length of left valve 0.57 mm., of right valve 0.55 mm. Esso Standard Oil Co., Hatteras Light well no. 1, 460–470 feet, upper Miocene. U.S.N.M. 560731	19
i–k.	*Clithrocytheridea* cf. *C. broussardi* (Howe and Garrett). *i*, Right side of a male; length 0.62 mm. (× 51). *j*. Left side of a female; length 0.75 mm. (× 56). *k*, Dorsal view of a female; length 0.73 mm. (× 53). Naval Auxiliary Air Station well, 90 feet, middle Eocene. U.S.N.M. 560730	24
l.	*Trachyleberis*? cf. *T. micula* (Ulrich and Bassler). Exterior of a right valve. Length 0.37 mm. (× 114). Esso Standard Oil Co., Hatteras Light well no. 1, 170–180 feet, upper Miocene. U.S.N.M. 560729	29
m, n.	*Acuticythereis* cf. *A. multipunctata* Edwards. Exterior and interior of a right valve. Length 0.77 mm. (× 55). Esso Standard Oil Co., Hatteras Light well no. 1, 610–620 feet, middle Miocene. U.S.N.M. 560728	42
o–q.	*Basslerites* cf. *B. giganticus* Edwards. Dorsal, right side and ventral views of a complete shell (× 50). Length 1.22 mm. Esso Standard Oil Co. Hatteras Light well no. 1, 170–180 feet, upper Miocene. U.S.N.M. 560727	47

Genus CYTHERELLOIDEA Alexander, 1929

Cytherelloidea howei Swain

Plate 1, figures 2, 3

Cytherelloidea howei Swain, 1948, Maryland Dept. Geology, Mines and Water Res., Bull. 2, p. 190, pl. 12, fig. 5.

Shell subquadrate in side view; dorsal margin slightly convex; ventral margin slightly concave medially; anterior margin broadly rounded, truncate medially. Right valve larger than left, overlap greatest along dorsum; greatest convexity posterior; wedge-shaped in dorsal view.

Anterodorsal, anterior, and posterior margins bear a broad marginal rim. A broad, ventral, longitudinal ridge rises about one-fourth from anterior end, and extends back to posterior end where it curves dorsally to postdorsal angle, then bends anteriorly to midlength. Above ventral portion of this ridge is a second, shorter

longitudinal ridge. A conspicuous median pit with a low ridge over it lies slightly above midheight. Internal features not observed.

Length of a complete shell (plate 1, fig. 2) 0.65 mm., height 0.38 mm., thickness 0.23 mm.; thickness of a second complete example (pl. 1, fig. 3) 0.27 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 195 feet, lower Eocene U.S.N.M. 560596. Described from the Aquia formation of the subsurface of Maryland (Swain, 1948).

Cytherelloidea sp.

An imperfect specimen representing this genus was collected. It bears a broad, moderately elevated marginal rim, with adjacent, inner, rather deep furrow; a prominent ventral longitudinal swelling, and other more dorsal swellings that are poorly preserved in this specimen.

Occurrence: Middle Eocene, Esso Standard Oil Co. Hatteras Light well no. 1, 1,770–1,780 feet. U.S.N.M. 560733.

Family CYPRIDAE Baird, 1846

Genus PARACYPRIS Sars, 1866

Paracypris cf. P. franquesi Howe and Chambers

Plate 1, figure 6

Paracypris franquesi Howe and Chambers, 1935, Louisiana Dept. Conserv. Geol. Bull. 5, p. 10, pl. 2, figs. 9, 13, pl. 4, figs. 15, 19. Van den Bold, 1946, Contrib. to the study of Ostracoda, J. H. De Bussy, Amsterdam, p. 66, pl. 1, fig. 16. Stephenson, 1946, Jour. Paleontology, vol. 20, p. 309, pl. 42, fig. 4, pl. 44, fig. 11.

Paracypris strecca Schmidt, 1948, Jour. Paleontology, vol. 22, p. 408, pl. 63, figs. 21, 22.

Left valve elongate-acuminate in side view; highest about one-third from anterior end; dorsal margin moderately convex; ventral margin slightly concave; anterior margin uniformly rounded; posterior margin acuminate, extended below. Surface smooth.

Hinge of left valve formed of the slightly narrowed, rabbeted edge of valve, which apparently fits over right valve along dorsum. Other internal features obscured by matrix.

Length of figured specimen 1.10 mm., height 0.35 mm.

Remarks: *P. franquesi* Howe and Chambers was originally described as having a hinge groove on the left valve, whereas the present specimen appears to have the hinge of the left valve rabbeted; in shape the forms seem to be identical.

The type of *Paracypris strecca* Schmidt was examined and judged to be *P. franquesi.*

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 2,720–2,730 feet, lower Eocene. U.S.N.M. 560599. Occurs in the Jackson formation, upper Eocene, of the central Gulf region (Howe and Chambers, 1935, p. 10; Bergquist, 1942, p. 105); in the Claiborne group, middle Eocene, of Texas (Stephenson, 1946, p. 310); Aquia formation, lower Eocene of Virginia (Schmidt, 1948, p. 408); lower Oligocene of Cuba (van den Bold, 1946, p. 66).

Family BAIRDIIDÆ Sars, 1887

Genus BAIRDIA McCoy, 1844

Bairdia cf. B. fortificata Brady

Plate 1, figure 14

Bairdia fortificata Brady, 1880, Challenger Reports, vol. 1, pt. 3, Ostracoda, p. 59, pl. 11, figs. 4a, b.

Shell subquadrate in lateral view; highest about two-fifths from anterior end; hinge margin straight, about half of shell length, with well defined, broadly obtuse cardinal angles; ventral margin nearly straight in left valve, slightly sinuous in right; anterior margin narrowly rounded and extended medially, slightly convex and finely spinose below, strongly truncate above; posterior margin acuminately rounded and extended medially, slightly convex and finely spinose below, strongly truncate and slightly concave above. Left valve larger than right, overlapping and extending beyond the other around entire periphery; greatest overlap ventral and along dorsal slopes. Convexity of valves strong and nearly uniform, greatest medially. Surface strongly pitted, with width of interspaces equalling or exceeding diameter of pits.

Internal features not observed.

Length of figured specimen 0.73 mm., height 0.40 mm., thickness 0.35 mm.

Remarks: This bairdiid specimen, unique in its strongly pitted surface, seems identical with Brady's Recent species but lack of knowledge of internal features makes the generic designation insecure. Specimens from the Tertiary of England assigned by Jones (1856, p. 52) to *B. subdeltoidea* (Muenster) are more finely punctate. *Bairdia* sp. from the Weches formation, middle Eocene of Texas (Stephenson, 1946, p. 310, pl. 42, fig. 7) is close to *B. fortificata.*

Occurrence: Edenton Naval Air Base well no. 1 Chowan County, N. C., 40 feet, upper Miocene. U.S.N.M. 560605. The species was originally collected off Booby Island at Lat. 10°36′ S., Long. 141°55′ E. in 6 feet of water from a coral and sand bottom (Brady, 1880, p. 59).

Bairdia sp.

A broken recrystallized specimen of this genus was obtained from the middle Eocene, Hatteras Light well no. 1, 2,040–2,050 feet. U.S.N.M. 560734.

Bairdia cf. B. laevicula Edwards

Bairdia laevicula Edwards, 1944, Jour. Paleontology, vol. 18, p. 506, pl. 85, figs. 3, 4.

Occurrence: Naval Air Base well no. 4, Edenton, N. C., 88 feet, middle Miocene. U.S.N.M. 560735. Described from the Duplin marl, upper Miocene at Natural Well, N. C.

Genus TRIEBELINA van den Bold, 1946

Triebelina van den Bold, 1946, Contrib. to study of Ostracoda, J. H. De Bussy, Amsterdam, pp. 23, 73.
Glyptobairdia Stephenson, 1946, Jour. Paleontology, vol. 20, no. 4, pp. 345–347.
Triebelina van den Bold, Stephenson, 1947, Jour. Paleontology, vol. 21, no. 6, pp. 577–579.

Triebelina sp.

Plate 1, figure 7

Two imperfectly preserved specimens represent this genus in the present collections. The surface bears three prominent longitudinal ridges, respectively dorsal, submedian, and ventral in position; ridges do not cross the compressed posterior end of the valve; ventral surface slopes steeply toward margin of valve, and posteriorly bears a large shallow excavation. Entire surface coarsely reticulate.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 610–620 feet in the upper Miocene U. S. N. M. 560789, and 1,380–1,390 feet in the lower Miocene. U. S. N. M. 560600.

Genus BAIRDOPPILATA Coryell, Sample and Jennings, 1935

Bairdoppilata? cf. B. delicatula Jennings

Plate 1, figures 8, 9

Bairdoppilata delicatula Jennings, 1936, Bull. Am. Paleontology, vol. 23, no. 2, p. 45, pl. 6, fig. 7.

Shell subtriangular-ovate in side view; greatest height slightly postmedian; dorsal margin strongly arched; ventral margin gently convex; anterior margin rounded, extended medially, slightly truncate above; posterior margin narrowly rounded, extended slightly below midheight, truncate to slightly concave above. Left valve larger than right, greatest overlap dorsal and mid-ventral. Surface weakly and sparsely punctate.

Hinge of left valve consists of a groove for reception of edge of right valve. The right valve of one specimen was removed in an attempt to see the internal features. Small hinge-crenulations, characteristic of *Bairdoppolita*, occur near base of posterior dorsal slope; corresponding anterior features could not be seen.

Length of a figured specimen (plate 1, fig. 9) 1.25 mm., height 0.79 mm., thickness 0.60 mm.

Remarks: The present specimens are close to *B. delicatula* Jennings in external shell features. The internal structures are not completely known, so the generic assignment is tentative.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 2,135–2,145 feet, lower Eocene; U. S. N. M. 560602. N. C. Esso well no. 2, 1,620–1,630 feet, middle Eocene. U.S.N.M. 560601. *B. delicatula* occurs in the Hornerstown formation, lower Eocene, of New Jersey (Jennings, 1936, p. 45).

Genus BYTHOCYPRIS Brady, 1880

Bythocypris? wicomicoensis Swain

Plate 1, figures 4, 5

Bythocypris? wicomicoensis Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 191, pl. 12, fig. 1.

The species was first described from the Miocene of the subsurface of Maryland, 200 feet below the top of the Calvert formation in the Ohio Oil Co.'s no. 1 Hammond well, Wicomico County. The present specimens closely resemble the Maryland example species. Recrystallization of the interior of the shells from both localities obscures the internal features so that the generic status remains uncertain.

Length of a figured specimen (plate 1, fig. 4) 0.93 mm., height 0.47 mm., thickness 0.38 mm.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 1,740–1,750 feet, drill-cutting sample 1,770–1,780 feet at top of middle Eocene. U.S.N.M. 560597.

Bythocypris cf. B. parilis Ulrich

Bythocypris parilis Ulrich, 1901, Maryland Geol. Survey, Eocene, p. 117, pl. 16, figs. 5–8. Jennings, 1936, Bull. Am. Paleontology, vol. 23, no. 78, p. 45, pl. 6, fig. 8. Schmidt, 1948, Jour. Paleontology, vol. 22, p. 409, pl. 63, figs. 14–16.

Occurrence: Karsten no. 1 Laughton well, 1,213–1,244 feet, in the lower Eocene U.S.N.M. 560736. Described from the Aquia formation, Upper Marlboro, Md., (Ulrich, 1901, p. 117, Schmidt, 1948, p. 409), and recorded from the Hornerstown formation of New Jersey (Jennings, 1936, p. 45).

Family CYTHERIDAE Baird, 1850

The members of this family are currently undergoing revision. Sylvester-Bradley (1948, p. 793) introduced the family Trachyleberidae to include the following genera discussed in this paper: *Trachyleberis* Brady, *Hemicythere* Sars, *Pterygocythereis* Blake, *Buntonia* Howe, and *Favella* Coryell and Fields. The present

writer agrees that the family Cytheridae needs revision, but doubts the validity of the Trachyleberidae as defined by Sylvester-Bradley (1948, p. 793) this is

Cytheracea with accommodation groove lacking or reduced to a narrow shelf; straight hinge, with subdivided median element; and compressed carapace (especially anteriorly and posteriorly) though sometimes with alae.

Many of the genera of this group of ostracodes have not been adequately defined and further study of them probably should be made before new families are proposed. In the present paper the genera listed above are left in the Cytheridae.

Genus XESTOLEBERIS Sars, 1866

Xestoleberis cf. X. longissima Schmidt

Plate 1, figure 10

Xestoleberis longissima Schmidt, 1948, Jour. Paleontology, vol. 22, p. 411, pl. 63, figs. 11–13.

Shell elongate suboblong in lateral view; dorsal margin gently convex; ventral margin slightly concave medially; anterior margin narrowly rounded, extended below; posterior margin more broadly rounded. Left valve slightly larger than right, extending beyond the other along dorsum. Greatest convexity in posterior half. Surface details destroyed by recrystallization. Internal features also obscured by recrystallization.

Length of figured specimen 0.65 mm., height 0.25 mm., thickness 0.26 mm.

Remarks: The present form was compared with the type *X. longissima* and on the basis of external characteristics the two are conspecific. Recrystallization of the surface and lack of knowledge of the internal features prevent accurate classification of the North Carolina forms. Schmidt (1948, p. 411) reported several similarly poorly-preserved specimens in her collections from the Aquia formation near Oak Grove, Md.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 2,390–2,400 feet, lower Eocene. U.S.N.M. 560603. Described from the Aquia formation, lower Eocene, Maryland.

Xestoleberis? ventrostriata Swain, n. sp.

Plate 4, figures 12, 13

Shell elongate-subovate in lateral view; greatest height median; dorsal margin moderately convex; ventral margin nearly straight; anterior margin narrowly rounded, slightly extended below; posterior margin more broadly rounded, extended below. Left valve larger than right, extending beyond the other most noticeably along dorsum. Ventral surface of each valve greatly inflated, overhanging ventral margin. Ventral portion bears weak longitudinal grooves; surface otherwise smooth. Internal features not observed.

Length of holotype 0.49 mm., height 0.26 mm., thickness 0.28 mm.

Relationships: This species is more elongate than *X. dumblei* Stephenson (1946, p. 320) from the Weches formation of Texas and *X. sarsi* Howe and Chambers (1935, p. 48) from the Jackson formation of Louisiana. In shape it resembles the smooth-surfaced *X. vicksburgensis* Howe and Law (1936, p. 78) and to the papillate *X. depressa* Sars (1928, p. 244) and *X. aurantia Baird* (Sars, 1928, p. 243) of the Recent, but differs from all of them in its weakly grooved ventrum.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 380–390 feet, upper Miocene. U.S.N.M. 560659.

Xestoleberis? sp.

Text figure 3d

A left valve doubtfully assigned to this genus was obtained from the Upper Miocene. The shell is elongate-subovate, with the posterior margin greatly extended below midheight. The surface is minutely pitted, with weak longitudinal ridges along the ventral surface. It is much more elongate than *X. ventrostriata* Swain n. sp., and the ventral surface is not inflated.

The hinge consists of the simple edge of the valve and thus differs from the hingement prescribed for the genus. The left valve hinge of *Xestoleberis* according to Alexander (1934, p. 232) consists of an anterior notched groove, an interterminal denticulate bar, and a posterior socket. The specimen is very small and delicate and may be a miniature molt of *Xestoleberis*. The observed muscle scar consists of a vertical row of 3 or 4 spots.

Occurrence: North Carolina Esso no. 2 well, 130–140 feet, upper Miocene. U.S.N.M. 560732.

Genus EUCYTHERE Brady 1866

Eucythere cf. E. chickasawhayensis Howe

Plate 1, figures 11–13

Eucythere chickasawhayensis Howe, 1936, Jour. Paleontology, vol. 10, no. 2, pp. 143–145, text figure 2.

Shell subtriangular in side view; greatest height slightly anterad of midlength; dorsal margin strongly convex, truncate in posterior portion; ventral margin nearly straight; anterior margin broadly rounded, slightly extended below; posterior margin narrowly rounded, extended ventrally, truncate above. Left valve slightly larger than right, greatest overlap middorsal. Greatest thickness in posterior third of shell.

Surface more or less concentrically and coarsely reticulate.

Hinge of left valve consists of a prominent long ridge occupying the truncated postdorsal slope; near anterior end of ridge and joined to its ventral surface is a second, shorter toothlike ridge that defines a more dorsal, narrow, elongate socket; at posterior end of hinge is a narrow elongate crenulate socket; incised lines define the main ridge element dorsally and ventrally. Correspondingly, hinge of right valve consists of an anterior toothlike ridge and subjacent socket, a long narrow interterminal groove, and a posterior, weak, crenulate tooth. Inner lamellae are broad anteriorly but narrow abruptly to about half their width just anterad [10] of midventral region. The radial pore canals are rather widely spaced. Inner margin and line of concrescence are widely separated anteriorly. Muscle scar consists of three hourglass-shaped spots or six single spots in a median, curved, subvertical row, and an anterad U-shaped spot, open dorsally.

Length of figured specimen 0.69 mm, height 0.44 mm, thickness 0.43 mm.

Remarks: Howe (1936, p. 144) based his description of *E. chickasawhayensis* on two right valves, and illustrated the species by means of an outline drawing of the interior of one valve. The surface ornamentation of the present form is similar to that described but not illustrated by Howe. The description of the hingement of the present form differs in its wording from that of Howe, but there apparently is close similarity between the Gulf Coast and North Carolina examples.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 700–710 feet, upper Miocene. U.S.N.M. 560604. Described from the lower part of the Chickasawhay formation, upper Oligocene, Wayne County, Miss. (Howe, 1936, p. 144).

Eucythere sp.

Text figures 3, e-h

Outline of the single left valve found subovate-acuminate, highest about one-third from anterior end; dorsal margin strongly arched; ventral margin nearly straight, slightly concave medially; anterior margin broadly rounded; posterior margin acuminate, strongly extended below. Posterior half of surface pitted. Greatest convexity ventral and slightly postmedian.

Hinge margin imperfect but probably consists of an anterior narrow rabbet-joint lying at position of greatest height, a long ridge and a posterior narrow groove. Inner lamellae broadest anteriorly; line of concrescence and inner margin separate anteriorly. Muscle scar anteromedian, and consists of a curved row of 3 or 4 spots and a more anterior large curved spot.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 460–470 feet, upper Miocene. U.S.N.M. 560731.

Genus CYTHERIDEA Bosquet, 1852

Cytheridea? sp.

A broken and recrystallized specimen from the middle Eocene, probably is a *Cytheridea* or a related genus. The surface is coarsely pitted and the anterior margin is extended ventrally.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 2,180–2,190 feet. U.S.N.M. 560737.

Cytheridea? sp.

A poorly preserved incomplete left valve from the middle Miocene belongs to this, or to a related, genus. U.S.N.M. 560738.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 760–70 feet.

Genus CYTHERIDEIS Jones, 1856

Cytheideis ashermani Ulrich and Bassler

Cytherideis ashermani Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 126, pl. 37, figs 10–16. Howe and others, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 14, pl. 3, figs. 8–10. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 195, pl. 13, fig. 1.

Cytherideis longula Ulrich and Bassler, Howe and others, idem., p. 14.

Cytherideis semicircularis Ulrich and Bassler, Howe and others, idem.

Occurrence: Esso Standard Oil Co., Hatteras Light well no. 1, 170–180 feet, upper Miocene, U.S.N.M. 560739; from the Cape Lookout well, 101–125 feet, middle Miocene, U.S.N.M. 560740; and from the Hatteras Light well no. 1, 1,220–1,230 feet, lower Miocene, U.S.N.M. 560741. Previously known from the middle Miocene.

Cytherideis longula Ulrich and Bassler

Cytherideis longula Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 128, pl. 37, figs. 21–27. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 195, pl. 13, fig. 2.

Howe and others (1935) considered the form synonymous with *C. ashermani* Ulrich and Bassler. It may represent the male of that species, although it is not in all cases associated with the shorter and higher *C. ashermani*.

[10] In this paper "posterad" and "anterad" are used as contractions of "posteriorad" and "anteriorad," respectively. The Latin suffix "ad" indicates the direction "toward"; "posterad," therefore, means "toward the rear," and "anterad" means "toward the front."

Occurrence: Middle Miocene (Calvert formation) of Maryland and upper Miocene at Hatteras Light well no. 1, 170–180 feet, U.S.N.M. 560742.

Cytherideis rugipustulosa Edwards

Cytherideis rugipustulosa Edwards, 1944, Jour. Paleontology, vol. 18, p. 514, pl. 86, figs. 5–7.

Occurrence: Middle Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 850–860 feet, U.S.N.M. 560743; upper Miocene, North Carolina Esso well no. 2, 350–360 feet, U.S.N.M. 560744; Pleistocene, Hatteras Light well no. 1, 90–100 feet, U.S.N.M. 560745. Edwards described the species from the Duplin marl of North Carolina.

Genus HAPLOCYTHERIDEA Stephenson, 1936

Haplocytheridea sp. aff. H. israelskyi Stephenson

Plate 1, figures 15–17

Shell subovate in side view; highest about one-third from anterior end; dorsal margin moderately arched, subtruncate behind position of greatest height; ventral margin nearly straight to slightly convex, somewhat sinuous in right valve; anterior margin broadly and nearly uniformly rounded, slightly spinose; posterior margin narrowly rounded, extended below, slightly truncate above. Left valve larger than right, and overlapping it except at posteroventral bend and middorsally.

Surface of each valve bears rows of large pits and intervening low ridges that are arranged concentrically on marginal third of surface. Two inconspicuous subvertical pitted groves occur about at midlength.

Hinge of right valve consists of an anterior elongate elevated series of 6 or 7 denticles at about midheight, an interterminal structure that begins as a depressed series of tiny crenulations, gradually rises and becomes more coarsely crenulate and slightly broader, and a posterior elevated crenulate tooth. Some of the posterior crenulations are doublets. Above the back part of the hinge is a groove that receives a corresponding rabbeted overlap of the left valve. Hinge of left valve consists of an anterior, elongate, crenulate socket, and a crenulate structure rather strongly elevated at midlength but becomes progressively lower behind, and a shallow socket. Above midportion of hinge is a groove that receives the overlapping edge of right valve. Muscle scar consists of a subvertical row of four pits and two more anterior pits. Inner lamellae of moderate width, broadest anteriorly and sloping inward. Line of concrescence and inner margin separate. Radial canals numerous.

Length of figured specimen 0.77 mm., height 0.44 mm., thickness 0.45 mm.

Remarks: In shape, hingement and coarsely pitted surface this form is close to *H. israelskyi* Stephenson (1944, p. 159) from the subsurface middle Tertiary of Jefferson County, Texas. The latter apparently lacks the terminal rows of pits and intervening low ridges of the present species. *H. veatchi* (Howe and Garrett) from the Wilcox and Claiborne groups of the Gulf states has stronger curving ridges and weaker pits. *H. veatchi aquia* Schmidt from the Aquia formation of the Middle Atlantic region is similar but lacks distinctive terminal ornamentation. The Aquia example seems to be much like the Claiborne form *H. lisbonensis* Stephenson which that author later (1946, p. 325) placed with *H. veatchi*. *H. israelskyi* to which the North Carolina species is most closely related is represented, in addition, in the Calvert formation, middle Miocene, of the subsurface of Maryland (Swain, 1948, p. 210).

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene. A specimen probably of the same species, was obtained from the Esso Standard Oil Co. Hatteras Light well, no. 1, 1,620–1,630 feet lower Miocene or Oligocene. U.S.N.M. 560606.

Haplocytheridea montgomeryensis (Howe and Chambers)

Plate 1, figure 18, plate 2, figures 1–4

Cytheridea montgomeryensis Howe and Chambers, 1935, Louisiana Dept. Conservation Geol. Bull. 5, p. 17, pl. 1, fig. 1, pl. 2, figs. 1–3, pl. 6, figs. 17, 18.

Cytheridea (Haplocytheridea) montgomeryensis Howe and Chambers, Stephenson, 1936, Jour. Paleontology, vol. 10, p. 700, pl. 94, figs. 3, 4, 9, text figs. 1g, h, j, k, Stephenson, 1937, idem., vol. 16, p. 109, pl. 18, figs. 17, 18.

Cytheridea montgomeryensis Howe and Chambers, Bergquist 1942, Mississippi Geol. Survey Bull. 49, p. 106, pl. 11, fig. 51.

Haplocytheridea montgomeryensis (Howe and Chambers) Stephenson, 1946, Jour. Paleontology, vol. 20, p. 322, pl. 42, fig. 29.

Shell subpyriform in side view; male dimorphs elongate, females shorter and higher; greatest height about one-third from anterior end; dorsal margin strongly convex, truncate behind point of greatest height; ventral margin nearly straight to slightly concave postmedially, the later particularly in male dimorphs; anterior margin broadly rounded, its ventral portion bearing several short spines; posterior margin acuminate, extended below; postdorsal slope truncate, forming a very obtuse but distinct angle with dorsum. Anterior two-thirds of valves strongly convex, posterior third somewhat compressed. Median and anteromedian portions of shell bear eight or more subvertical, curved, sparsely pitted furrows, separated by inter-

spaces that are approximately twice width of furrows; surface otherwise smooth.

Left valve larger than right, extending beyond the other most along dorsum and ventrum. Internal features not well preserved in specimens at hand.

Length of figured female shell (plate 2, fig. 1) 0.85 mm., height 0.46 mm., thickness 0.35 mm.

Remarks: The internal features of the present specimens are not known but the form probably is conspecific with *Haplocytheridea montgomeryensis.* The flattened posterior and dorsal slopes, the ventrally acuminate posterior end, and the surface ornamentation are characteristic of the species.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 1,740–1,750 feet (male dimorphs only) middle Eocene; Esso no. 2 well 1,610–1,620 feet, middle Eocene; Naval Auxiliary Air Station well, Washington, N. C., 115 feet, middle Eocene; N. C. Esso no. 2 well 1,950–1,960 feet, lower Eocene. In the Gulf region, the species occurs in the Claiborne group and the Jackson formation. U.S.N.M. 560607, 560612, 560613.

Haplocytheridea cf. H. veatchi (Howe and Garrett)

Plate 1, figure 22

Cytheridea mülleri (Münster) (part), Cushman, 1925, Am. Assoc. Petroleum Geologists Bull., vol. 9, p. 301, pl. 8, figs. 4a-c.

Cytheridea veatchi Howe and Garrett, 1934, Louisiana Dept. Conserv. Geol. Bull. 4, p. 43, pl. 3, figs. 1–4.

Cytheridea (Haplocytheridea) veatchi Howe and Garrett, Stephenson, 1938, Jour. Paleontology, vol. 12, p. 574, pl. 67, fig. 6, text figs. 25–27.

Cytheridea (Phractocytheridea) compressa Sutton and Williams, 1939, idem., vol. 13, p. 572, pl. 64, figs. 23–25.

Cytheridea (Haplocytheridea) lisbonensis Stephenson, 1942, idem., vol. 16, p. 108, pl. 18, figs. 11, 12.

Haplocytheridea lisbonensis Stephenson, 1944, idem., vol. 18, p. 449, pl. 76, fig. 12.

Haplocytheridea veatchi (Howe and Garrett) Stephenson, 1946, idem., vol. 20, p. 325, pl. 42, fig. 27, pl. 44, fig. 14.

Haplocytheridea veatchi aquia Schmidt, 1948, idem., vol. 22, p. 424, pl. 63, figs. 1–7.

Valves subovate in side view; greatest height about one-third from anterior end; dorsal margin moderately arched, nearly straight in posterior two-thirds; ventral margin nearly straight, converging backward toward dorsum; anterior margin broadly and uniformly rounded, bearing 10 or more spines along its ventral part; posterior margin narrowly rounded, extended below. Left valve larger than right; complete shells not observed, but greater height of left as compared to right valves suggests that greatest overlap is not terminal. Entire surface of each valve bears subvertical, weak, rather closely spaced, narrow, pitted grooves that are convex forward in front of midshell and backward behind midshell. Posteroventrally, surface bears several small pustules.

Hingement consists in right valve of terminal, narrow, elongate, taxodont teeth and intervening, less elevated, finely crenulate bar, bounded dorsally by a narrow groove. Hinge of left valve not clearly observed. Muscle scar consists of a vertical row of four spots, and two, more anterior spots. Inner lamellae broadest anteriorly; line of concrescence and inner margin separated terminally. Radial canals not clearly observed.

Length of figured specimen 0.75 mm., height 0.44 mm., thickness 0.27 mm.

Remarks: The present form is close to *H. veatchi* (Howe and Garrett) in shape, hingement, and in the possession of numerous subvertical grooves on the surfaces of the valves. The intervening ridges are lower on the specimens at hand than on typical members of the species but Stephenson (1946, p. 325) reports that the strength of the ridges is varied. The type of *H. veatchi aquia* Schmidt from the Aquia formation of Maryland and Virginia was examined and although more weakly ornamented terminally than typical examples of *H. veatchi* is so similar that its separation as a distinct variety is of questionable value.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 1,740–1,750 feet, middle Eocene; U.E.N.M. 560611. Occurs in Wilcox and Claiborne groups of the Gulf region (Stephenson, 1946, p. 325), Aquia formation of the Middle Atlantic region (Schmidt, 1948, p. 425).

Haplocytheridea cf. H. wallacei (Howe and Garrett)

Plate 2, figures 6, 7

Cytheridea mülleri (Münster) (part), Stadnichenko, 1927, Jour. Paleontology, vol. 1, p. 237, pl. 39, figs. 14–17, not fig. 13.

Cytheridea wallacei Howe and Garrett, 1934, Louisiana Dept. Conserv. Geol. Bull. 4, p. 44, pl. 3, figs. 5–8.

Cytheridea (Haplocytheridea) wallacei Howe and Garrett, Stephenson, 1938, Jour. Paleontology, vol. 12, p. 575, pl. 67, fig. 25, text figs. 17, 18.

Cytheridea (Haplocytheridea) habropapillosa Sutton and Williams, 1939, idem., vol. 13, p. 570, pl. 64, figs. 20–22. Stephenson, 1942, idem., vol. 16, p. 107, pl. 18, figs. 21, 22.

Halplocytheridea habropapillosa (Sutton and Williams), Stephenson, 1944, idem., vol. 18, p. 449, pl. 76, fig. 4.

Haplocytheridea wallacei (Howe and Garrett), Stephenson, 1946, idem., vol 20, p. 325, pl. 42, fig. 28.

The present specimens exhibit the following characteristics:

Shell subpyriform in side view; greatest height one-third shell length from anterior end; dorsal margin moderately to strongly arched, slightly truncate on posterior slope; ventral margin sinuous, convex in front,

concave behind; anterior margin broadly and nearly uniformly rounded, slightly extended below and bearing six short spines along lower portion in each valve; posterior margin acuminate, strongly extended below. Left valve larger than right, overlapping and extending beyond the other around entire periphery. Anterior two-thirds of shell strongly convex; midventrally the swollen shell overhangs ventral margin. Posterior end compressed, especially in ventral region. Shell subtriangular in end view.

Anteroventral two-thirds of each valve ornamented with large, low pustules that in part coalesce to form irregular ridges, and with large intervening pits. Anteriorly, pustules are in curved rows about parallel to anterior margin. Posterodorsal third of surface smooth.

Hinge of left valve consists of terminal, crenulate groove; hinge of right valve not seen. Other internal features not observable in these specimens.

Length of a relatively short high specimen (pl. 2, fig. 7), probably a female dimorph, 0.57 mm., height 0.32 mm., thickness 0.33 mm. Length of a probable male dimorph (pl. 2, fig. 6) 0.61 mm., height 0.40 mm.

Remarks: The present specimens possibly are a distinct variety of *H. wallacei* as shells of that species do not bear pits between the surface pustules.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 1,740–1,750 feet, middle Eocene U.S.N.M. 560615; North Carolina Esso well no. 2, 1,950–1,960 feet, lower Eocene. U.S.N.M. 560616. According to Stephenson (1946, p. 326), *H. wallacei* occurs in the Wilcox and Claiborne groups of the Gulf States.

Haplocytheridea? cf. H.? subovata (Ulrich and Bassler)

Plate 1, figures 19, 20

Cytheridea subovata Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene volume, p. 124, pl. 37, figures 1–8.

Shell subovate-elongate in lateral view; greatest height slightly post-median; dorsal margin gently arched, its sloping posterior portion nearly straight; ventral margin gently convex in left valve; nearly straight in right valve; anterior margin broadly rounded, bearing 4 or 5 short spines in its ventral part; posterior margin narrowly rounded, extended below, truncate above, that of right valve bearing 5 short spines in its ventral part. Left valve larger than right, greatest extension in midventral portion.

Posterior surface of right valve bears two or three curved subvertical grooves; corresponding features on left valve are inconspicuous. Entire surface of each valve bears widely spaced shallow pits. Hingement and other internal features not observed.

Remarks: The present material probably is conspecific with *Cytheridea subovata* Ulrich and Bassler from the Calvert formation, middle Miocene of Maryland. Its external shell characteristics resemble those of *Haplocytheridea*, but critical internal characters are unknown.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 1,620–1,630 feet, U.S.N.M. 560608 and 560609. Lower Miocene or Oligocene; Bogue water well no. 65, Carteret County, 150 feet, upper Miocene(?); U.S.N.M. 560759.

Haplocytheridea sp. aff. H. hammondensis (Swain)

Plate 1, figure 21

Shell subovate in side view; highest slightly anterad of midlength; dorsal margin gently arched, ventral margin nearly straight in right valve, slightly convex in left; terminal margins nearly equal in curvature, bearing ventral, short, flangelike extensions. Left valve larger than right and extending beyond it, except ventro-terminally. In edge view, posterior third of shell rather strongly swollen, possibly a female dimorphic feature; behind swollen area, surface slopes gradually to margins. Surface bears widely spaced pits of various sizes, without systematic arrangement.

Hinge of right valve consists of terminal, slightly elevated notched dental areas, with intervening finely crenulate bar formed of the narrowed valve edge. Hinge of left valve consists of terminal, shallow, notched sockets, connected by a narrow, crenulate groove. Muscle scar lies forward of shell beneath anterior end of hinge; it consists of a vertical row of four spots, and two or more anterior spots. Inner lamellae of moderate width anteriorly and vertically, becoming narrower posteriorly; line of concrescence and inner margin separated terminally. Radial pore canals were not clearly observed but probably are widely spaced.

Length of a complete shell (pl. 1, fig. 22) 0.58 mm., height 0.33 mm., thickness 0.27 mm.

Remarks: The present form resembles *H. hammondensis* Swain (Swain 1948, p. 210, pl. 14, fig. 15), and *H. texana* Stephenson (1944, p. 160). In internal features and general shape, particularly the relatively narrow anterior end, it is close to *H. hammondensis* from the Calvert formation, middle Miocene, of the subsurface of Maryland, but the Maryland example has a more weakly pitted surface and is less tumid. *H. texana*, from the middle Tertiary *Marginulina idiomorpha* zone of the subsurface of Texas, is highest at midlength, more pointed posteriorly and more weakly pitted than the North Carolina form.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., at a depth of 90 feet, middle Eocene; U.S.N.M. 560610.

Haplocytheridea? cf. H. goochi (Stephenson)

Plate 2, figure 8

Cytheridea (Haplocytheridea) goochi Stephenson, 1942, Jour. Paleontology, vol. 16, p. 106, pl. 18, figs. 9, 10.

Shell elongate-subquadrate in side view; highest about one-third from anterior end; hinge margin straight, about half of shell length, defined by broadly obtuse cardinal angles; ventral margin nearly straight, slightly concave medially in right valve; anterior margin truncate above, rounded and extended below; posterior margin narrower, truncate above, rounded and extended below. Left valve slightly larger than right, extending beyond it postdorsally and midventrally. Valves moderately convex; greatest convexity in posterior third. Surface bears large, scattered, rounded pits.

Internal features not observed in the single specimen at hand.

Length 0.61 mm., height 0.31 mm., thickness 0.28 mm.

Remarks: In shape and surface ornamentation this form is close to *H. goochi* (Stephenson) but the internal features on which positive generic placement can be made, were not seen.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, core 2,196–2,206 feet, middle Eocene U.S.N.M. 560617. Described from the Claiborne group of Alabama (Stephenson, 1942, p. 106).

Haplocytheridea cf. H. nowotnyi Stephenson

Haplocytheridea nowotnyi Stephenson, 1946, Jour. Paleontology, vol. 20, p. 324, pl. 42, fig. 26.

Several specimens that seem to represent this species were obtained. The shell is subovate, strongly inflated and bears weak pits scattered over the surface.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 90 feet U.S.N.M. 560746, and from the Esso Standard Oil Co., Hatteras Light well no. 1, 2,140–2,150 feet, middle Eocene, U.S.N.M. 560758.

Haplocytheridea? cf. H? hopkinsi (Howe and Garrett)

Plate 2, figure 5

Cytheridea hopkinsi Howe and Garrett, 1934, Louisiana Dept. Conserv., Geol. Bull. 4, p. 31, pl. 1, figs. 16–18.

?Cytheridea (Leptocytheridea) hopkinsi Howe and Garrett, Stephenson, 1938, Jour. Paleontology, vol 12, p. 583, pl. 67, figs. 13, 14, text figs. 8, 11, 12.

?Cytheridea (Haplocytheridea?) sp., Stephenson, 1942, idem., vol. 16, p. 110, pl. 18, figs. 7, 8.

Left valve subovate in side view; highest about one-fourth from anterior end; hinge margin nearly straight behind position of greatest height, and equal to about half of shell length; ventral margin nearly straight to slightly concave postmedially, converging strongly backward with respect to dorsum; anterior margin broadly and nearly uniformly rounded; posterior margin acuminately curved at its ventral bend, truncate above. Surface finely pitted; anteromedially there is a cluster of larger, more conspicuous pits, some of which are arranged in short subvertical rows. Internal features not observed.

Length of figured left valve 0.63 mm., height 0.42 mm.

Remarks: The shape of the shell and the hinge characters as described by Howe and Garrett (1934, p. 31, Stephenson, 1938, p. 583) from the Nanafalia formation, suggest that this species belongs in *Haplocytheridea* Stephenson. The form referred by Stephenson (1938, p. 583) to *Cytheridea (Leptocytheridea) hopkinsi* Howe and Garrett, from the Nanafalia and Tuscahoma formations has a hinge resembling that of *Clithrocytheridea*, but in other shell features it is similar to *Haplocytheridea.* Stephenson later (1941, pp. 426, 427) abandoned *Leptocytheridea* and considered species he had assigned to that subgenus to be immature molts of other cytherideid ostracodes. Subsequently Stephenson (1942, p. 110) reported as *Cytheridea (Haplocytheridea?)* sp., specimens from the Claiborne group of Texas that "are closely similar to the form described by Howe and Garrett . . . as *Cytheridea hopkinsi.*"

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 2,840–2,850 feet, lower Eocene U.S.N.M. 560614; Nanafalia formation, lower Eocene of Louisiana; Nanafalia and Tuscahoma formations, Wilcox group of Alabama; Claiborne of Texas.

Genus CLITHROCYTHERIDEA Stephenson, 1936

Clithrocytheridea cf. C. smithvillensis Stephenson

Plate 2, figure 9

Clithrocytheridea smithvillensis Stephenson, 1946, Jour. Paleontology, vol. 20, p. 327.

Shell subovate in side view; greatest height about two-fifths from anterior end; dorsal margin moderately convex; ventral margin nearly straight to slightly concave medially; anterior margin rounded, extended below, truncate above in right valve; ventral portion of anterior margin in each valve bears a low but distinct slightly spinose flange; posterior margin narrowly rounded, rather strongly extended below, truncate above in right valve; ventral portion of posterior margin bears a low flange. Left valve larger than

right, greatest projection along dorsal slopes. Surface bears large scattered pits and numerous, very small, closely spaced, weak pits. Hingement and other internal features not observed.

Length of figured specimen 0.52 mm., height 0.27 mm., thickness 0.23 mm.

Remarks: In outline and pitted surface ornamentation this form is like *Haplocytheridea hadleyi* (Stephenson) from the basal part of the Moody's Branch marl and underlying transition beds in Mississippi. As described, however, that species lacks the ventral terminal flanges. *Clithrocytheridea rugata* Schmidt (1948, p. 428) from the Aquia formation of Virginia has a more sinuous ventral margin and lesser convexity, but otherwise is closely similar to *C. smithvillensis*. Topotypes of *C. smithvillensis* resemble the specimens from North Carolina, but the internal characteristics of the latter are not known and the present designation is tentative.

Occurrence: Esso Standard Oil Co., North Carolina Esso no. 2, 1,480–1,490 feet, middle Eocene U. S. N. M. 560618. Described from the Weches formation, Claiborne group at Smithville, Tex. (Stephenson, 1946, p. 327).

Clithrocytheridea virginica Schmidt

Plate 2, figures 10–13

Clithrocytheridea virginica Schmidt, 1948, Jour. Paleontology, vol. 22, p. 429, pl. 64, figs. 21–23.

The external features of the species have been adequately described by Schmidt.

Hinge of right valve consists of an anterior, moderately elevated, elongate, crenulate dental area; a posterior, shorter, less elevated, crenulate dental area; and an intervening long, finely crenulate rabbet-joint shelf that is bounded dorsally by a strong ridgelike extension of the valve margin, but ventrally lacks a confining ridge. Hinge of left valve consists of terminal elongate, crenulate sockets, and an intervening thick, crenulate bar, formed of the valve edge. Muscle scar lies beneath anterior end of hinge, and consists of a vertical row of four spots and two more anterior spots. Inner lamellae broad and parallel to free margins; inner margin and line of concrescence nearly coincide. Marginal pore canals numerous, closely but irregularly spaced, and present around entire free margin.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C. 115–120 feet, middle Eocene U. S. N. M. 560619. Described from the Aquia formation of Maryland (Schmidt, 1948, p. 429).

Clithrocytheridea cf. C. caldwellensis (Howe and Chambers)

Plate 2, figure 28

Cytheridea? caldwellensis Howe and Chambers 1935, Louisiana Dept. Conserv. Geol. Bull., p. 11, pl. 1, fig. 7, pl. 2, figs. 4–6.

Cytheridea (Clithrocytheridea) caldwellensis Howe and Chambers, Stephenson, 1937, Jour. Paleontology, vol. 11, p. 154, pl. 26, fig. 13.

Clithrocytheridea caldwellensis (Howe and Chambers) Stephenson, 1946, Jour. Paleontology, vol. 20, p. 327, pl. 42, fig. 13.

Shell subquadrate in side view; greatest height about one-third from anterior end; hinge margin straight, about half of shell length; ventral margin nearly straight; anterior margin broadly rounded, slightly extended below; posterior margin acuminate, extended below, truncate above.

Surface ornamentation consists of a marginal anterior broad, low, swelling; a posterior and postventral low inconspicuous ridge separated from shell margin by a compressed zone; a posterior broad, longitudinal swelling bounded on all sides except the dorsal by a shallow, broad furrow; most of surface coarsely pitted.

Internal features not observed because of poor preservation.

Length of a left valve (plate 2, fig. 28) 0.55 mm., height 0.31 mm.

Remarks: The specimen so closely resembles *C. caldwellensis* externally that probably the two are conspecific. Recrystallization and matrix obscure the inner structures so that the identification is tentative.

Occurrence: Esso Standard Oil Co. Hatteras Light well no 1, core 2,135–2,145 feet, middle Eocene U.S.N.M. 560631; Claiborne and Jackson groups of the Gulf states (Stephenson, 1946, p. 327).

Clithrocytheridea cf C. broussardi (Howe and Garrett)

Text figures 3*i–k*

Cytheridea? broussardi Howe and Garrett, 1934, Louisiana Dept. Conserv., Geol. Bull. 4, p. 30, pl. 1, figs. 12–15.

Cytheridea (Clithrocytheridea) broussardi, Howe and Garrett, Stephenson, 1938, Jour. Paleontology, vol. 12, p. 576, pl. 67, fig. 24, text figs. 12–15.

Occurrence: Several examples were found in the middle Eocene samples from the Naval Auxiliary Air Station well, Washington, N. C., 90 feet; U.S.N.M. 560730 previously reported from the Wilcox group (lower Eocene).

Clithrocytheridea sp.

Plate 2, figure 14

Shell subovate in side view; highest about one-third from anterior end; dorsal margin gently convex, nearly straight behind position of greatest height; ventral

margin nearly straight to slightly concave medially; anterior margin rounded, extended below, subtruncate above. Valves nearly equal in size, the left slightly larger. Valves moderately convex, greatest convexity post median; posterior end somewhat compressed. Surface ornamented by strong scattered pits, corresponding to positions of normal canals; a conspicuous longitudinal broad furrow lying behind and slightly below middle of shell; an obscure dorsal longitudinal swelling and four weak subvertical furrows in dorsal third of valve. The anterior furrow trends obliquely forward and is suggestive of the anteromedian sulcus present in some Jurassic and Cretaceous cytherideids.

Hinge of right valve consists of terminal elongate, finely crenulate teeth and an interterminal, narrow, finely crenulate groove. Hinge of left valve correspondingly consists of terminal crenulate sockets and an interterminal high crenulate bar. Inner lamellae of moderate width, sloping steeply toward valve interior. Line of concrescence and radial canals not observed.

Length of a right valve 0.56 mm., height 0.30 mm.

Remarks: In general shape and surface ornamentation this form closely resembles *Haplocytheridea harrisi* (Stephenson) from the Nanafalia and Tuscahoma formations of the Wilcox group of Alabama. However, its hingement is that of *Clithrocytheridea* and not of *Haplocytheridea.* Three species of *Clithrocytheridea* in the Wilcox of Alabama are similar to the present form in outline and in coarsely ornamented surface: *C. nanafaliensis* (Stephenson), *C. alexanderi* (Stephenson), and *C. broussardi* (Howe and Garrett). *C. nanafaliensis* seems closest to the present species but, as illustrated it lacks the conspicuous posteromedian furrow. *Clithrocytheridea virginica* Schmidt from the Aquia formation of Maryland and Virginia possesses a submedian furrow but has a more acuminate posterior margin, and bears marginal swellings and enclosed furrows that are lacking in the present example.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, Dare County, N. C., core 2,593–2,603 feet, lower Eocene U.S.N.M. 560620.

Genus LOXOCONCHA Sars, 1865

Loxoconcha subrhomboidea Edwards

Plate 2, figures 18, 19

Loxoconcha subrhomboidea Edwards, 1944, Jour. Paleontology, vol. 18, p. 527, pl. 88, figs. 28–32.

Shell subrhomboidal in side view; highest about two-fifths from posterior end; hinge margin slightly convex, length about half of shell; ventral margin somewhat sinuous, slightly concave about one-third from anterior end; anterior margin rounded, extended below, slightly truncate ventrad of cardinal angle; posterior margin more broadly rounded, subacuminate to slightly caudate just above midheight. Valves of about equal size, greatest convexity median to somewhat postmedian. Free margins bear a narrow but distinct rim, broadest anteriorly. Marginal half of each valve bears 4 or 5 narrow concentric ridges. Surface closely but weakly pitted.

Hinge of right valve consists of the following elements: an anterior small socket; a postjacent and slightly more ventrad, small, elongate tooth dorsad of which is a small, inconspicuous socket; an interterminal narrow, very weakly crenulate groove; and a posterior curved tooth, concave ventrally, with a median saddle and with several weak markings on its surface. Hinge of left valve consists of an anterior curved tooth, concave ventrally, very low and weak posteriorly; an interterminal narrow, very weakly crenulate bar formed of narrow edge of valve; and a posterior hinge process consisting of the following elements, progressing posteriorly: a small socket, a small beaklike tooth, a larger socket, and a tiny, inconspicuous tooth. Ventral margin of right valve grooved for reception of an interlocking ridge in marginal portion of left valve.

Inner lamellae rather broad, with the greatest width anterior; posteriorly, lamellae formed as a rather broad platform, bounded on its inner side by a high knife-edged ridge; line of concrescence and inner margin widely separated terminally; ventrally they nearly coincide. Marginal pore canals few, simple, and widely spaced. Muscle scar consists of a slightly anteromedian curved row of four spots, concave anteriorly, and one large spot just in front of dorsal part of main group, a single spot located some distance in front of the main group, and two small spots anteroventrad of the main group.

Length of a figured specimen (pl. 2, fig. 18) 0.53 mm., height 0.31 mm., thickness 0.27 mm.

Remarks: The specimens from North Carolina wells were compared with the type of *L. subrhomboidea* Edwards. The weak concentric ridges are obscure except when the specimen is coated with ammonium chloride. The platform-like posterior portion of the inner lamellae is absent in some specimens and may be a dimorphic feature.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 75 feet, U.S.N.M. 560623 Esso Standard Oil Co.; Hatteras Light well no. 1, 320–330 feet, upper Miocene U.S.N.M. 560770; Edenton Naval Air Base well no. 4, Chowan County, 88 feet, middle Miocene U.S.N.M. 560768; Hatteras Light well no. 1, 1,090–1,100 feet, lower Miocene U.S.N.M. 560769. Described from

the Duplin marl, upper Miocene of North Carolina (Edwards, 1944, p. 527); present in Yorktown formation (upper Miocene) of Virginia.

Loxoconcha cf. L. reticularis Edwards

Loxoconcha reticularis Edwards, 1944, Jour. Paleontology, vol. 18, p. 527, pl. 88, figs. 26, 27.

Occurrence: Two examples from the upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 460–470 feet, U.S.N.M. 560747; described from exposures of Duplin marl in North Carolina.

Loxoconcha edentonensis Swain, n. sp.

Plate 2, figures 20, 21

Shell subovoid in side view; greatest height about median; dorsal margin gently convex; ventral margin nearly straight, passing with smooth curvature into posterior margin; anterior margin rounded, slightly truncate at dorsal bend; posterior margin broadly rounded, with median portion rather strongly curved. Valves approximately equal in size; greatest convexity in posterior portion of shell; posterior end compressed.

Entire margin of each valve bears a narrow, well defined, elevated rim. Mid-dorsally, exposed marginal rims flare apart to form a lenticular depression as seen in dorsal view. Entire surface ornamented by strong ridges that are concentrically arranged except in median portion, where they are short, discontinuous, and branching, but more or less longitudinal.

Hinge of right valve consists of an anterior small socket with postjacent and slightly more ventral rounded tooth, dorsad of which is a deep, short furrow; an interterminal narrow groove; and a posterior elongate, curved toothlike ridge, concave ventrally. Hinge of left valve consists of an anterior elongate, somewhat irregular toothlike ridge; an interterminal narrow bar formed of narrowed edge of valve, and a posterior, elongate, curved socket, below whose center is a small rounded tooth.

Muscle scar consists of an anteromedian curved row of four spots, a fifth spot lying just in front of dorsal part of main group, and a large spot considerably in front of main group. Inner lamellae fairly broad, line of concrescence and inner margin widely separated; posteriorly, inner lamellae form a small platform which, near its inner margin, is traversed by a distinct narrow ridge. Radial canals not clearly observed but seem to be few and widely spaced.

Length of holotype, a complete example, 0.65 mm., height 0.39 mm., thickness 0.32 mm.

Relationships: The ovoid shape and pattern of surface ridges apparently distinguish this species from other described members of *Loxoconcha*. The transverse ridges on the posterior portion of the inner lamellae resemble those of *L. subrhomboidea* Edwards, which is probably a related species.

Occurrence: Edenton Naval Air Base well no. 1, Chowan County, N. C., 40 feet, upper Miocene; U.S.N.M. 560626 and 560627.

Loxoconcha cf. L. mcbeanensis Murray

Plate 2, figures 22, 23

Loxoconcha mcbeanensis Murray, 1938, Jour. Paleontology, vol. 12, p. 591, pl. 68, figs. 7, 10.

The specimens from North Carolina apparently are examples of this species. Except for its greater length, this form is very similar to *Loxoconcha* sp. aff. *L. claibornensis* and may indicate sexual dimorphism. However, the two forms were obtained from different stratigraphic levels.

Length of a figured specimen (pl. 2, fig. 22) 0.44 mm., height 0.22 mm., thickness 0.18 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 feet, middle Eocene U.S.N.M. 560628. Described from the McBean formation, middle Eocene, of Georgia.

Loxoconcha sp. aff. L. claibornensis Murray

Plate 2, figures 16, 17

Shell subquadrate in side view; greatest height median; hinge margin straight, about five-eighths of shell length, with well-defined cardinal angles of which the anterior is the more obtuse; ventral margin nearly straight, passing with uniform broad curvature into posterior margin and bending more sharply into anterior margin; anterior margin broadly rounded, extended below, slightly truncate above; posterior margin broadly rounded, subacuminate a little dorsad of midheight, truncate above. Left valve slightly larger than right valve. Greatest convexity slightly postmedian.

Terminal areas strongly compressed. Margin of each valve bears a narrow distinct rim, continuous except at the postcardinal angle where there is an en echelon effect; a narrow groovelike depression forms inner boundary of rim along free margins. Remainder of shell ornamented by rather strong ridges and intervening pitted grooves; except anteriorly, outer series of ridges arranged more or less concentrically, exhibiting greatest strength in ventral region; more median series of ridges arranged longitudinally.

Internal features not observed owing to poor preservation.

Length of a complete example (plate 2, fig. 16) 0.42 mm., height 0.26 mm., thickness 0.21 mm.

Remarks: In describing *L. claibornensis* Murray (1938, p. 588) emphasized the concentrically arranged pits about the outer portion, and a reticulate pattern of pits on the midportion. He did not specifically refer to ridges separating the rows of pits, such as characterize the present examples, nor did he refer to marginal rims. Stephenson (1946, p. 315) described the surface ornamentation as consisting of small pits aligned between low, rounded ridges. He stated that the species exhibits considerable variation but did not refer to distinct marginal rims. *Loxoconcha corrugata* Alexander, from the Wills Point formation, Midway group, of Texas, is closely similar but the midventral portion of the valves is perhaps more strongly inflated. A new species is not erected on the basis of the North Carolina specimens because the internal characters are unknown. Additional specimens may reveal this form to be a connecting link between *L. corrugata* and *L. claibornensis.*

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 115–120 feet, middle Eocene U.S.N.M. 560622.

Loxoconcha cf. L. creolensis Howe and Chambers

Plate 2, figure 15

Loxoconcha creolensis Howe and Chambers, 1935, Louisiana Dept. Conserv. Geol. Bull. 5, p. 40, pl. v, fig. 13. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res. Bull. 2, p. 194, pl. 12, fig. 13.

Shell subquadrate in side view; greatest height median; hinge margin nearly straight, about two-thirds of shell length, bounded by broadly obtuse cardinal angles; ventral margin moderately convex, converging posteriorly with respect to dorsum; anterior margin broadly rounded, slightly extended below; posterior margin more narrowly rounded, extended and very slightly caudate above. Left valve slightly larger than right. Greatest convexity median.

Terminal margins provided with low, unornamented rims; antero-midventrally are two short ridges, adjacent and subparallel to valve margins. Prominent curving ridges, forming slight alate expansions, occupy median and posterior portions of ventral surfaces; in ventral view midventral portion of ridges overhangs valve margins. Median two-thirds of valves ornamented with conspicuous large pits that are in part arranged in longitudinal rows. A small eye tubercle lies just beneath anterior cardinal angle. Internal features not observed.

Length of figured specimen 0.35 mm., height 0.23 mm., thickness 0.19 mm.

Remarks: The present form is similar to *L. creolensis* Howe and Chambers in general shape and surface ornamentation; particularly the ventral alaeform ridges that slightly overhang midventral portion of shell, and the horizontal rows of pits. Positive identification is impossible because the internal features are not exposed in the present example.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 90 feet, middle Eocene, U.S.N.M. 560621. Described from the Jackson formation, upper Eocene of Louisiana (Howe and Chambers, 1935, p. 40), and also occurs in the subsurface Eocene of Maryland (Swain, 1948, p. 194).

Loxoconcha cf. L. surreala Murray

Plate 2, figure 24

Loxoconcha surreala Murray, 1938, Jour. Paleontology, vol. 12, p. 590, pl. 68, figs. 5, 8.

Shell subovate in lateral view; greatest height median; hinge margin slightly convex, about two-thirds of shell length; ventral margin gently convex, posteriorly converging with dorsum; anterior margin broadly rounded, slightly extended at ventral bend, truncate near dorsal bend; posterior margin narrowly rounded, extended and somewhat caudate a little above midheight, slightly concave above. Valves about equal, convexity moderate, greatest medially.

Ends rather strongly compressed; free margins bear narrow, low, but distinct rims; antero-midventrally, rims are absent at position of cythereid inturning of valve edges; narrow grooves bound marginal rims on their inner sides. Inner portion of surface of each valve ornamented as follows: a strong ridge subparallel and close to dorsal margin which gradually diverges from margin posteriorly and mid-dorsally extends rather strongly beyond margin of valve; a less distinct ridge that extends ventrally from anterior end of dorsal ridge to a point below midheight; posterior end of dorsal ridge bifurcates into a short spur directed toward posterior cardinal angle and a long curving ridge that runs subparallel to posterior and ventral margins as far forward as anteroventral and marginal bend; midventrally, this ridge is strongly elevated and forms a short ala; just above midheight is a narrow, moderately elevated, somewhat angularly sinuous, longitudinal ridge; below it is a shorter, curved, longitudinal ridge; short spurs are directed inward from submarginal ridges at several places, and similar spurs project from flanks of median longitudinal ridge.

Internal features not observable in single whole specimen at hand.

Length of figured specimen 0.38 mm., height 0.23 mm., thickness 0.20 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 135 feet, middle Eocene; U.S.N.M. 560629. Described from the Cook Mountain formation, Claiborne group, of Winn Parish, La. (Murray, 1938, p. 590).

Genus TRACHYLEBERIS, Brady, 1898

Trachyleberis evax (Ulrich and Bassler)

Plate 3, figures 1–3

Cythere evax Ulrich and Bassler, 1904, Geol. Survey, Miocene vol., p. 119, pl. 36, figs. 6–8.
Cythere evax oblongula Ulrich and Bassler, idem., figs. 9, 10.
Cythereis evax (Ulrich and Bassler), van den Bold, 1946, Contrib. to the Study of Ostracoda, Amsterdam, p. 90, pl. 21, fig. 19. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 204, pl. 12, figs. 19, 20.

The external features of the shell were described in detail by Ulrich and Bassler (1904, p. 119). In the specimens at hand, the submedian ridgelike swelling is weak on the elongate specimens (*T. evax oblongula*), but weak on the shorter ones. The surfaces of the valves are coarsely reticulate, with prominent nodes occurring principally at junctions of reticulating ridges, but also along their crests in some areas.

Hinge of right valve consists of an anterior high tooth bearing a depression on its ventral slope; a postjacent deep rounded socket; a long interterminal very minutely crenulate groove that expands into a shallow elongate socket at its posterior end; and a posterior high rounded tooth bearing several indistinct markings on its flattened summit. Hinge of left valve not observed.

Muscle scar lies in a large depression that externally forms the anteromedian swelling; scar consists of a subvertical row of several spots, but additional details could not be observed because of poor preservation. Inner lamellae rather broad; inner margin and line of concrescence are separated except along midportion of ventrum. About 30 radial canals occur about anterior end, mostly in pairs; posterior and ventral radial canals fewer but not clearly visible. Normal canals widely spaced, terminating interiorly in deep pits. A narrow groove for reception of a corresponding ridge on left valve borders free margins of right valve.

Length of a male left valve (pl. 3, fig. 1) 0.94 mm., height 0.50 mm.; length of a female left valve (pl. 3, fig. 3) 0.85 mm., height 0.50 mm.

Remarks: The shape, ornamentation, and hingement identify this species with *Trachyleberis* Brady, as emended by Sylvester-Bradley (1948, p. 794). The species is present in the middle and lower Miocene of North Carolina. Perhaps *T. evax oblongula* (Ulrich and Bassler) is a male dimorph and the specimens considered by Ulrich and Bassler to be typical of the species are female dimorphs. The writer does not agree with van den Bold (1946, p. 90) that *T. oblongula* represents the adult of the species and that the shorter but equally high forms are immature molts. A specimen believed to be an immature molt is figured on plate 3, fig. 2.

Occurrence: Trachyleberis evax occurs in the Esso Standard Oil Co. Hatteras Light well no. 1 middle Miocene at 810–820 feet (U.S.N.M. 561416) and below, lower Miocene at 1,200–1,210 feet (U.S.N.M. 560773), and in questionable Oligocene or lower Miocene at 1,540–1,550 feet (U.S.N.M. 561417). The species was described by Ulrich and Bassler (1904, p. 119) from the Calvert formation at Plum Point, Md., and was also reported from the Chesapeake group at Yorktown, Va.

Van den Bold (1946, p. 90) reports the species from 8 localities in the Oligocene of Cuba, but it is not evident from his illustrations (pl. 10, figs. 19a–d) that he is dealing with *T. evax*. There are no exterior views and the line drawings of the interiors of several specimens do not reveal the prominent, rounded posterior hinge-tooth characteristic of the species.

Trachyleberis rosetta Swain, n. sp.

Plate 3, figure 7

Shell subquadrate in lateral view; dorsal margin nearly straight, about three-fourths of shell length; ventral margin slightly convex, converging posteriorly with respect to dorsum; anterior margin broadly rounded, truncate above; posterior margin more narrowly rounded. Left valve larger than right, greatest overlap at anterodorsal marginal bend. Surface has large, numerous pustules, widely spread, strongly elevated, and bearing 4 to 5 small papillae at their crests; between the pustules, surface covered by small papillae. Each valve has a narrow depressed, unornamented median area. Terminal margins bear a row of small pustules.

Hingement and other internal features not observed.

Length of holotype 0.85 mm., height 0.52 mm., thickness 0.47 mm.

Relationships: The only specimen obtained was found in association with *Trachyleberis evax* (Ulrich and Bassler) which it resembles in shape, but the papillate pustules are more widely spaced, tiny pustules cover the surface between the larger ones, and the low longitudinal ridge is lacking.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 840–850 feet, middle Miocene, U.S.N.M. 560636.

Trachyleberis? martini (Ulrich and Bassler)

Plate 3, figures 8, 15

Cythere martini Ulrich and Bassler, 1904, Maryland Geol. Surv. Miocene Vol., pp. 112–113, pl. 36, figs. 11–15.

Cythereis martini (Ulrich and Bassler), Swain, 1948, Maryland Dept. Geol., Mines, and Water Res., Bull. 2, p. 196, pl. 12, figs. 16, 17.

Shell subquadrate in lateral view; highest about one-fourth from anterior end; dorsal margin made sinuous by the high anterocardinal angle and postdorsal projection of valve surface; ventral margin nearly straight, posteriorly converging slightly toward dorsum; anterior margin broadly rounded, extended below, and bearing a fringe of tiny spines along ventral two-thirds; posterior margin narrower, rounded and finely spinose below, concave above. Left valve slightly larger and extending beyond the other at cardinal angles.

Free margins bear a narrow rim, bounded on its inner side by a narrow groove; both ridge and groove are distinct, except midventrally. Area enclosed by submarginal grooves coarsely reticulate; the pits elongated longitudinally. Just anterior of middle is a low swelling with a faint furrow behind it. A ridge, slightly more prominent than others of the reticulum extends sinuously from near post-cardinal angle obliquely and forward. Two other similar more prominent ridges occur behind median swelling above midheight. Small eye tubercles lie beneath anterior cardinal angles.

Hinge of right value consists of an anterior, ovate, coarsely crenulate tooth and postjacent small socket, a narrow finely crenulate interterminal groove, and a posterior elongate tooth whose surface is irregular but not crenulate. Hinge of left valve the antithesis of right, but interterminal bar is only faintly crenulate in a few places. Line of concrescence and inner margin nearly coincide; inner lamellae rather broad. Marginal pore canals numerous; about 30 in anterior half of shell; some occur in pairs, others are single.

Length of figured specimen 0.61 mm., height 0.31 mm., thickness 0.27 mm.

Remarks: In general shape and in surface ornamentation this form resembles *Trachyleberis* Brady, but the anterior hinge tooth and socket are crenulate as in *Cythereis* Jones. The posterior tooth and socket, although irregular, are not crenulate. The specimen figured here (plate 3, fig. 8) differs from some examples of *T. martini* in that it is more nearly equivalved, lacks the smooth posterior end and the postventral nodelike swelling. In the writer's collection from the same zone of the subsurface of Maryland are examples both of typical *T. martini* and of forms identical with those described here. The atypical specimens from Maryland are generally smaller than typical *T.? martini* and probably represent immature molts, but the specimens from North Carolina are evidently mature.

Occurrence: Upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 210–220 feet, U.S.N.M. 560776; North Carolina Esso well no. 2, 290–300 feet; Edenton Naval Air Base well no. 1, 30 feet, U.S.N.M. 560778; Edenton no. 4 well, 45 feet, Middle Miocene, U.S.N.M. 560777; Edenton no. 1 well, 50–55 feet, U.S.N.M. 560779, 560637; Williamston test well no. 2, 90–95 feet, U.S.N.M. 560781. Lower Miocene, Hatteras Light well no. 1, 1,160–1,170 feet, U.S.N.M. 560780. The species occurs in the Choptank and Calvert formations of Maryland, the Chesapeake group at Yorktown, Va. (Ulrich and Bassler, 1904, p. 113), and in the Calvert formation of the subsurface of Maryland (Swain, 1948, p. 196).

Trachylebris? cf. T. micula (Ulrich and Bassler)

Text figure 3*l*

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

The present specimen differs from *T.? martini* (Ulrich and Bassler) in its smaller size and weaker ornamentation. *Trachyleberis micula* may include immature molts of *T. martini.*

Occurrence: Upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 170–180 feet, U.S.N.M. 560728; Calvert formation of Maryland and the Chesapeake group of Virginia.

Trachyleberis? cf. T? angulata (Sars)

Plate 3, figures 9–12

Cythereis angulata Sars, 1865, Oversight Forhandlingar Norges Ostracoda, Videnskabsselskabet, Christiana, p. 40.

Cythere clathrata nuda Brady, 1886, Zool. Trans., vol. 5, p. 377, pl. 59, figs. 9, 10.

Cythere angulata (Sars), Brady, 1868, Mon. Recent British Ostracoda, p. 409, pl. 26, figs. 39–42. Brady, Crosskey, and Robertson, 1874, Post-Tertiary Entomostraco, Paleontographical Soc., p. 162, pl 4, figs. 21–24, pl. 10, fig. 22. Brady and Norman, 1889, Roy. Dublin Soc. Trans., vol. 4, ser. 2, pt. 2, p. 165.

Not *Hemicythere angulata* (Sars), Sars, 1923–1928, Curstacea of Norway, p. 187, pl. 86. fig. 2.

Shell subovate in lateral view; dorsal margin nearly straight, about 0.7 of shell length; greatest height at anterodorsal marginal bend, about one-fourth from anterior end; ventral margin slightly convex, converging posteriorly toward dorsum; anterior margin broadly rounded, extended below, slightly truncate above; posterior margin narrowly rounded, extended below, slightly angulate above. Left valve larger than right,

overlapping and extending beyond the other most in anterodorsal region.

Valves have distinct marginal rims. A low swelling, bearing several pits lies slightly below and in front of center; a smaller swelling lies just behind and above the other. A low dorso-median ridge lies parallel to dorsal and postdorsal margins, and the ventral surface bears a narrow longitudinal ridge; posterior terminations of these two ridges elevated. Surface within marginal rim coarsely reticulate. Eye tubercles below anterodorsal marginal bend, distinct, and surrounded by a low swelling.

Hinge of right valve consists of an anterior high reniform tooth; a postjacent deep socket; an interterminal crenulate groove expanding posteriorly to form a shallow, elongate socket; and a posterior high oval tooth. Hinge of left valve consists of an anterior large socket, a postjacent rounded tooth; a strong interterminal crenulate bar ending in a small blunt tooth; and a posterior oval oblique socket.

Muscle scar lies on the posterior slope of a large submedian internal depression. It is composed of a subvertical row of 3 or 4 elongate parallel spots, and at least three more anterior spots. Inner lamellae broadest anteriorly; inner margin and line of concrescence only slightly separated. Pore canals not clearly observed.

Length of a figured left valve (pl. 3, fig. 9) 0.77 mm., height 0.48 mm.

Remarks: In outline and hingement this species resembles *Hemicythere* Sars, but the submedian swelling, submarginal ridges terminating in blunt elevations, and the muscle scar pattern ally it to *Trachyleberis* with which it is here tentatively placed. The specimens at hand are close to "*Cythereis*" *macropora* Sars in general shape and ornamentation. The status of *T? angulata* is obscured by the fact that Sars (1928, p. 187) referred it to *Hemicythere*, but his description of the shell, and his illustrations (pl. 86, fig. 2) deal with an entirely different form.

Occurrence: Edenton Naval Air Base well no. 4, Chowan County, N. C., 70 feet, middle Miocene; U.S.N.M. 560638; previously reported from the Quaternary of Europe, North America, and Spitzbergen.

Trachyleberis? cf. T? reesidei (Swain)

Plate 3, figure 13

Cythereis reesidei Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 199, pl. 14, fig. 3.

Shell of the present specimen subovate in lateral view; dorsal margin slightly convex; greatest height about one-fourth from anterior end; ventral margin gently convex, converging posteriorly toward dorsum; anterior margin broadly rounded, extended below, subtruncate above; posterior margin narrowly rounded, extended below. Left valve larger than right, greatest overlap in anterodorsal region.

Entire margin of each valve bears a narrow, well defined, slightly elevated rim. A broad sparsely pitted swelling lies slightly behind and below middle of shell. Low dorsal and ventral swellings lie on posterior slope of each valve; low ridges converge backward from each swelling. Surface of valves coarsely reticulate. Eye spots distinct, in low anterodorsal swellings. Internal features not observed.

Length of figured specimen 0.79 mm., height 0.47 mm., thickness 0.38 mm.

Remarks: The hingement, subcentral node, and marginal rims of this species relate it to *Trachyleberis* Brady, but the subovate outline prevents definite classification. Externally, the species is indistinguishable from *T.? reesidei* (Swain) (1948, p. 199) from the subsurface Upper Cretaceous of Maryland. The present specimen from the upper Miocene of North Carolina may have been reworked, although there is no direct evidence. The stratigraphic position of the original occurrence in a core sample from Maryland is much more certain. In general shape and ornamentation the species is close to "*Cythereis*" *theeli* Skogsberg (1928, p. 106), but surface pitting differs slightly.

Occurrence: Harvey Neck well, Perquimans County, N. C., 43–46 feet; upper Miocene; U.S.N.M. 560639.

Trachyleberis? rukasi (Gooch)

Plate 4, figures 8–10

Cythereis rukasi Gooch, 1939, Jour. Paleontology, vol. 13, p. 586, pl. 67, figs. 20–22.

Shell subquadrate in side view; highest one-fourth from anterior end; hinge margin nearly straight, about three-fifths of shell length; ventral margin nearly straight to slightly convex, converging posteriorly toward dorsum; anterior margin broadly rounded, slightly extended below; posterior margin subacuminately rounded, strongly extended below, truncate to slightly concave above. Left valve larger than right, extending beyond it most along dorsal slopes. Greatest convexity about median.

Free margins have a narrow distinctly elevated rim. Postventrally there are several low, blunt spines. Rounded, well-developed, eye tubercles at anterocardinal angles. Posterior third of shell compressed. Just in front of and below posterior cardinal angle is a prominent node from which an irregular, slightly nodose ridge extends forward and terminates about at

midlength but well below dorsal margin; a short ridge extends downward from node, parallel to posterior margin. About one-third from posterior end along ventrum is a second prominent node that forms the posterior termination of a long midventral alaform ridge. A low ridge connects the two postmedian nodes. Just in front of middle is a prominent rounded node from which in dorsal, ventral, and posterior directions radiate 6 or more irregular, in part bifurcated ridges; 3 of these ridges are higher and end in small nodes.

Hinge of right valve consists of an anterior rounded tooth and postjacent socket, supported by a thickened subjacent cardinal process; an interterminal narrow, very faintly denticulate groove; and a posterior rounded tooth. Hinge of left valve the antithesis of right, with the interterminal ridge faintly denticulate and formed of the narrowed valve edge. Muscle scar not clear but probably consists of four spots in a curved row around posterior and dorsal flanks of median depression on interior of each valve, and additional spots in anterior part of depression. Inner lamellae broadest anteriorly; line of concrescence and inner margin nearly coincide except in a narrow anterior zone. Radial canals numerous, some in twos or in threes.

Length of a figured specimen (plate 4, fig. 8) 0.52 mm., height 0.27 mm., thickness 0.21 mm.

Remarks: This is one of the cythereisid group that bear dorsal and ventral longitudinal ridges terminating posteriorly in pointed nodes. It is uncertain whether *Trachyleberis* should include such forms.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 115–120 feet, middle Eocene; U.S.N.M. 560649. Described from the Cook Mountain formation, middle Eocene of central Louisiana.

Trachyleberis? sp. aff. T? communis aquia (Schmidt)

Plate 4, figure 11

An abraded left valve doubtfully referred to *Trachyleberis* exhibits the following features:

Subquadrate in lateral view; highest about one-fourth shell length from anterior end at position of the cardinal angle; hinge margin about two-thirds of shell length, slightly concave just behind antero-cardinal angle; ventral margin nearly straight or slightly convex, rising posteriorly in relation to dorsum. Anterior margin broadly rounded, slightly extended below and bearing five thick, blunt spines along its ventral half; posterior margin more narrowly rounded, bearing several blunt spines. Greatest convexity posteromedian.

Anterior end bears a broad, coarsely pitted, marginal ridge that merges with general surface of valve just behind anteroventral bend; a rounded, probably imperfectly preserved eye tubercle lies at anterodorsal angle. Posterior one-fifth of valve compressed, with a narrow marginal rim; surface merges smoothly with the elevated median portion of valve. Anteriorly, a broad furrow, having several low, narrow cross-ridges, separates marginal rim from median surface; an anterior boundary of the latter is an inconspicuous curved ridge. Medially, there is a large rounded swelling, with a rather broad longitudinal ridge extending backward to margin of raised median area; near its junction with median swelling, ridge somewhat narrower, and ventrad of this narrowness lies a low, ovate, broad swelling. Midventral and postventral surface forms a small alate expansion that terminates posteriorly in a rounded elevation. A similar low ridgelike expansion, parallel to hinge margin, also ends in a posterior elevation. General median surface coarsely pitted, perhaps in a reticulate pattern, although shell is so abraded that these details are not clear.

Hinge of left valve consists of an anterior deep socket and postjacent large blunt tooth, both supported beneath by a thickening of shell wall; a long thick interterminal ridge, bounded dorsally by a faint groove; and a posterior large socket. Inner lamellae fairly broad, inner margin uniformly curved, nearly coinciding with line of concrescence. Radial canals and musculature not observed.

Length of figured specimen 0.61 mm., height 0.36 mm.

Remarks: This shell resembles *T.? communis aquia* (Schmidt) but is somewhat more quadrate, higher in proportion to length, and has a subsidiary swelling below the postmedian longitudinal ridge that is not present in the examples from Maryland.

Occurrence: Esso Standard Oil Co. N. C. Esso well no. 2, 1,810–1,820 feet, lower Eocene; U.S.N.M. 560650. *T. aquia* was described from the Aquia formation (Paspotansa greensand marl member) of Maryland (Schmidt, 1948, p. 420).

Trachyleberis hilgardi (Howe and Garrett)

Plate 4, figures 14–16, 20, plate 5, figures 2–5, 16

Cythereis hilgardi Howe and Garrett, 1934, Louisiana Dept. Conserv. Geol. Bull. 4, p. 53, pl. 4, figs. 14, 15.

Cythereis siegristae Schmidt, 1948, Jour. Paleontology, vol. 22, p. 421, pl. 64, figs. 5–9.

Shell subquadrate in lateral view; greatest height slightly more than one-fourth from anterior end; hinge margin nearly straight, about three-fourths of shell length, with well-defined cardinal angles of which the posterior is the more obtuse. Ventral margin slightly concave medially; anterior margin broadly rounded, extended below, fringed with a double row of small spines; posterior margin more narrowly rounded,

obtusely angulated medially, and bearing about 5 coarse spines. Left valve larger than right, extending beyond the other most at cardinal angles. Valves moderately convex, greatest convexity about median.

Shells that are higher but not much longer are presumed to represent females.

Anterior end of each valve provided with a distinctly elevated, slightly nodose rim separated from spinose margin by a narrow pitted groove; near its dorsal termination, rim bears a lucid eye tubercle. Posteriorly and ventrally, marginal area of each valve bears a narrow ridge that swings inward and terminates in the highly ornamented valve surface, about one-fifth from anterior end; along its posterior course ridge bears marginal spines previously mentioned. Middle half of dorsal marginal area in each valve bears a nodose ridge that sends 4 or 5 spurlike ridges ventrally, and at its posterior termination bends ventrally nearly to midheight. About one-third from anterior end is a small reticulate median swelling, before which are several reticulating ridges. Behind the swelling is a narrow longitudinal ridge with several side spurs that merges with end of ventrally extended dorsal ridge. Below midheight is a long, discontinuous ridgelike elevation with many side spurs. At first glance the valves appear to be coarsely reticulate, but the writer believes that the ornamentation can be more accurately described as a pattern of ridges with accompanying spurlike projections.

All available shells of this description are firmly closed, and internal features could not be observed.

A figured specimen (plate 5, fig. 3) measures, length 0.69 mm., height 0.35 mm., thickness 0.28 mm.

Remarks: According to Stephenson (1946, p. 340), this species is close to *Trachyleberis stenzeli* (Stephenson) but is less strongly spinose. *T. siegristae* (Schmidt) (1948, p. 421) from the Aquia formation of Maryland and Virginia is so similar that it is placed in synonymy. *T. marginoreticulata* (Swain) (1948, p. 197) lacks the longitudinal ridges of *T. hilgardi* and is more completely reticulate. In these respects, *T. marginoreticulata* is like *T. smithvillensis* (Sutton and Williams) from the Weches formation of Texas, and although the latter is not so narrowly rounded posteriorly, the two species may prove to be synonymous.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 115–165 feet, middle Eocene U.S.N.M. 560661, 560662, 560663; Esso Standard Oil Co. Hatteras Light well no. 1, 2,390–2,400 feet and 2,531–2,541 feet (core), lower Eocene U.S.N.M. 560651 and 560652; described from the Nanafalia formation, Wilcox group, at Pendleton, Tex. (Howe and Garrett, 1934, p. 53).

Trachyleberis stenzeli (Stephenson)

Plate 4, figures 17, 18, 22, plate 5, figure 1

Cythereis hilgardi Howe and Garrett, Stephenson, 1944, Jour. Paleontology, vol. 18, p. 450, pl. 76, fig. 1.

Cythereis stenzeli Stephenson, 1946, idem., vol. 20, p. 340, pl. 45, fig. 5.

Shell subquadrate in side view; greatest height about one-fourth from anterior end; hinge margin straight, about three-fourths of shell length, terminating in well defined cardinal angles of which the posterior is the more obtuse. Ventral margin gently convex, converging posteriorly with dorsum; anterior margin broadly rounded, slightly extended below, fringed with a double row of small spines; posterior margin narrowly rounded, acuminate medially, coarsely and strongly spinose below, weakly spinose above, with most of ventrally located spines bifurcating in well preserved specimens. Left valve larger than right, extending beyond the other most at cardinal angles. Valves moderately convex, greatest convexity slightly postmedian.

Anterior end bears a narrow, strongly elevated, discontinuous rim; dorsally, rim is high and unbroken; ventrally, it is lower and bears several blunt spines. Anterodorsally is a well-defined eye tubercle with postjacent bifurcate, blunt spines. Along hinge margin are three stout, bifurcating spines and behind them a fourth smaller spine. Posterior end and posterior half of ventrum bear a low, narrow, marginal rim on which lie the marginal spines. Median part of each valve separated from marginal rims by a rather broad shallow furrow, but furrow terminates antero-midventrally, in ventral part of more elevated median portion of shell. Latter area coarsely reticulate and bears a longitudinal submedian, somewhat oblique, ridgelike swelling with a conspicuous node just in front of shell middle, and has bluntly spinelike projections at several other positions. A more oblique and less conspicuous longitudinal ridge that bears several blunt, bifurcated spines or strong nodes, occupies a lower position. Postdorsally is a high, narrow transverse plate that in well-preserved specimens is concave toward the posterior. Male dimorphs (pl. 5, fig. 1) relatively more elongate and slightly less convex than females (pl. 4, figs. 18, 22).

Hinge of left valve consists of an anterior deep rounded socket; a postjacent high rounded and bluntly pointed tooth; a long interterminal ridge that ends posteriorly as a small swelling and is bounded dorsally by a faint groove; and a posterior slightly ovate socket

that opens ventrally just beneath blunt end of interterminal ridge. Hinge of right valve the antithesis of left. Inner lamellae bear faint concentric striae; line of concrescence and inner margin coincide. Radial canals not clearly observed. Muscle scar lies in a rounded anteromedian depression represented by the conspicuous external node, but its details could not be determined.

Length of a male dimorph (pl. 5, fig. 1) 0.87 mm., height 0.42 mm.

Remarks: In general shape, marginal spines, surface reticulation, longitudinal spiny ridges, and postdorsal short subvertical plate, all the present specimens resemble *T. stenzeli* (Stephenson).

Stephenson (1946, p. 340) had difficulty in distinguishing *T. stenzeli* from *T. hilgardi* (Howe and Garrett) and the same problem is encountered in the North Carolina material. The two species are associated in the collections from the Naval Auxiliary Air Base well at Washington, N. C. The specimens here assigned to *T. hilgardi* are not so spinose as *T. stenzeli* and their two longitudinal ridges bear spurlike projections on each side, rather than spines on the ridges themselves. Both species have a short postdorsal subvertical ridge or plate on each valve, but that of *T. hilgardi* is not strongly elevated.

Trachyleberis exanthemata (Ulrich and Bassler) of the Miocene, and *T. orelliana* (Stadnichenko) of the middle Eocene are very close to *T. stenzeli* but are not reticulate. The short, postdorsal, subvertical ridge or plate is present in *T. exanthemata* and also in several species of *Cythereis* in rocks as old as the Washita group, Lower Cretaceous (*C. worthensis* Alexander). The plate is well developed in *C. austinensis* Alexander of the Austin group, Upper Cretaceous, and *C. midwayensis* of the Midway group, Paleocene. Species possessing this feature may seem to form a natural group, but such a grouping would put together species that differ in several important characters. The ridge may be an isomorphous structure developed, perhaps as a strengthening or stabilizing feature, by several unrelated species of *Cythereis* and of *Trachyleberis*.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 100–135 feet, middle Eocene, U.S.N.M. 560654, 560655, 560660; Esso Standard Oil Co. Hatteras Light well no. 1, drill-cutting sample 1,860–1,870 feet, middle Eocene, U.S.N.M. 560653; 2,390–2,400 feet, core, 2,531–2,541 feet, lower Eocene; previously recorded from the Weches formation, middle Eocene of Texas (Stephenson, 1946, p. 340).

Trachyleberis davidwhitei (Stadnichenko)

Plate 4, figure 19, plate 5, figures 6, 7

Cythereis davidwhitei Stadnichenko, 1929, Jour. Paleontology, vol. 1, p. 240, pl. 39, fig. 24. Stephenson, 1946, idem., vol. 20, p. 336, pl. 44, fig. 5, pl. 45, fig. 12.

Cythereis quinquespinosa Sutton and Williams, 1939, idem., vol. 13, p. 566, pl. 63, figs. 10, 11.

Shell subquadrate in lateral view; highest about one-third from anterior end; hinge margin straight, about four-sevenths of shell length, bounded by distinct but widely obtuse cardinal angles; ventral margin nearly straight, posteriorly converging moderately toward dorsum; anterior margin broadly rounded, slightly extended below, and bearing about 15 small stout spines on each valve; posterior margin narrowly rounded to subacuminate, extended medially, truncate to slightly concave above, its ventral portion bearing 7 or more stout spines of variable size, most of the larger ones bifurcated. Left valve slightly larger than right, extending beyond the other most at anterior cardinal angle. Females relatively higher than males.

Anterior end bears a marginal rim that terminates dorsally in a rounded transluscent eye tubercle, and dorsad of midheight is high and narrow; medially and ventrally it consists of a series of various-sized stout nodes and a few blunt spines. Posterior margin provided with a narrow, low, well-defined rim that extends forward beyond midlength. Shallow grooves bound each terminal marginal rim or inner side. Dorsal margins of each valve bear several long, thick spines; one lies just behind eye tubercle, three are in dorsal midsection, a fourth lies near posterior end of hinge and is connected to another spine just below it by a thickening of shell. Slightly in front of midlength a high, thick spine rises from a rounded swelling; two or three spines lie behind, and one or two spines lie below it; these spines form a row that dorsally curves slightly backward. A row of five stout spines along midventral surface more or less parallels the ventral margin. Between spines surface is smooth. Internal features not observed.

Length of a female (pl. 5, fig. 7) 0.68 mm., height 0.39 mm., thickness 0.23 mm.; length of a male (pl. 5, fig. 6) 0.68 mm., height 0.32 mm., thickness 0.21 mm.

Remarks: The present specimens closely resemble *T. davidwhitei* (Stadnichenko) in shape and ornamentation. The species, as described, has several spines just below posterior end of the hinge, whereas the North Carolina specimens have but one.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 115–120 feet, 130 feet, middle Eocene, U.S.N.M. 560664, 560665; Esso Standard Oil Co., North

Carolina Esso no. 2, 1,610–1,620 feet, middle Eocene, U.S.N.M. 560772; North Carolina Esso no. 1, core, 2,531–2,541 feet, lower Eocene, U.S.N.M. 560656; and in the Yegua and Weches formations, middle Eocene of Texas (Stadnichenko, 1929, p. 240, Stephenson, 1946, p. 336).

Trachyleberis? pellucinoda (Swain)

Plate 4, figure 24, plate 5, figure 10

Cythereis pellucinoda Swain, 1948, Maryland Dept. Geol., Mines, and Water Res., Bull. 2, p. 200 (pl. 14, figs. 1, 2).

Shell subquadrate in lateral view; highest about one-third from anterior end; hinge margin nearly straight, about two-thirds of shell length; ventral margin sinuous, slightly concave medially; anterior margin broadly rounded, slightly truncate above; posterior margin narrowly rounded, extended below, truncate above. Left valve larger than right, extending beyond the other noticeably only at anterior cardinal angle and along postdorsal slope. Posterior end compressed; greatest convexity about median.

Free margins of each valve bear a narrow but distinct, moderately elevated rim; well-preserved specimens have a fringe of tiny spines along anterior, and along ventral half of posterior margins. Lucid, rounded eye spots situated anterodorsally. A narrow ridge, not well preserved in worn specimens, roughly parallels hinge margin but curves slightly away from margin near its anterior termination just above eye tubercle. A conspicuous longitudinal ridge extends from just below and behind eye tubercle posteriorly to a point below postcardinal angle, doubles back downward and forward to terminate at midlength; ridge highest posteriorly, where it forms the postdorsal node characteristic of the genus; three to four low, subvertical cross-ridges connect dorsal and ventral limbs of ridge. A conspicuous rounded, lucid node occupies a slightly anteromedian position; in front of node are three to four low, short, longitudinal ridges. Below the node a longitudinal ridge extends along nearly whole length of ventrum and posteriorly is expanded into a short ala. Raised median surface pitted in a roughly reticulate pattern.

Most internal characters obscured. Anteriorly, radial canals are numerous and appear to occur in groups of two or three.

Length of a figured specimen (pl. 4, fig. 24) 0.48 mm., height 0.26 mm., thickness 0.21 mm.

Remarks: The outline and the ornamentation of the present specimens agree closely with those of *T.? pellucinoda* (Swain) from the Aquia formation of Maryland. On the holotype the ventral limb of the double postdorsal ridge is less strong than on the specimens described here, but the difference is not sufficient to distinguish the two forms.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 and 165 feet, middle Eocene, U.S.N.M. 560658 and 560669.

Trachyleberis? bassleri (Ulrich)

Plate 5, figures 8, 11–15

Cythereis bassleri Ulrich, 1901, Maryland Geol. Survey, Eocene, p. 120, pl. 16, figs. 19–21. Weller, 1907, Geol. Survey New Jersey Paleontology, vol. 4, p. 843, pl. 110, figs. 1–3. ?Cushman, 1925, Bull. Am. Assoc. Petroleum Geologists, vol. 9, p. 302, pl. 8, figs. 3a–c. Alexander, 1934, Jour. Paleontology, vol. 8, p. 219. ?Jennings, 1936, Bull. Am. Paleontology, vol. 23, no. 78, p. 51, pl. 7, figs. 1a–b. ?Van den Bold, 1946, Contrib. to the Study of Ostracoda, Amsterdam, p. 94, pl. 6. fig. 20. Schmidt, 1948, Jour. Paleontology, vol. 22, p. 422, pl. 64, fig. 13. Swain, 1948, Maryland Geol. Survey, Bull. 2, p. 197, pl. 13, fig. 7.

Cythereis bassleri lata Jennings, 1936, Bull. Am. Paleontology, vol. 23, no. 78, p. 52, pl. 7, figs. 2a–b.

Cythereis claibornensis Gooch, 1939, Jour. Paleontology, vol. 13, p. 581, pl. 67, figs. 5, 6, 10. Stephenson, 1946, idem., vol. 20, p. 336, pl. 45, fig. 4.

Cythereis bassleri reticulolira Schmidt, 1948, idem., vol. 22, p. 423, pl. 64, figs. 14, 15.

Cythereis plusculmenis Schmidt, 1948, Jour. Paleontology, vol. 22, p. 422, pl. 64, figs. 2–4.

Paracythereis potomaca Schmidt, idem., p. 419, pl. 64, figs. 18, 19.

Shell subquadrate in lateral view; highest about one-fourth from anterior end; hinge margin nearly straight, about three-fourths of shell length; ventral margin straight, posteriorly converging moderately toward dorsum; anterior margin broadly and nearly uniformly rounded, fringed with small spines; posterior margin more narrowly rounded, truncate to slightly concave above, extended medially, and bearing several coarse spines below. Left valve slightly larger than right, extending beyond the other only at anterior cardinal angle.

Anterior and posterior one-fifth of each valve compressed; parallel to free margins of each valve is a narrow distinct rim. As viewed from beneath, opposing rims diverge from margins and just in front of midlength enclose a shallow depression formed by inward turning of valve edges, a podocopid characteristic (pl. 5, fig. 13). Anterodorsally, marginal rim ends in a small eye tubercle that is bounded above and on either side by a narrow groove. A narrow ridge rises near anteroventral marginal bend, extends backward and upward with increasing height, thus forming a small midventral ala; at a point about one-third shell length from posterior end (where it attains its greatest altitude) ridge bends abruptly toward dorsum, extends obliquely to near posterocardinal angle, then bends acuminately and

extends forward and slightly downward to nearly one-third shell length from anterior end. In most specimens there is a slight dip in ridge just in front of its posterodorsal angulation. Anteromedially is a large, high, rounded node, steepest on its posterior slope. Entire surface within marginal rims, coarsely reticulate. In front of median node in most specimens are three short longitudinal ridges of which the most ventral is the strongest. Above and before submedian node in a large. (and possibly worn) shell that lacks anteromedian ridges reticulation has a slightly spiral arrangement (pl. 5, fig. 8).

Internal features not observed in the examples from North Carolina. The hingement of specimens from the subsurface of Maryland has been described (Swain, 1948, p. 197).

Remarks: The writer considers the present specimens conspecific with *T.? bassleri* (Ulrich) from the Aquia formation at Upper Marlboro, Md. Ulrich remarked (1901, p. 121), "considering that the specimens studied present considerable variation in surface sculpture, it is possible that they represent more than a single specific type." Ulrich's types have only weak anteromedian longitudinal ridges, possibly because of abrasion, and are most like figure 8, plate 5 of this paper. The other specimens of the present collection have the short anteromedian ridges preserved in various degrees of perfection. The best preserved shells have the strongest ridges. Comparison with hypotypes shows them to be conspecific with *T.? claibornensis* (Gooch) (1939, p. 581). This species is therefore placed in synonymy with *T.? bassleri*. *Trachyleberis? plusculmenis* (Schmidt) (1948, p. 422) is a slight variant of typical *T.? bassleri* in that there are two and not three ridges in front of the median node. It thus resembles *T.? bicarinata* (Swain) (1946, p. 376) which is, however, much more strongly sculptured. *T.? bassleri reticulolira* (Schmidt) (1948, p. 423) closely resembles Ulrich's syntypes of *T.? bassleri*. *Paracythereis potomaca* (Schmidt) (1948, p. 419) appears to be based on somewhat abraded specimens of an immature molt stage of *T.? bassleri*.

The generic position of the species is in doubt. The terminal elements of the hinge are not crenulate as in *Cythereis* and the species is therefore closer to *Trachyleberis* Brady as emended (Sylvester-Bradley, 1948, p. 794). In common with *T.? rukasi* (Gooch) and some other cythereisid ostracodes, *T.? bassleri* differs from typical *Trachyleberis* in possessing well defined dorsal and ventral longitudinal ridges that terminate posteriorly in elevated nodes. It may prove advantageous to erect a genus including such forms.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 100 and 165 feet, middle Eocene, U.S.N.M. 560666, 560667; Esso Standard Oil Co. N. C. Esso well no. 2, 1,610–1,620 feet, middle Eocene, U.S.N.M. 560771. It occurs in the Aquia formation of Maryland and Virginia (Ulrich, 1901, Schmidt, 1948, Swain, 1948), in the Claiborne group of Texas and Louisiana (Gooch, 1939, Stephenson, 1946). In a collection obtained by F. S. MacNeil in Sec. 15, T. 3 N., R. 19 E., Coffee County, Ala., just below Pea River bridge, *T.? bassleri* is associated with *T.? vicksburgensis* (Howe and Law), *T. weaveri* (H. and L.), and other fossils of Oligocene age. Presence of the species in the Mt. Laurel and Navesink formations, Upper Cretaceous, of New Jersey (Jennings, 1936, p. 51) is questionable—Jennings' illustrations are of a form that appears to lack the postmedian transverse ridge at the anterior margin of the compressed portion of the shell. Van den Bold (1946, p. 94) tentatively identified *T.? bassleri* from the Paleocene and Eocene of Guatemala and British Honduras. Its range is Paleocene(?) to Oligocene.

Trachyleberis smithvillensis (Sutton and Williams)

Plate 5, figure 9

Cythereis smithvillensis Sutton and Williams 1939, Jour. Paleontology, vol. 13, p. 564, pl. 63, figs. 18–20. Stephenson 1947, idem., vol. 21, p. 580.

Cythereis orelliana (Stadnichenko), Stephenson, 1946, idem., vol. 20, p. 338: (Not) Stadnichenko, 1927, Jour. Paleontology, vol. 1, p. 236, pl. 39, figs. 8–10.

Shell subquadrate in lateral view; greatest height about two-sevenths from anterior end; hinge margin straight, about four-sevenths of shell length; ventral margin nearly straight, slightly concave medially, posteriorly converging moderately toward dorsum; anterior margin broadly rounded, slightly truncate above and fringed with many small spines; posterior margin narrowly rounded, subacuminate at midheight, strongly truncate above, and bordered by stout spines, some of which are bifurcated. Left valve slightly larger than right, extending beyond the other only along dorsal slopes. Valves moderately convex, greatest thickness median. Anterior and posterior ends of shell compressed.

Anterior margin with spinose rim that ends just behind ventral marginal bend, and ends dorsally by the conspicuous eye tubercle; an high node lies just behind tubercle. Posterior end has a narrow rim from which project thick submarginal spines, and which extends along ventrum nearly to midlength. Surface of valves coarsely reticulate and spinose; spines rise from crests and junctures of reticulating ridges but without discernible pattern. Internal structures not observed.

Length of figured specimen 0.68 mm., height 0.34 mm., thickness 0.29 mm.

Remarks: In general shape and in coarsely spinose reticulate surface the present specimens resemble *T. smithvillensis* (Sutton and Williams) of the Weches formation. *T. sabinensis* (Howe and Garrett) (1934, p. 55) from the Wilcox group is similarly reticulate, but lacks the spines and the dorsal and ventral margins are more nearly parallel. *T. parexanthemata* (Swain) (1946, p. 377), is spinose but possesses short ventral alae and is not reticulate.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 feet, middle Eocene, U.S.N.M. 560668; Weches formation, middle Eocene at Smithville, Tex.; Wilcox group, lower Eocene at Sabinetown, Tex.

Trachyleberis mundorffi Swain, n. sp.

Plate 5, figure 19, plate 6, figure 4

Shell subquadrate in lateral view; highest about one-fourth from anterior end; hinge margin nearly straight, about three-fifths of shell length; ventral margin slightly sinuous, posteriorly converging dorsum; anterior margin broadly rounded, extended below, and fringed with two rows of tiny spines that extend around ventral bend; posterior margin narrower than the anterior, subtruncate, obtusely angulated at its dorsal and ventral bends. No complete specimens were found, but left valve is relatively higher at those places and presumably extends beyond right at ends of hinge.

Middle of each valve higher than ends; posterior end the more compressed. A fairly continuous narrow rim parallels free margins. Middle section of ventral rim double; around anteroventral bend rim is broken into about 4 nodes; at posterior end rim consists of a row of blunt nodes that become sparse above midheight; an oblique eye tubercle lies at anterodorsal termination of marginal ridge. A shallow trough separates marginal rim from raised median surface. Parallel to hinge margin is a low ridgelike swelling with about 5 nodes: posterior node elongate with two weak downward spurs; next two nodes shorter and with stronger spurs; fourth node small and without a spur; fifth node forming dorsal termination of a subvertical ridge that extends to a point just below midheight and forms posterior boundary of raised portion of valve. A second longitudinal, irregular, and somewhat nodose ridge extends from below midheight obliquely backward nearly to edge of raised portion of valve and ends just above midheight; several spurs project from this ridge and in front of midlength it is enclosed within a submedian enlarged, pitted, thickened, swelled area of shell that is characteristic of genus; a narrow curved ridge extends from area to eyespot. A third longitudinal ridge forms ventral boundary of raised portion of valve, and gives the shell a flattened aspect when viewed ventrally. The ridge consists mainly of about 7 nodes, of which the middle 3 or 4 send spurs toward the dorsum.

Hinge of right valve consists of an anterior high pointed tooth and postjacent small socket, a narrow nondenticulate interterminal groove, and a posterior low, narrow tooth that is elongated parallel to valve margin. Hinge of left valve the anthithesis of right. Muscle scar consists of a slightly anteromedian subvertical row of four tiny spots; other spots not observable. Inner lamellae rather narrow, broadest anteroventrally; line of concrescence and inner margin separate terminally, coincident ventrally. Pore canals not clear.

Length of a right valve (pl. 5, fig. 19) 0.69 mm., height 0.40 mm.

Relationships: There is very close relationship in surface ornamentation between *T. mundorffi* and *T. linospinosa* (Sutton and Williams) (1939, p. 566) from the Weches formation of Texas. However, in that species the longitudinal ridges are not as high, the ventral ridge does not give a flattened aspect to the ventral surface of the shell, the posterior boundary of the raised median portion of the valves merges more evenly into the compressed posterior end, there are more numerous minor ridges on the valve surface, the submarginal furrow is not continuous ventrally, and the posterior margin is more pointed. In general shape and distribution of surface ridges, *C. mundorffi* is closely related to several Cretaceous *Cythereis*, such as *C. hazzardi* Israelsky (1929, p. 19) and *C. bicornis* Israelsky (idem.), but small differences in surface ornamentation permit distinction of this new species. *Trachyleberis exanthemata* (Ulrich and Bassler), (1904, p. 117) of the Miocene bears rows of coarse nodes rather than longitudinal ridges, but otherwise is closely similar.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene, U.S.N.M. 560672, 560675. Edenton Naval Air Base well no. 1, Chowan Co., N. C., 55 feet, middle Miocene, U.S.N.M. 560782.

Trachyleberis pidgeoni (Berry)

Plate 6, figure 1

Cytheridea pidgeoni Berry, 1925, Am. Jour. Sci., 5th ser., no. 9, p. 485, figs. 7, 8.

Cythereis pidgeoni (Berry), Schmidt, 1948, Jour. Paleontology. vol. 22, p. 421, pl. 62, figs. 2–6.

Occurrence and remarks: The figured specimen (U.S.N.M. 560673) was obtained from the Naval Auxiliary Air Station well, Washington, N. C., at a depth of 115–120 feet, where it is associated with

Haplocytheridea montgomeryensis (Howe and Chambers), *Trachyleberis? rukasi* (Gooch) and other characteristic Eocene ostracodes. *C. pidgeoni* has been reported from the Monmouth formation, Upper Cretaceous, and its present occurrence probably is due to reworking. The species was not found in undoubtedly Cretaceous beds in other wells, suggesting that it may have been restricted to a nearshore facies of the Cretaceous.

Trachyleberis? cf. T.? triplistriata (Edwards)

Plate 6, figures 2, 3

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

A collection of ostracodes from the upper Miocene Duplin marl, Natural Well, N. C., submitted by Mr. Mundorff, yielded the specimens discussed here. They resemble the holotype of *T.? triplistriata* Edwards, but are coarsely pitted. Examination of the types reveals no pitting, and possibly they are immature molts or recrystallized shells. In the present collections, a specimen resembling the types was obtained from the Edenton Naval Air Base well no. 1, 45 feet, in the upper Miocene.

Ostracodes identified by Alexander (1934, p. 220) as *Cythereis prestwichiana* Jones and Sherborn from the Midway group, Paleocene, of Texas, are nearly identical with the present specimens, but they have a narrower posterior portion of the curving median ridge, and the posterior end of the ventral ridge is higher. Perhaps these slight differences are insufficient to make the Miocene specimens a distinct species. In hingement both forms resemble *Trachyleberis* Brady rather than *Cythereis* Jones. Other very similar species, *C. austinensis* Alexander (1929, p. 99) and *C. paraustinensis* Swain (1948, p. 199) occur in the Upper Cretaceous of Texas and Maryland, respectively.

Trachyleberis exanthemata (Ulrich and Bassler)

Plate 6, figure 5

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

Cythereis exanthemata marylandica Howe and Huff, 1935, Florida Dept. Conserv. Geology Bull. 13, p. 18, pl. 1, figs. 1–5, pl. 4, fig. 7.

Cythereis exanthemata (Ulrich and Bassler), van den Bold, 1946, Contrib. to the Study of Ostracoda, Amsterdam, p. 88, pl. 10, fig. 2. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 204, pl. 12, figs. 14, 15.

This coarsely nodose and spinose form is widely distributed in the Miocene deposits of the Atlantic coastal region. It shows considerable range in its ornamentation, and a variety has been recognized, *T. exanthemata gomillionensis* (Howe and Ellis) (1935, p. 19). Closely related forms in earlier Tertiary deposits are *T. stenzeli* (Stephenson) (1946, p. 340), and *T. hilgardi* (Howe and Garrett) (1934, p. 53). *T. mundorffi* Swain, n. sp., from the middle and upper Miocene, is very similar to *T. exanthemata* but medially has a longitudinal nodose ridge, rather than just a row of nodes or spines.

Occurrence: Edenton well no. 1, Chowan County, 45 feet, Edenton no. 4 well, 45 feet, Naval Auxiliary Air Station well, Washington, N. C., 60 feet, both upper Miocene U.S.N.M. 560676 and 560774; Harvey Neck well, Perquimans County, 46 feet, middle Miocene U.S.N.M. 560775. The species occurs in the Calvert formation of Maryland (Ulrich and Bassler, 1904, p. 117; Swain, 1948, p. 204), in the Choptank formation of Maryland (Ulrich and Bassler, 1904, p. 117), in the Chesapeake group of Virginia (Ulrich and Bassler, 1904, p. 117), in the Choctawhatchee formation of Florida (Howe and others, 1935, p. 18), and in the Miocene of Cuba and Guatemala (van den Bold, 1946, p. 88).

Trachyleberis vaughani (Ulrich and Bassler)

Plates 6, figures 6, 7

Cythere vaughani Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 109, pl. 38, figs. 25–27.

Cythereis vaughani (Ulrich and Bassler), Howe and others, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 25, pl. 3, figs. 24, 25, pl. 4, fig. 13. Coryell and Fields, 1937, Am. Mus. Novitates 956, p. 9, fig. 10a. Edwards, 1944, Jour. Paleontology, vol. 18, p. 522, pl. 87, figs. 27, 28. Van den Bold, 1946, Contrib. to the study of Ostracoda, Amsterdam, p. 88, pl. 10, fig. 1.

The external characteristics of the species were described in detail by Edwards (1944, p. 522), and additional information concerning the internal features is given here.

Hinge of right valve consists of an anterior pointed tooth and postjacent elongate shallow socket, an interterminal shallow, narrow, finely crenulate groove, and a posterior reniform tooth whose posterior lobe is higher. Hinge of left valve the antithesis of right. Inner lamellae rather uniformly broad, line of concrescence and inner margin nearly coincide; in the specimen examined there is anteriorly a broad calcified extension of the inner lamellae beyond the line of concrescence. Radial canals very numerous about entire periphery and much crowded in anterior border. Several canals bifurcate. Muscle scar not clearly observed. Marginal zone of each valve provided with a rabbet-joint interlocking process.

Occurrence: Harvey Neck well, Perquimans County, 43–57 feet, middle and upper Miocene, U.S.N.M. 560677,

560787, 560788; Esso Standard Oil Co. Hatteras Light well no. 1, 330–340 feet, upper Miocene. Other occurrences of the species are: Chesapeake group, James River, Va. (Ulrich and Bassler, 1904, p. 109); Choctawhatchee formation of Florida (Howe and others, 1935, p. 25); Duplin marl of North Carolina (Edwards, 1944, p. 522).

Trachyleberis? rugipunctata (Ulrich and Bassler)

Plate 6, figure 8

Cythere rugipunctata Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, 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, vol. 18, p. 524, pl. 88, figs. 5, 6. Van den Bold, 1946, Contrib. to the study of Ostracoda, Amsterdam, p. 100, pl. 10, fig. 3.

The external features of the species have been described. Internal features of a typical specimen in the present collection are as follows:

Hinge of right valve consists of an anterior high pointed tooth and postjacent deep oval socket, an interterminal faint groove, and a posterior large, rounded, somewhat crenulate tooth; hinge of left valve consists of an anterior deep socket and postjacent high, pointed tooth; an interterminal narrow bar bounded dorsally by a faint groove, and a posterior large, coarsely crenulate socket. Along the straight portion of hinge, the slight groove in right valve simply overlaps the extended and slightly rabbeted edge of left valve. Muscle scar lies within deep anteromedian depression that externally produces a rounded eminence; it consists of a main group of five elongate spots of which the more anterior three form a subvertical row; in front of main group are two spots, the lower one a doublet. Inner lamellae fairly broad, line of concrescence and inner margin nearly coincide.

Remarks: Present knowledge is insufficient to distinguish this species from *Trachyleberis* as emended (Sylvester-Bradley, 1949, p. 794), and it is also doubtful that *Favella* Coryell and Fields (1937, p. 8) as it has been defined, differs sufficiently from *Trachyleberis* to permit its recognition. The species is tentatively classified as *Trachyleberis* rather than as *Favella* (Edwards, 1944, p. 524) because of its shape, hingement, subcentral node, and compressed posterior end with anteriorly adjacent high dorsal and ventral areas. However, the muscle scar differs from that of many species of *Trachyleberis* in which the main element is a single subvertical row of pits.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet U.S.N.M. 560678, Edenton Naval Air Base well no. 1, 30–35 feet U.S.N.M. 560785, Edenton well no. 4, 49 feet, Esso Standard Oil Company Hatteras Light well no. 1, 320–330 feet U.S.N.M. 560784, N. C. Esso no. 2, 130–140 feet U.S.N.M. 560786, all upper Miocene; Cape Lookout well, Carteret County, N. C., 75–100 feet, middle Miocene U.S.N.M. 560783; Hatteras Light no. 1, 1,210–1,220 feet, lower Miocene. Previously recorded from the Chesapeake group, James River, Va. (Ulrich and Bassler, 1904, p. 118), the Choctawhatchee formation of Florida (Howe and others, 1935, p. 23), the Duplin marl of North Carolina (Edwards, 1944, p. 524), and the Miocene of Cuba, Guatemala, and British Honduras (van den Bold, 1946, p. 100).

Genus BUNTONIA Howe, 1935

Cythereis? Howe and Pyeatt, 1934, in Howe and Garrett, Louisiana Dept. Conserv. Geol. Bull. 4, p. 50; 1935, in Howe and Chambers, idem., Bull. 5, p. 33.

Buntonia Howe, 1935, Louisiana Dept. Conserv. Geol. Bull. 5, p. 22. Stephenson, 1947, Jour. Paleontology, vol. 21, p. 579.

Pyricythereis Howe, 1936, in Howe and Law, idem., Bull. 7, p. 65. Sutton and Williams, 1939, Jour. Paleontology, vol. 13, p. 569. Stephenson, 1944, idem., vol. 18, p. 453. Van den Bold, 1946, Contrib. to Study of Ostracoda, Amsterdam, pp. 30, 103. Stephenson, 1946, Jour. Paleontology, vol. 20, p. 329.

Buntonia howei (Stephenson)

Plate 2, figures 25–27

Pyricythereis howei Stephenson, 1946, Jour. Paleontology, vol. 20, p. 330, pl. 42, figs. 16, 17.

Buntonia howei (Stephenson), Stephenson, 1947, *idem.*, vol. 21, p. 579.

The external features of the present specimens are those of the species as described in detail by Stephenson (1946, p. 330).

Hinge of right valve consists of an anterior large, blunt tooth and postjacent socket; an interterminal, narrow, finely denticulate groove; and a posterior large, strongly elevated, rounded tooth. Hinge of left valve consists of an anterior deep socket and postjacent large tooth; an interterminal faintly denticulate bar formed of the extended and slightly thickened valve edge; and a posterior deep socket. Inner lamellae moderately broad, line of concrescence and inner margin nearly coincide; marginal pore canals rather numerous, apparently simple. Muscle scar obscured by matrix.

Length of a figured specimen (pl. 2, fig. 26) 0.48 mm., height 0.22 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 115–120 feet, middle Eocene, U.S.N.M. 560630. Described from the Weches formation, Claiborne group, at Smithville, Tex. (Stephenson, 1946, p. 330).

Buntonia? cf. B.? lacunosa (Jones)

Plate 7, figure 21

Cythere lacunosa Jones, 1856, Tertiary Entomostraca, Paleontographical Soc., p. 31, pl. 3, figs. 5a–b.

Shell subelliptical in side view; highest about one third from anterior end; hinge margin nearly straight, more than half of shell length; ventral margin nearly straight, slightly concave medially; anterior margin broadly rounded, somewhat extended and finely spinose below; posterior margin more narrowly rounded, truncate above. Left valve slightly larger than right, ventrally extended beyond the other. Valves moderately convex, greatest thickness posteromedian.

Posterior margin and posterior three-fifths of ventral margin of each valve provided with a rounded rim and on its inner side an adjacent groove. Anterior end bears a deep narrow groove, lying close to margin. An inconspicuous low median node present on right valve but not on left valve of specimen at hand, possibly removed by abrasion. Surface bears coarse scattered pits, some of which are arranged in rows parallel to margins.

Length 0.57 mm., height 0.24 mm., thickness 0.22 mm.

Remarks: This small, perhaps abraded specimen, conforms in shape and general surface features to *Buntonia* Howe, but its internal characteristics have not been observed. It is closely similar to *Cythere lacunosa* Jones, except that, perhaps as a result of abrasion, it lacks, the prominent median node.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 feet, middle Eocene, U.S.N.M. 560704. *B. ? lacunosa* (Jones) was described from the Pliocene and Recent of England and Norway (Jones, 1856, p. 31).

Buntonia? planibasilis (Ulrich and Bassler)

Plate 3, figures 4, 5

Cythere planibasilis Ulrich and Bassler, 1904, Maryland Geol. Survey Miocene vol., p. 99, pl. 38, figs. 1–3.

The external features of the present specimens are as described by Ulrich and Bassler. Dimorphism in the species is suggested by proportionally shorter, higher female shells (pl. 3, fig. 5) and longer, lower male shells (pl. 3, fig. 4).

Hinge of left valve as follows: an anterior very deep, rounded socket above an ocular depression, and defined postventrally by a delicate spurlike projection or by a continuous bar, and anteriorly by a rounded beadlike elevation; a postjacent rounded tooth; a long noncrenulate bar; and a posterior oblique socket. Hinge of right valve not observed.

Muscle scar median and consisting of a vertical row of four spots and one more anterior spot. Inner lamellae broadest anteriorly; inner margin smooth, nearly coinciding with line of concrescence. Radial canals numerous, with a few paired, and a few bifurcated near outer margin. In one specimen radial canals occur around entire free margin and penetrate shell beneath posterior hinge socket.

Length of a male left valve (pl. 3, fig. 4) 0.98 mm., height 0.55 mm.; length of female left valve (pl. 3, fig. 5) 0.89 mm., height 0.53 mm.

Remarks: The hinge of this species is like that in *Trachyleberis* Brady, but in the subpyriform outline and generally more convex valves it resembles *Buntonia* Howe. *Buntonia? mcguirti* Howe from the Vicksburg group and Red Bluff clay of the central Gulf region is very close to *B.? planibasilis*, but is more rounded posteriorly and less convex medially than that species. In both forms the anterior hinge socket of the left valve lies above an ocular depression, separated from it by a delicate spur or a complete ridge. Closely related species are "*Cythere*" *septentrionalis* Brady and *C. marabilis* Brady of the Quaternary, and *C. laquaeta* Jones of the Pliocene and Pleistocene. The whole group is rather closely related to the Cretaceous genus *Protocythere* Triebel in general form, but the latter bears a prominent anteromedian elevation and a median longitudinal ridge.

Occurrence: Esso Standard Oil Co. N. C. Esso well no. 2, 320–330 feet, upper Miocene, U.S.N.M. 560634; described from the Chesapeake group at James River, Va. (Ulrich and Bassler, 1904, p. 99).

Buntonia? cf. B.? garretti (Howe and McGuirt)

Plate 3, figure 6, plate 4, figures 4–6

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

The relationships of the specimens from the Miocene of North Carolina illustrated here are problematical. In shape, hingement, other internal features, and general pustulose surface the specimens resemble *Buntonia* Howe and are like *B.? garretti* Howe and McGuirt. They seem to be a little more finely pustulose than that species. In all other features except details of hingement they are identical with *Buntonia? okeechobiensis* (Swain) from the Ocala limestone of the subsurface of Florida (Swain, 1946, p. 778, pl. 54, figs. 10a–b). The right valve hinge of the North Carolina form consists of an anterior rounded, high tooth, a postjacent deep socket, a narrow interterminal ridge and an oblique, posterior, elevated tooth. In *B.? okeechobiensis* the

hinge of the right valve consists of an anterior rounded tooth and postjacent socket, an interterminal narrow ridge formed by the valve edge and a posterior angulate tooth formed of an elevated and thickened portion of the valve margin at its post-dorsal bend. The general similarity between *B.? garretti* and *B.? okeechobiensis* evidently is a matter of isomorphism and they are distinguished by the minor but clear difference in the hinge structure.

The muscle scar of the present form lies in an anteromedian depression and consists of a subvertical row of four spots and at least one more anterior spot.

Length of figured specimen, a right valve 1.01 mm., height 0.58 mm.

Occurrence: Esso Standard Oil Co. North Carolina Esso well no. 2, 400–410 feet, upper Miocene, U.S.N.M. 560635, 560647; Esso Standard Oil Co. Hatteras Light well no. 1, 900–910 feet, middle Miocene, U.S.N.M. 560646.

Buntonia? mcguirti (Howe)

Plate 4, figures 2, 3

Cythereis mcguirti Howe, 1936, Louisiana Dept. Conserv., Geol. Bull. 7, p. 48, pl. 4, figs. 21, 22.

?Brachycythere betzi Jennings, Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 209, pl. 14, figs. 12, 13.

Shell subovate in lateral view; greatest height about one-fourth from anterior end; dorsal margin nearly straight, about three-fifths of shell length; ventral margin gently convex, converging strongly backward with dorsum; anterior margin broadly rounded, slightly extended below, bearing three rows of marginal spines along its ventral half; posterior margin narrowly rounded, subacuminate, extended medially, slightly truncate above, weakly spinose. Valves nearly equal in size; greatest convexity behind center of shell.

Surface of each valve strongly swollen behind midventral area, and in some specimens midventral margin obscured by overhang of shell. Ends compressed; the anterior bears a narrow low marginal ridge; corresponding feature on posterior end is barely discernible. Inflated portion of valve surface weakly and coarsely reticulated; ventrally there are weak longitudinal ridges. Male? proportionally longer than female?, but contrary to usual relationships, the two forms are about the same height.

Hinge of right valve consists of an anterior rounded tooth and postjacent socket, an interterminal narrow groove, and a posterior oval tooth. Hinge of left valve the antithesis of right. Other internal features not clear.

Length of a figured male? dimorph (pl. 4, fig. 2) 0.95 mm., height 0.53 mm.; length of a female? dimorph (pl. 4, fig. 3) 0.87 mm., height 0.55 mm.

Remarks: The generic relationships of this species are obscure, but in a general way it is close to *Buntonia* Howe and is here provisionally included in that genus. *Anticythereis* van den Bold is similar in shape and hingement, but is said to have the right valve larger than the left (van der Bold, 1946, p. 30), a characteristic that is subject to question judging from the description of the genotype *A. reticulata* (Jennings). Jennings (1936, p. 56) erected *Pseudocythereis* with *P. reticulata* Jennings as genotype. Van den Bold, observing this to be an instance of homonymy with *Pseudocythereis* Skogsberg (1928) introduced *Anticythereis* for Jennings' specimen and provided the following generic summary:

> Carapace small, subrectangular. Right valve larger than left, overlapping along the dorsal margin. Line of concrescence and inner margin coincide. Hingement like *Cythereis* (Range) Upper Cretaceous.

According to Jennings (1936, p. 56):

> The righ valve overlaps the left on dorsal magrin; strongest development in center of dorsal region; left valve overlaps right on ventral margins, strongest near center.

It is not at all clear that the right valve in *P. reticulata* is larger than the left, and the overlap relationships are inconspicuous in dorsal view (Jennings, 1936, pl. 7, fig. 10b). Jennings' figure 10a suggests that the left valve is the larger, but this impression may be due to poor orientation of the specimen.

The writer believes that in this general group, including *B.? mcguirti* (Howe), *B.?* okeechobiensis (Swain) and *Leguminocythereis clarkana* (Ulrich and Bassler) the valves are nearly equal in size and that slight differences in comparative size of the valves are not of generic value. Jennings described the hinge of "*Pseudocythereis*" as consisting of terminal teeth with an intervening groove in the right valve, and terminal sockets with an intervening ridge in the left. He illustrates (Jennings, 1936, pl. 7, fig. 10d) but does not mention crenulation of the interterminal ridge in the left valve. It is not known that such hinge crenulation is common in *Anticythereis* van den Bold (=*Pseudocythereis* Jennings). Crenulation of the hinge was used to distinguish *Butonia* Howe (=*Pyricythereis* Howe) and in part to distinguish *Paracythereis* Jennings, 1936, (not *Paracythereis* Delachaux, 1928, or *Paracythereis* Elofson, 1941), but the writer considers crenulation alone an insufficient basis for generic distinction. *Anticythereis* has not been well defined, and although

the present species is closely related, the writer hesitates to place it in that genus.

Occurrence: Esso Standard Oil Co., Hatteras Light well no. 1, core 1,740–1,750 feet, middle Eocene, U.S.N.M. 560645. The species was described (Howe and Law, 1936, p. 49) as "the commonest and most distinctive ostracode in the Vicksburg group" of Louisiana, Mississippi, and Alabama. The same or a closely related species was identified as *Brachycythere betzi* Jennings by Swain (1948, p. 209) from the subsurface Eocene of Maryland.

Genus FAVELLA Coryell and Fields, 1937

Favella cf. F. mesacostalis Edwards

Favella mesacostalis Edwards, 1944, Jour. Paleontology, vol. 18, p. 524, pl. 88, figs. 1–4.

One left valve of an immature specimen was obtained. The hinge consists of an anterior, somewhat elongate, very faintly crenulate socket, an interterminal bar formed of the valve edge, and a posterior slightly crenulate? socket. The hinge resembles that of *Oligocythereis* Sylvester-Bradley (1948, p. 795), a Middle Jurassic genus, and supports his theory of the evolution of the hinge in the Cytheracea. Other writers have observed the same relationships in the molts of several species of *Cythereis* and related genera. In mature specimens of *F. mesacostalis* (Edwards 1944, p. 523), the left valve hinge consists of an anterior rounded high tooth, postjacent socket, long interterminal groove and posterior curved tooth.

Occurrence: Esso Standard Oil Co., Hatteras Light no. 1 well, 160–170 feet, upper Miocene, U.S.N.M. 560748. Described from the Duplin marl (upper Miocene) near Lumberton, N. C.

Genus PTERYGOCYTHEREIS Blake, 1929

Pterygocythereis washingtonensis Swain, n. sp.

Plate 4, figure 21

Shell elongate-subquadrate in side view; highest one-fourth from anterior end at position of anterocardinal angle; hinge margin nearly straight, with small posterior cardinal node; ventral margin nearly straight, converging posteriorly with dorsum; anterior margin broadly and uniformly rounded, bearing 12 or more thick, blunt spines; posterior margin narrower, strongly truncate to slightly concave above midheight, and bearing several thick blunt spines below. Left valve slightly larger than right, extending beyond the other at cardinal angles; along straight portion of hinge right valve extends slightly beyond left.

Broad, low, anterior marginal rim merges with general surface of valve a short distance behind ventral bend. Lower rounded part of posterior end bears a narrow, rather elevated rim that extends anteriorly along ventrum, nearly to midlength, but is less elevated in front of ventral bend. Posterior and postventral areas of valves strongly compressed. Midventral surface of each valve strongly expanded, with short, high, postmidventral alae, that in ventral view give the shell the arrowhead outline characteristic of the genus. An inconspicuous ridge parallels dorsal margin and a high, rounded, elevation lies at posterior cardinal angle. Anterior half of each valve variably pitted; two subparallel rows of large pits lie behind anterior marginal rim; subcentrally, and below elongate low swelling with postjacent shallow groove, are 6 or 8 pits in two adjacent longitudinal rows; an oblique, narrow furrow consisting essentially of a row of closely spaced small pits lies below an anteromedian smooth area; dorso-medially are many small pits arranged in fairly good longitudinal rows; just beneath anterior cardinal angle are two oblique rows of tiny pits. A low ridge extends dorsally from anteromedian smooth area nearly to anterocardinal angle, terminating in an obscure swelling that may be an eye tubercle. Most of posterior half and of alate midventral area smooth; a few small pits occur postdorsally. Two or three short spurs extend forward from inner edge of posterior marginal rim.

Internal features not visible in the specimen at hand. Length 0.74 mm., height 0.33 mm., thickness 0.26 mm.

Relationships: The general subquadrate form and ventral alae of this species clearly ally it to *Pterygocythereis* Blake. It is not so strongly pitted as the Eocene *P. forbesiana* (Müller), and as compared to *P. cornuta* (Roemer) and var. *americana* (Ulrich and Bassler) it has a pitted surface, weaker dorsal ridges, more rounded alate expansions and a more uniformly curved anterior margin.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 135 feet, middle Eocene, U.S.N.M. 560657.

Pterygocythereis cornuta americana (Ulrich and Bassler)

Cythereis cornuta americana Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 122, pl. 37, figs. 29–33.

Cythereis (Pterygocythereis) americana Howe and others, 1935, Florida Dept. Conserv., Geology Bull. 13, p. 26, pl. 2, figs. 19, 21–24, pl. 4, fig. 24. Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 206, pl. 14, fig. 4.

A single right valve, from the upper Miocene is externally typical of the species. The hinge of this specimen consists of an anterior elongate tooth and postjacent socket, an interterminal crenulate groove, and a posterior kidney-shaped tooth. Howe (1935, p.

26) did not report crenulation of the interterminal area in specimens from the middle Miocene of Florida.

Occurrence: North Carolina Esso well no. 2, 280–290 feet, upper Miocene, U.S.N.M. 560749. Described from the Calvert formation of Maryland.

Genus CAUDITES Coryell and Fields, 1937

Caudites jacksonvillensis Swain, n. sp.

Plate 5, figures 17, 18

The two left valves at hand show the following features:

Shell elongate-subovate in side view; highest about one-third from anterior end; dorsal margin gently convex; ventral margin slightly sinuous, concave medially; anterior margin broadly rounded, slightly concave at dorsal bend; posterior margin bluntly acuminate, greatly extended below, concave above. Convexity moderate; ends compressed, especially the posterior.

A narrow low rim borders anterior and ventral margins; just above ventrum is a somewhat sinuous longitudinal ridge that is highest about one-third from posterior end; just below dorsum in posterior half of shell is a ridge that extends back to posterior compressed area, turns downward and becomes higher and broader above midheight, then narrows and joins ventro-longitudinal ridge; just anterior of midlength is a low swelling; two divergent ridges project forward from swelling, and another projects toward postdorsal region. Anteromedially is a small eye tubercle.

Hinge of left valve consists of an anterior very large, rounded, deep socket, and postjacent knoblike tooth; a long narrow interterminal bar, formed of the extended valve edge; and a posterior ovate socket. Inner lamellae of moderate width terminally; line of concrescence and inner margin slightly separated. Other internal features not clear.

Length 0.61 mm., height 0.32 mm.

Relationships: The new species is close to *C. sellardsi* (Howe and Neill), (Howe and others, 1935, p. 29) of the Choctawhatchee formation of Florida, but has ridges below and behind a median node, and the postdorsal ridge lies closer to the margin.

Occurrence: Jacksonville Tent Camp well no. 2, Onslow County, N. C., 103–110 feet, middle Eocene, U.S.N.M. 560670 and 560671.

Genus ACUTICYTHEREIS Edwards, 1944

Acuticythereis cf. A. laevissima Edwards

Acuticythereis laevissima Edwards, 1944, Jour. Paleontology, vol. 18, p. 519, pl. 87, figs. 4–11.

Occurrence: A crushed specimen, U.S.N.M. 560750 that may belong to this species was found at a depth of 46 feet, middle Miocene, in the well at Harvey Neck, Perquimans County, N. C. Described from the Duplin Marl, upper Miocene at Lumberton and other localities in North Carolina.

Acuticythereis laevissima punctata Edwards

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

One somewhat recrystallized specimen (U.S.N.M. 560751) represents this variety. The weak pits in the posterior half of the left valve distinguish this form from *A. laevissima* Edwards.

Occurrence: Well no. 65 at Bogue, Carteret, N. C., 230–245 feet, upper Miocene. The variety was originally obtained from the Duplin marl at Natural Well, N. C.

Acuticythereis cf. A. multipunctata Edwards

Text figures 3m, n

Acuticythereis multipunctata Edwards, 1944, Jour. Paleontology, vol. 18, p. 520, pl. 87, figs. 14–16.

This species closely resembles *Cytherideis ashermani* Ulrich and Bassler, but in the latter the left valve is more nearly equal-ended, the hinge consists of terminal interlocking grooves and flanges rather than rounded teeth and sockets, the inner lamellae are narrower, and the valves are more convex.

Occurrence: Upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1 at 610–620 feet, upper Miocene, U.S.N.M. 560728. Described from the Duplin marl of North Carolina.

Genus HEMICYTHERE Sars, 1925

Hemicythere conradi Howe and McGuirt

Plate 6, figures 9–12

Hemicythere conradi Howe and McGuirt, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 27, pl. 3, figs. 31–34, pl. 4, fig. 17. Edwards, 1944, Jour. Paleontology, vol. 18, p. 518, pl. 86, figs. 17, 18.

The external features of the species have been described. The hingement of specimens from the Duplin marl, Natural well, N. C., submitted by Mr. Mundorff is as follows:

Hinge of right valve consists of an anterior deep oval socket and postjacent strong rounded tooth; an interterminal thick bar, bounded dorsally by a rabbeted platform and step; and a posterior ovate deep socket. Hinge of left valve consists of an anterior strong rounded tooth and postjacent deep socket; an interterminal broad furrow, and a posterior strong, slightly reniform tooth. An immature left valve has an anterior elongate shallow socket, an interterminal finely crenulate bar, bounded dorsally by two rabbeted steps,

and a posterior elongate shallow socket. The conspicuous anterior teeth of the adult form are lacking in the immature molt whose hinge resembles that of *Orthonotocythere* Alexander of the Cretaceous and Paleocene, and *Hutsonia* Swain of the Upper Jurassic.

Occurrence: Esso Standard Oil Company Hatteras Light well no. 1, 160–170 feet U.S.N.M. 560753; North Carolina Esso well no. 2, 350–360 feet, upper Miocene U.S.N.M. 560764; Edenton Naval Air Base well no. 4, Chowan County, 88 feet U.S.N.M. 560760; Cape Lookout well, Carteret County, 75–100 feet U.S.N.M. 560762, middle Miocene; North Carolina Esso well no. 1, 1,130–1,140 feet, lower Miocene. Recorded from the Choctawhatchee formation of Florida (Howe, et al., 1935, p. 27), from the Duplin marl of North Carolina (Edwards, 1944, p. 518); present in the writer's collections from the Yorktown formation of Virginia.

Hemicythere sp. aff. H. conradi Howe and McGuirt

A single left valve represents this species. The surface ornamentation consists of concentric narrow ridges and pitted grooves. The middle part of the valve is abraded, but bears deep small pits. The hinge consists of an anterior deep elongate socket, postjacent high tooth, an interterminal finely crenulate groove, and a posterior elongate socket that contains 1 or 2 denticular elevations. Inner lamellae broad, line of concrescence and inner margin separate. Radial canals very numerous, present along entire free margin. Muscle scar not seen.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 60–70 feet, Pleistocene, U.S.N.M. 560752.

Hemicythere confragosa Edwards

Plate 6, figures 13, 14

Hemicythere confragosa Edwards, 1944, Jour. Paleontology, vol. 18, p. 518, pl. 86, figs. 23–26.

This species has been described in detail. It is much more rare than *H. conradi* Howe and McGuirt, and it has not been found in deposits older than late Miocene.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene, U.S.N.M. 560680; Duplin marl (upper Miocene) of surface exposures in North Carolina.

Genus LEGUMINOCYTHEREIS Howe, 1936

Leguminocythereis cf. L. scarabaeus Howe and Law

Plate 6, figures 15, 16

Leguminocythereis scarabaeus Howe and Law, 1936, Louisiana Dept. Conserv., Geol. Bull. 7, p. 63, pl. 4, figs. 12, 17, pl. 5, figs. 15–17.

Specimens (U.S.N.M. 560681) that are not well preserved, but which probably belong to this species, were obtained by Mr. Mundorff from the Castle Hayne formation at Pollacksville, N. C. They are slightly less extended dorsally than is typical of the species. The species was described from the Vicksburg group, Oligocene, of Louisiana and Mississippi (Howe and Law, 1936, p. 63).

Leguminocythereis clarkana (Ulrich and Bassler)

Plate 6, figure 18

Cythere clarkana Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, pp. 98, 99, pl. 35, figs. 1–10.

Leguminocythereis clarkana (Ulrich and Bassler), Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 207, pl. 13, fig. 6.

This has been adequately described. The well-preserved specimen (U.S.N.M. 560683) figured here is characterized by a pattern of broad, polygonal pits outlined by closely and finely spinose ridges.

Occurrence: Bogue well no. 65, Carteret County, 130 feet, upper Miocene U.S.N.M. 560683; Esso Standard Oil Company Hatteras Light well no. 1, 880–890 feet, middle Miocene U.S.N.M. 560767; Karsten no. 1 Laughton well, 471–508 feet U.S.N.M. 560765; North Carolina Esso well no. 1, 1,210–1,220 feet, lower Miocene. The species was described from the Calvert formation of Maryland, and was reported from the Chesapeake group at Yorktown, Va. (Ulrich and Bassler, 1904, p. 99; Swain, 1948, p. 207).

Leguminocythereis whitei Swain, n. sp.

Plate 3, figures 14, 16–18, plate 4, figure 1.

Shell subelliptical to elongate-ovate in lateral view; highest about one-fourth from anterior end; dorsal margin nearly straight, about four-fifths of shell length; ventral margin slightly sinuate; anterior margin broadly rounded, truncate in cardinal region on female dimorphs; posterior margin somewhat more narrowly rounded. Left valve slightly larger than right. Greatest convexity in posterior third of shell.

A narrow ridge, highest anteriorly, parallels free margins of valve. Terminal and ventral areas bear an additional ridge within and nearly parallel to marginal ridge. A third, more interior curved ridge occupies anterodorsal area, and a fourth ridge lies in a postdorsal position between marginal ridge and the more interior principal ridge. An elongate curved depression occupies a median position on each valve behind a low anteromedian swelling. Postdorsal fourth of valves somewhat swollen, especially in female dimorph. Entire surface coarsely and deeply pitted, subreticulate; interspaces only about one-fifth width of pits.

Hinge of right valve consists of an ovate, oblique, smooth tooth, a postjacent elongate shallow socket, a long, narrow interterminal smooth groove and a posterior elongate-ovate socket. About one-fourth from anterior end of hinge and below groove is a subtriangular thick process of uncertain function. It may indicate position of attachment of a ligament for opening valves as it follows a corresponding process in left valve. Hinge of left valve consists of an anterior elongate socket, a narrow interterminal ridge that bears a bulbous toothlike expansion at its anterior end, and a posterior elongate socket.

Muscle scar lies on the flanks of submedian internal depression corresponding to external swelling described above; it consists of a vertical row of four spots (of which the uppermost is rounded, the middle two elongate, and the lowermost one ovate) and two more anterior spots, the upper one rounded, the lower one elongate.

Inner lamellae rather broad, especially at anterior end; line of concrescence and inner margin nearly coincide. Radial canals few and widely spaced terminally, more numerous and closely spaced in anteroventral area.

Length of holotype (pl. 3, fig. 17) 0.71 mm., height 0.37 mm.

Relationships: Cythere ovalis Brady (1880, p. 66), a Recent species closely resembles *Leguminocythereis whitei* in general shape and coarsely pitted surface, but lacks the prominent marginal ridges. *Cythere cancellata* Brady (1868, p. 62), also from the Recent, is similar but has prominent transverse curved ridges. *Loxoconcha? postdecliva* Swain (1948, p. 194) from the Eocene of Maryland resembles the new species but has a more strongly developed median sulcus that reaches the dorsal margin, has several prominent transverse curved ridges, and is more compressed posteriorly. In general shape, hingement, musculature, sparse terminal radial canals and general ornamentation the present species resembles *Leguminocythereis* Howe. *Leguminocythereis clarkana* (Ulrich and Bassler) from the Miocene of Maryland is more finely pitted, partly spinose, has wider interpit areas and lacks the marginal ridge pattern of the new species.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 60–70 feet, Pleistocene, U.S.N.M 560711; North Carolina Esso no. 2, 370–380 feet U.S.N.M. 560710 and 1,400–1,410 feet, lower Miocene or Oligocene U.S.N.M. 560642, upper Miocene; Edenton Naval Air Base well no. 1, Chowan County, 55 feet U.S.N.M. 560640 and 560641, Edenton no. 4 well, 88 feet, middle Miocene U.S.N.M. 560643.

Genus BRACHYCYTHERE Alexander, 1933

Brachycythere cf. B. martini Murray and Hussey

Plate 6, figure 26

Brachycythere martini Murray and Hussey, 1942, Jour. Paleontology, vol. 18, p. 177, pl. 28, figs. 6, 10, text figs. 2, 8–10. Stephenson, 1946, idem., vol. 20, p. 333, pl. 44, fig. 21, pl. 45, fig. 24.

A single specimen was obtained. Length of the figured specimen is 1.12 mm., height 0.63 mm., thickness 0.59 mm.

Occurrence: Esso Standard Oil Co. North Carolina Esso well no. 2, 1,610–1,620 feet, middle Eocene, U.S.N.M. 560689. In the Gulf region, the species occurs in the Claiborne and Jackson groups (Stephenson, 1946, p. 333).

Brachycythere marylandica (Ulrich)

Plate 7, figure 1

Cythere marylandica Ulrich, 1901, Maryland Geol. Survey, Eocene, p. 119, pl. 16, figs. 16–18.

Brachycythere nanafaliana Howe and Pyeatt, Howe and Garrett, 1934, Louisiana Dept. Conserv., Geol. Bull. 4, p. 48, pl. 3, fig. 18, pl. 4, figs. 1–3. Murray and Hussey, 1942, Jour. Paleontology, vol. 16, p. 180, pl. 28, figs. 11, 12, text fig. 2.

Brachycythere marylandica (Ulrich), Schmidt, 1948, Jour. Paleontology, vol. 22, p. 416, pl. 63, figs. 17–20.

This species was described in detail by Schmidt (1948, p. 416), who also placed *B. betzi* Jennings (1936, p. 47) in synonmy. Swain (1948, p. 209) described a specimen from the subsurface of Maryland that he believed to represent *B. betzi;* that example differs in several respects from *B. marylandica*, but may represent *Cythereis? mcguirti* rather than *B. betzi.*

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 175 feet, lower Eocene, U.S.N.M. 560690; also in the Aquia formation of Maryland (Ulrich, 1901, p. 119; Schmidt, 1948, p. 416), the Nanafalia and Hatchetigbee formations (Wilcox group) of Louisiana and Alabama (Howe and Garrett, 1934, p. 48; Murray and Hussey, 1942, p. 180).

Brachycythere cf. B. hadleyi Stephenson

Plate 7, figures 7–9

Brachycythere hadleyi Stephenson, 1946, Jour. Paleontology, vol. 20, p. 333, pl. 44, fig. 23, pl. 45, fig. 23.

Several specimens strongly resembling this species were found. Several allied species of *Brachycythere*, including *B. hadleyi* Stephenson, *B. bernardi* Murray and Hussey, *B. alata* (Bosquet) and *B. watervalleyensis* Howe and Chambers, are distinguished by differences in development of the ventral alae, extension of the posterior end, degree of elongation of the shell, and

curvature of the dorsal margin. The difficulty of distinguishing these species with certainty reduces their stratigraphic value. The present specimens seem to be most similar to forms of middle Eocene (Claiborne) age.

Length of a figured specimen (pl. 7, figs. 7, 9) 1.11 mm., height 0.73 mm., thickness 0.68 mm.

Occurrence: Esso Standard Oil Co., North Carolina Esso well no. 2, 2,060–2,070 U.S.N.M. 560696 and 2,150–2,160 feet U.S.N.M. 560695, Paleocene(?), 1,800–1,810 feet U.S.N.M. 560755, lower Eocene; 1,470–1,480 feet U.S.N.M. 560756, middle Eocene; Esso Standard Oil Co., Hatteras Light well no. 1, 1,740–1,750 feet, middle Eocene U.S.N.M. 560754. Described from the Weches formation at Smithville, Tex. (Stephenson, 1946, p. 333).

Brachycythere cf. B. jessupensis Howe and Garrett

Plate 7, figure 10

Brachycythere jessupensis Howe and Garrett, 1934, Louisiana Dept. Conserv., Geol. Bull. 4, p. 47, pl. 3, figs. 14, 16, 17.

Shell subovate in side view; highest about one-third from anterior end. Dorsal margin moderately convex; ventral margin slightly convex, sinuous in right valve, converging toward dorsum posteriorly. Anterior margin broadly rounded, extended below, slightly truncate above, finely spinose in ventral half; posterior margin narrowly rounded, extended medially. Left valve much larger than right, extending beyond the other around entire periphery, greatest extension dorsal. Valves strongly convex, greatest thickness slightly postmedian. Ends compressed in relation to strongly inflated midportion of shell.

Median area of each valve coarsely pitted. Ventral surface inflated to form rounded alate expansions; a low longitudinal ridge present at crest of each ala. A low swelling, representing eye tubercle lies at anterior cardinal angle, and is defined below by a narrow oblique sulcus that ventrally bounds ornamented portion of valve. Anterior end bears a narrow, indistinct, marginal rim. Internal features not observed.

Length of figured specimen 1.07 mm., height 0.63 mm., thickness 0.50 mm.

Remarks: This form resembles *B. interrasilis* Alexander (1934, p. 217) of the Midway group, but is somewhat more coarsely pitted and has less strongly elevated ventral longitudinal ridges. Probably it is conspecific with *B. jessupensis* Howe and Garrett, but diagnostic internal characters are not visible in our specimens.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 160 feet, middle Eocene, U.S.N.M. 560697. Described from the horizon of the Nanafalia formation, Wilcox group, at Fort Jessup, La. (Howe and Garrett, 1934, p. 47).

Brachycythere sp.

An imperfect left valve identified as *Brachycythere* was collected. The dorsal portion of the valve is missing; the ventral portion bears an alaform midventral swelling that has a low ridge at its summit; surface apparently smooth.

Occurrence: Esso Standard Oil Co. Hatteras Light well, no. 1, 330–340 feet, upper Miocene, N.S.N.M. 560753.

Genus CYTHERETTA Müller, 1894

Cytheretta porcella (Ulrich and Bassler)

Plate 4, figure 7

Cythere porcella Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 106, pl. 36, figs. 26–33.

The general shape and the hingement ally this species to *Cytheretta*, and transfer to that genus is here made. The present smooth-surfaced single valve evidently is identical with *C. porcella* of the middle and upper Miocene of Maryland and Virginia. In some of the type specimens the posterior half of the valve is weakly pitted.

Length of figured specimen 0.74 mm., height 0.37 mm.

Occurrence: Esso Standard Oil Company, Hatteras Light well no. 1, 1,480–1,490 feet, lower Miocene, U.S.N.M. 560648; described from the Calvert formation, Plum Point, Md.; reported also from the Chesapeake group, Yorktown, Va.

Cytheretta cf. C. plebeia (Ulrich and Bassler)

Cythere plebeia Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 102, pl. 35, figs. 20–29.

Cytheretta plebia (Ulrich and Bassler), Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 212, pl. 13, figs. 3, 4.

A broken left valve, probably of this species was obtained. The species has been reported from middle Miocene deposits only, and the present specimen may have been reworked.

Occurrence: Pleistocene sands, Esso Standard Oil Co. Hatteras Light well no. 1, 60–70 feet, U.S.N.M. 560712. Described from the Calvert formation of Maryland, and the Chesapeake group of Virginia.

Cytheretta? sp. aff. C. plebeia (Ulrich and Bassler)

Plate 6, figure 17

Shell elongate-subovate in lateral view; greatest height about one-fourth from anterior end; hinge

margin nearly straight, about three-fifths of shell length; ventral margin gently convex, posteriorly converging moderately toward dorsum; anterior margin broadly rounded, slightly extended below; posterior margin more narrowly rounded, slightly extended above. Left valve larger than right, overlapping and extending slightly beyond the other around entire periphery; greatest extension midventral; greatest overlap at cardinal angles. Valves rather strongly convex, greatest convexity in posterior half. Surface ornamented by medium-sized, irregularly disposed pits, most of which lie in posterior half; posteroventrally, some pits arranged in short concentric rows.

Hinge not observed. Muscle scar not clear but seems to consist of a medial row of several spots and two more anterior spots.

Length of figured specimen 0.87 mm., height 0.46 mm., thickness 0.41 mm.

Remarks: The specimen differs from typical *C. plebeia* in the more uniformly ovate outline of the smaller right valve, and more uniform convexity in the ventral region. It is much less strongly pitted and more uniform in outline than *C. burnsi* (Ulrich and Bassler). The internal features of the single specimen are not fully known, so that its relationships are obscure.

Occurrence: Edenton Naval Air Base well no. 1, Chowan County, N. C., 45 feet, upper Miocene, U.S.N.M. 560682.

Cytheretta inaequivalvis (Ulrich and Bassler)

Cythere inaequivalvis Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 101, pl. 35, figs. 15–17.

Cytheretta inaequivalvis (Ulrich and Bassler) Swain, 1948, Maryland Dept. Geology, Mines, and Water Res., Bull. 2, p. 213, pl. 13, fig. 5.

Occurrences Well no. 65 at Bogue, N. C., 130 feet. U.S.N.M. 560713, and Esso Standard Oil Co. Hatteras Light Well no. 1, 670–680 feet, U.S.N.M. 560714, upper Miocene. It occurs also in the Calvert formation, middle Miocene, of Maryland.

Cytheretta cf. C. bassleri Howe

Cytheretta bassleri Howe, 1935, Florida Dept. Conservation, Geol. Bull. 13, p. 32, pl. 3, figs. 21, 22.

Occurrence: One specimen, from uppermost Miocene, Esso Standard Oil Co. Hatteras Light well no. 1, 160–170 feet, U.S.N.M. 560715. Described from the *Arca* zone of the Choctawhatchee formation, middle Miocene, of Florida.

Cytheretta karlana Howe and Pyeatt

Plate 6, figure 19

Cytheretta karlana Howe and Pyeatt, Howe and others, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 34, pl. 1, figs. 30, 34, pl. 3, figs. 3, 4.

Cytheretta reticulata Edwards, 1944, Jour. Paleontology, vol. 18, p. 525, pl. 88, figs. 7–10.

The present example (U.S.N.M 560684) from the water well at Harvey Neck, Perquimans County, N. C., at a depth of 55–57 feet, middle Miocene, was compared with the type of *C. reticulata* Edwards and found to be conspecific. Specimens of *C. karlana* Howe and Pyeatt have not been examined, but published descriptions and illustrations show that it resembles *C. reticulata* so closely that they are probably conspecific.

Occurrence: Cytheretta karlana was described from the Chipola formation, lower Miocene of Florida (Howe and others, 1935, p. 34). A slightly smaller and more delicate variety, *C. karlana* var. *choctawhatchiensis* Howe and Taylor was described from the *Arca* zone of the Choctawhatchee formation of Florida. *C. reticulata* was described from the upper Miocene Duplin marl, Duplin County, N. C. (Edwards, 1944, p. 525).

Cytheretta darensis Swain, n. sp.

Plate 6, figures 20–22

Shell subovate in side view; greatest height median; hinge margin nearly straight to gently convex, slightly more than half of shell length; ventral margin of left valve gently convex, that of right valve nearly straight and somewhat sinuous; anterior margin rounded, slightly extended below; posterior margin more narrowly rounded, extended medially, truncate above in left valve, slightly concave above in right valve. Left valve much larger than right, extending strongly beyond the other along ventrum, and overlapping rather strongly at antero-cardinal angle. Greatest convexity just behind midlength where valve surfaces, especially that of the right, are strongly swollen. Surface smooth, except for several weak longitudinal ridges in ventral portion of left valve.

Internal features not observed because of poor preservation.

Length of holotype, a complete specimen (pl. 6, fig. 20) 0.90 mm., height 0.53 mm., thickness 0.46 mm.

Relationships: This species lacks the pitted surface of *C. plebeia* (Ulrich and Bassler) of the Miocene, and the strong longitudinal ridges of *C. alexanderi* Howe and Chambers of the upper Eocene. *Cythereis? ever-*

greenica (Stadnichenko) (1927, p. 235) of the middle Eocene resembles it in shape and nearly smooth surface, but lacks the cytherettid overlap at the ends of the hinge.

Occurrence: Esso Standard Oil Co., Hatteras Light well no. 1, 1,740–1,750 feet, middle Eocene, U.S.N.M. 560685 and 560686.

Cytheretta cf. C. alexanderi Howe and Chambers

Plate 6, figures 23–25

Cytheretta alexanderi Howe and Chambers, 1935, Louisiana Dept. Conserv., Geol. Bull. 5, p. 45, pl. 5, figs. 17–21, pl. 6, figs. 27, 28.

Shell elongate-subovate in lateral view; greatest height about one-third from anterior end; hinge margin slightly convex, a little more than half of shell length; ventral margin of left valve gently convex, that of right valve sinuous to slightly concave medially; anterior margin slightly extended medially; posterior margin more narrowly rounded, extended medially, concave near cardinal angle, and bearing small spines along ventral portion. Left valve much larger than right, extending strongly beyond other along ventrum, and overlapping at anterocardinal angle. Convexity of valves moderate, posterior end compressed; greatest convexity behind and slightly below middle.

Several longitudinal ridges and grooves present, some converging posteriorly; grooves bear scattered coarse pits; just beneath anterocardinal angle in each valve is a short, shallow, oblique sulcus.

Internal features not observed because of recrystallization of shell material.

Length of a figured specimen (pl. 6, fig. 25) 0.83 mm., height 0.46 mm., thickness 0.38 mm.

Remarks: The present specimen probably belongs in this species but its poor preservation prevents comparison of internal features. The surface ridges and grooves are somewhat less strongly developed than indicated in illustrations of *C. alexanderi*, but this may be the result of imperfect preservation.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 100 feet, middle Eocene U.S.N.M. 560688; Esso Standard Oil Co. North Carolina Esso well no. 2, 1,620–1,630 feet U.S.N.M. 560687. Described (Howe and Chambers, 1935, p. 45) from the Jackson formation, upper Eocene, at Creole Bluff, Montgomery County, La.

Genus BASSLERITES Howe, 1937

Basslerella Howe, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 30 (preoccupied).

Basslerites Howe, Howe in Coryell and Fields, 1937, Am. Mus. Novitates 956, p. 11.

Basslerites cf. B. miocenicus (Howe)

Plate 7, figures 5, 6

Basslerella miocenica Howe, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 31, pl. 1, figs. 19, 24–26.

Basslerites miocenicus (Howe), Howe, in Coryell and Fields, 1937, Am. Mus. Novitates 956, p. 11. Edwards, 1944, Jour. Paleontology, vol. 18, p. 521.

Shell subquadrate in side view; highest about one-fourth from anterior end; hinge margin nearly straight, about two-thirds of shell length, with well-defined cardinal angles; ventral margin gently convex, converging moderately backward with respect to dorsum; anterior margin broadly rounded, slightly extended below; posterior margin less broadly rounded, somewhat extended above. Left valve larger than right, overlapping the other rather strongly at ends of hinge, less strongly elsewhere. Surface nearly smooth, ventral slope bears a few faint, discontinuous, longitudinal ridges; other faint ridges parallel dorsal margin in posterior half. Internal features not observed.

Length of a figured specimen (pl. 7, fig. 5) 0.83 mm., height 0.46 mm., thickness 0.37 mm.

Remarks: External characteristics like those prescribed for *B. miocenicus* but as the internal features are unknown, the present assignment is tentative.

Occurrence: Williamston test well no. 2, Martin County, N. C., 90–95 feet, middle Miocene U.S.N.M. 560694. Described from the Choctawatchee formation of Florida (Howe and others, 1935, p. 31). The types include specimens from the upper part of the formation and from the *Arca* zone below.

Basslerites cf. B. giganticus Edwards

Text figures 3*o–q*

Basslerites giganticus Edwards, 1944, Jour. Paleontology, vol. 18, p. 521, pl. 87, figs. 19–23.

Occurrence: One specimen (U.S.N.M. 560727) from the upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 170–180 feet; described from the Duplin marl near Lumberton, N. C.

Genus EOCYTHEROPTERON Alexander, 1935

Eocytheropteron? sp.

Plate 7, figure 16

Shell subquadrate in lateral view; highest about one-fourth from anterior end; dorsal margin nearly straight, about two-thirds of shell length; ventral margin sinuate and converging posteriorly toward dorsum; anterior margin broadly rounded, extended below; posterior margin narrowly rounded. Ventral portion of shell swollen, especially the posterior third where

enlargement overhangs ventral margin as weakly developed alae. Posterior end somewhat compressed.

Surface has a faint reticulate pattern of narrow ridges and broad minutely punctate interspaces.

Hinge of left valve consists of terminal, elongate, weakly crenulate sockets, an interterminal crenulate ridge, dorsad of which is a narrow groove. Muscle scar of single specimen found consists of a subvertical row of three elongate spots. Inner lamellae fairly broad anteriorly, narrower elsewhere; antero-ventrally, inner margin and line of concrescence widely separated. Radial canals few, flaring where they open along line of concrescence, giving it a scalloped outline.

Length of figured specimen, a left valve, 0.44 mm., height 0.25 mm.

Remarks: In general outline and weak alation this specimen resembles *Eocytheropteron* Alexander, but the hingement is that of *Cytheropteron* Sars. The ornamentation of the specimen differs from that of species of *Cytheropteron* familiar to the writer, and it may represent a new species. The small specimen found may be an immature molt.

Occurrence: Esso Standard Oil Co. North Carolina Esso well no. 2, 380–390 feet, upper Miocene U.S.N.M. 560700.

Genus CYTHEROPTERON Sars, 1865

Cytheropteron cf. C. subreticulatum van den Bold

Plate 7, figures 11, 13

Cytheropteron subreticulatum van den Bold, 1946, Contrib. to the Study of Ostracoda, Amsterdam, p. 113, pl. 14, fig. 6.

Shell subovate in side view; highest slightly anterad of midlength; dorsal margin moderately convex in left valve, less convex in right valve; ventral margin slightly convex, somewhat sinuous; anterior margin rounded, extended below, subtruncate above; posterior margin more narrowly rounded with a median blunt caudal extension. Left valve larger than right, greatest extension in middorsal region.

Midventral surface of each valve strongly inflated to form blunt alae; crests of alae occupied by low longitudinal ridges. Anteromedian portion of valve coarsely pitted; postermedian portion bears strong, subvertically elongate pits and intervening short ridges. Marginal areas smooth. Posterior caudate portion of valves strongly compressed.

Hinge of right valve consists of terminal small teeth, separated by a long denticulate groove; hinge of left valve consists of terminal sockets and intervening thick denticulate bar. Inner lamellae fairly broad with a distinctly wider postventral area; inner margin and line of concrescence widely separated; radial canals few, widely and irregularly spaced. Muscle scar obscured by matrix.

Length of figured right valve (pl. 7, fig. 11) 0.58 mm., height 0.35 mm.

Remarks: In most features this form resembles *C. subreticulatum*, but van den Bold's drawing shows weaker ornamentation.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene, U.S.N.M. 560698. Described from the Miocene of Cuba (van den Bold, 1946, p. 113).

Cytheropteron cf. C. variosum Martin

Plate 7, figures 12, 14, 15

Cytheropteron variosum Martin, 1939, Jour. Paleontology, vol. 13, p. 178, pl. 22, figs. 7–9.

The specimens appear identical with Martin's species from the Claiborne group of the Gulf region. As compared to *C. cf. C. subreticulatum*, the present species possesses more strongly elevated ridges on the alae, is smaller, and more coarsely pitted. *C. montgomeryensis* Howe and Chambers (1935, p. 19) from the lower part Jackson formation in the Gulf states is closely similar in shape but is more weakly ornamented. Perhaps *C. subreticulatum* and some of the more or less smooth specimens included by Martin in *C. variosum* are conspecific.

Length of a figured specimen (pl. 7, fig. 12) 0.43 mm., height 0.26 mm., thickness 0.23 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 135 feet, middle Eocene, U.S.N.M. 560699. Described from the Cook Mountain formation of Louisiana, and recorded in the McBean formation of Georgia, and the Gosport sand of Alabama.

Cytheropteron sp. (a)

Plate 7, figure 17

Left valve subquadrate in side view; highest medially; dorsal margin gently convex; ventral margin nearly straight; anterior margin extended and narrowly rounded below, truncate above; posterior margin extended above as a broad caudal process. Shell strongly alate ventrally, and medially bears a depression on the alate expansion; anterior margin bears a narrow rim. Surface of specimen at hand consists of granular calcite that obscures its original finer details.

Hinge of left valve consists of terminal elongate sockets connected by a high, narrow, finely denticulate ridge. Other internal features obscured by recrystallization of shell and matrix.

Length of figured left valve 0.60 mm., height 0.32 mm.

Remarks: In outline, small size, and smooth surface this form resembles *Cytheropteron crassipinnatum* Brady and Norman from the Recent of the North Atlantic region as figured by Sars (1928, p. 227) but in that species the alae are longer and more pointed. Sars' illustration shows weaker surface pits and sharper alae than were indicated by Brady and Norman. The single poorly preserved left valve at hand does not allow a complete analysis of the species.

Occurrence: Esso Standard Oil Co. Hatteras Light well no. 1, 320–340 feet, upper Miocene, U.S.N.M. 560701.

Cytheropteron sp. (b)

A small, probably immature, right valve represents this genus. The ventral surface is strongly swollen but not crested. The median portion of the valve bears weak and irregular longitudinal ridges.

Occurrence: Lower Miocene, Esso Standard Oil Co. Hatteras Light well no. 1, 1,220–1,230 feet, U.S.N.M. 560716.

Genus CYTHEROMORPHA Hirschmann, 1909

Cytheromorpha cf. C. warneri Howe and Spurgeon

Plate 7, figures 18, 19

Cytheromorpha warneri Howe and Spurgeon, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 11, pl. 2, figs. 5, 8, 9, pl. 4, fig. 4.

The specimens from North Carolina wells appear to be intermediate between *C. warneri* Howe and Spurgeon and *C. warneri okaloosaensis* Howe and Spurgeon in that the anterior half to two-thirds of the valve surface is pitted rather than reticulate. The entire surface is somewhat more finely ornamented than illustrated for *C. warneri.* The present species is also much like *C. rosefieldensis* Howe and Law of the Vicksburg group, but lacks the median ventral ridge of that species.

Length of a figured specimen (pl. 7, fig. 18) 0.57 mm., height 0.31 mm., thickness 0.21 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene, U.S.N.M. 560702; the species occurs in the Choctawhatchee formation of Florida, and the Calvert formation of Maryland (Howe and others, 1935, p. 12). *C. warneri okaloosaensis* occurs in the Shoal River formation of Florida and the Calvert formation of Maryland (idem., p. 13).

Cytheromorpha curta Edwards

Plate 7, figure 22

Cytheromorpha curta Edwards, 1944, Jour. Paleontology, vol. 18, p. 516, pl. 86, figs. 19–22.

The example figured here was compared with the holotype and found to be conspecific. Except for short length in proportion to height, it is very much like *C. warneri* Howe and Spurgeon, and may prove to be an immature molt stage or a dimorphic variation of that species.

Length of figured specimen 0.42 mm., height 0.28 mm., thickness 0.18 mm.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 60 feet, upper Miocene, U.S.N.M. 560705; described from the Duplin marl near Lumberton, N. C.

Cytheromorpha cf. C. eocenica Stephenson

Plate 7, figure 20

Cytheromorpha eocenica Stephenson, 1946, Jour. Paleontology, vol. 20, p. 311, pl. 43, fig. 9.

Shell subelliptical in side view; highest about one-fourth from anterior end; hinge margin nearly straight, about seven-tenths of shell length; ventral margin sinuous, concave medially, converging slightly toward dorsum posteriorly; anterior margin broadly rounded, somewhat produced ventrally; posterior margin more narrowly rounded, extended medially, concave above. Valves approximately equal in size and of moderate convexity; greatest thickness in posterior third.

Free margins with a narrow rim, except in midventral portion; a narrow groove, deepest anteriorly, bounds rim on its inner side. Midportion of valves slightly constricted. Surface within marginal grooves coarsely pitted in a reticulate pattern; terminally, pits somewhat smaller than medially.

Length of a figured specimen 0.51 mm., height 0.22 mm., thickness 0.17 mm.

Remarks: The present example is somewhat more nearly equal-ended and less concave ventrally than that figured by Stephenson, but otherwise it fits his description.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 feet, middle Eocene, U.S.N.M. 560703. Described from the Weches formation, Claiborne group, at Smithville, Tex. (Stephenson, 1946, p. 311).

Cytheromorpha? sp.

Plate 7, figure 26

Shell subquadrate in side view; highest about one-fourth from anterior end; hinge margin nearly straight, about five-eighths of shell length; ventral margin slightly concave in midportion, converging toward dorsum posteriorly, anterior margin broadly rounded, somewhat extended ventrally, truncate dorsally; posterior margin more narrowly rounded, slightly extended medially. Left valve slightly larger than the right. Convexity moderate, with greatest thickness in midportion.

Free margins have smooth rims. Surface coarsely pitted. A small node lies beneath anterocardinal angle and eye tubercle; two elongate longitudinal swellings occur dorsally a little behind middle of shell and ventrally at midlength; a broad depression lies in postventral area; a low subvertical ridge is present ventrad of postcardinal angle. Internal features not observed.

Length of figured specimen 0.42 mm., height 0.20 mm., thickness 0.15 mm.

Remarks: The general shape of this form allies it with *Cytheromorpha* Hirschmann, but in shape and ornamentation it resembles *Limnocythere* Brady, a fresh-water genus. Probably it represents a new species but, as only one specimen was found and the internal features are unknown, the form is not named.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 130 feet, middle Eocene, U.S.N.M. 560708.

Genus CYTHERURA Sars, 1865

Cytherura elongata Edwards

Plate 7, figures 24, 25

Cytherura elongata Edwards, 1944, Jour. Paleontology, vol. 18, p. 527, pl. 88, figs. 21–25.

The present examples were compared with the types and found to be conspecific. The species apparently is a guide fossil for late Miocene age in this region, as it has not been found in deposits older than the Duplin marl. *C. wardensis* Howe and Brown, originally described from the Choctawhatchee formation of Florida, also occurs in the Duplin marl, together with *C. reticulata* Edwards and *C. forulata* Edwards. *C. wardensis* has a shorter hinge than *C. elongata*, more evenly reticulate surface, and no anterior submarginal ridges. *C. reticulata* has a shorter hinge than the present species, is more evenly reticulate, has a more uniformly convex surface and a more medially located posterior caudal extension. *C. forulata* has a more convex dorsum and more conspicuous longitudinal surface ridges.

Occurrence: Edenton Naval Air Base well no. 1, Chowan County, N. C., U.S.N.M. 560707, 45 feet; Esso Standard Oil Company Hatteras Light well no. 1, 220–230 feet, upper Miocene, U.S.N.M. 560757; Duplin marl near Lumberton, N. C.

Cytherura sp. aff. C. washburni Stephenson

Plate 7, figure 27

Shell subelliptical-acuminate in side view; dorsal margin gently convex, straight in midportion; ventral margin nearly straight to slightly concave; anterior margin broadly rounded; posterior margin greatly extended with well developed caudal process at midheight. Valves approximately equal in size, strongly convex; greatest thickness midventral.

Surface ornamentation consists of a midventral alaform ridge, highest posteriorly and merging with general surface of shell in anterior third; crest of ridge bears two narrow grooves. Flattened ventrum ornamented by several longitudinal grooves and intervening narrow ridges. Remainder of the probably abraded surface weakly ornamented by inconspicuous pits and short ridges. Margins of each valve bear narrow low ridges. Internal features not observed.

Length of the single specimen at hand 0.42 mm., height 0.20 mm., thickness 0.20 mm.

Remarks: This species probably belongs in the alate group of *Cytherura* represented in the Oligocene by *C. byramensis* Howe and Law (1936, p. 69), *C. wailesi* Howe and Law (1936, p. 71), *C. sylvernica* Howe and Law (1936, p. 70), and in the Eocene by *C. washburni* Stephenson (1946, p. 317). It is less conspicuously pitted than *C. byramensis* and bears more abundant small ornamental features than *C. washburni* to which, perhaps, it is most closely related.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 135 feet, middle Eocene, U.S.N.M. 560709; species described from the Weches formation at Smithville, Tex.

Cytherura wardensis Howe and Brown

Cytherura wardensis Howe and Brown, Howe and others, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 36, pl. 1, figs. 23, 27, pl. 4, fig. 19.

Occurrence: Upper Miocene, Esso Standard Oil Co., Hatteras Light well no. 1, 160–170 feet, U.S.N.M. 560717; and in the middle Miocene, Edenton Naval Air Base well no. 4, 88 feet, U.S.N.M. 560718, and the Cape Lookout well, 75–100 feet, U.S.N.M. 560719. Described from the *Arca* zone of the Choctawhatchee formation of Florida.

Cytherura forulata Edwards

Cytherura forulata Edwards, 1944, Jour. Paleontology, vol. 18, p. 526, pl. 88, figs. 21–25.

Occurrence: One specimen in Pleistocene sand, Esso Standard Oil Co. Hatteras Light well no. 1, 60–70 feet, U.S.N.M. 560720. Described from the Duplin marl, upper Miocene, near Lumberton, N. C.

Cytherura reticulata Edwards

Cytherura reticulata Edwards, 1944, Jour. Paleontology, vol. 18, p. 526, pl. 88, figs. 13–16.

Occurrence: Upper Miocene, Esso Standard Oil Co. Hatteras Light well no. 1, 460–470 feet, U.S.N.M.

560721. Described from the Duplin marl, near Lumberton, N. C.

Genus MONOCERATINA Roth, 1928

Monoceratina cf. M. harrisi Stephenson

Plate 7, figure 23

Monoceratina harrisi Stephenson, 1946, Jour. Paleontology, vol. 20, p. 313, pl. 43, fig. 14.

Shell subquadrate in side view; dorsal margin slightly convex, about four-fifths of shell length; ventral margin slightly convex, curving gently into posterior margin and much more sharply into anterior margin; anterior margin strongly produced above, subtruncate below. Valves nearly equal in size, the left slightly larger.

Free marginal areas of each valve compressed and separated from inflated median portion by a rather discontinuous submarginal groove. Medially and slightly above midheight is an oval depression. Postventral surface strongly inflated, forming a conspicuous subalaform elevation. Most of surface coarsely and deeply pitted. Internal features not observed.

Length of figured specimen, a somewhat damaged shell, 0.57 mm., height 0.29 mm., thickness 0.23 mm.

Remarks: The specimen closely resembles *M. harrisi* from the Weches formation, but the latter has a less distinct compressed marginal border. *M. musei* Stephenson, also from the Weches, is more sparsely punctate and has a Z-shaped median depression, but otherwise resembles the present form.

Occurrence: Naval Auxiliary Air Station well, Washington, N. C., 90 feet, middle Eocene, U.S.N.M. 560706. Described from the Weches, middle Eocene, from Smithville, Tex.

Genus PARACYTHERIDEA Müller, 1894

A readily available generic description was provided by Edwards (1944, pp. 511–512; on page 512, seventh line, fourth word, read "left" instead of "right"). Van den Bold (1946, p. 26) also discussed *Paracytheridea* and stated its range to be Cretaceous to Recent, but placed *Mooreina* Harlton from the lower Pennsylvanian Johns Valley shale in synonymy.

Paracytheridea is close to *Perissocytheridea* Stephenson (1938), but in the latter alae are lacking and the line of concrescence does not coincide terminally with the inner margin. *Hutsonia* (Swain, 1946) from the upper Jurassic is similar to *Perissocytheridea* in general form and hingement but is typically bisulcate. *Hutsonia* may be close to the ancestral stock of the other two genera.

Paracytheridea nodosa (Ulrich and Bassler)

Plate 3, figures 19–22

Cytheropteron nodosum Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 129, pl. 38, figs. 37–40.

Paracytheridea nodosa (Ulrich and Bassler), Howe and others, 1935, Florida Dept. Conserv., Geol. Bull. 13, p. 37, pl. 3, fig. 7.

?*Paracytheridea altila* Edwards, 1944, Jour. Paleontology, vol. 18, p. 512, pl. 85, figs. 20, 21.

The external characters of the species were described by Ulrich and Bassler. Internal features observed in the present material are as follows:

Hinge of right valve consists of an anterior elongate, low, crenulate tooth. Hinge of left valve comprises an anterior shallow crenulate socket, a narrow interterminal crenulate bar, and a posterior, shallow crenulate socket. Inner lamellae not well defined; inner margin and line of concrescence coincide throughout. Muscle scar a submedian vertical row of four spots, with possibly some anterior spots that were not observed clearly. Radial canals few and widely spaced.

Length of figured specimen (pl. 3, fig. 21) 0.66 mm., height 0.29 mm.

Occurrence: Edenton Naval Air Base well no. 1, Chowan County, N. C., at 55 feet, middle Miocene, U.S.N.M. 560644. Described from the Chesapeake group (undifferentiated) at James River, Va. (Ulrich and Bassler, 1904, p. 130); occurs also in the Choctawhatchee formation at Red Bay, Walton County, Fla. (Howe and others, 1936, p. 37), and in the Miocene at several localities in Cuba and Guatemala (van den Bold, 1946, p. 86). *P. altila* Edwards (1944, p. 512) from the Duplin marl of North Carolina may have been based on immature molts of *P. nodosa.*

Paracytheridea? wetherellii (Jones)

Plate 7, figures 2–4

Cythere wetherellii Jones, 1854, Quart. Jour. Geol. Soc., London, vol. 10, p. 161, pl. 3, fig. 9; Jones 1856, Tertiary Entomostraca of England, p. 27, pl. 4, fig. 15, pl. 6, figs. 16a–d.

Shell subtrapezoidal in lateral view; greatest height submedian; dorsal margin nearly straight, about two-fifths of shell length with broadly obtuse cardinal angles; ventral margin gently convex; anterior margin narrowly rounded below, truncate above; posterior margin subacuminate below, truncate above. In posterior four-fifths ventral surface moderately alate, overhanging valve margin. Entire surface coarsely but not uniformly reticulate. Depressed areas between reticulating ridges finely papillate. Left valve overlaps right along free margins.

Hinge of left valve consists of terminal oblique, elongate, crenulate sockets separated by a narrow, very finely crenulate ridge. Hinge of right valve the antithesis of the left. Inner lamella broadest anteriorly; line of concrescence and inner margin nearly coinciding. Muscle scar and other internal features obscured by matrix.

Length of a figured left valve 0.56 mm., height 0.31 mm.

Remarks: The general outline, ventral alation, and hingement of the species resembles features of *Paracytheridea* Müller, but the shell is not compressed posteriorly as are more typical members of the genus. The present specimens seem identical with *P.? wetherellii* (Jones) from the middle Eocene.

Occurrence: Esso Standard Co. Hatteras Light well no. 1, 320–340 feet, U.S.N.M. 560691; North Carolina Esso no. 2, 340–350 feet, middle Miocene, U.S.N.M. 560692. Described from the middle Eocene, Isle of Wight.

Paracytheridea cf. P. rugosa Edwards

Paracytheridea rugosa Edwards, 1944, Jour. Paleontology, vol. 18, p. 513, pl. 85, fig. 24.

A single right valve that probably belongs to this species was obtained. The hinge consists of an anterior crenulate dental area, not noticeably elevated, formed of the edge of the valve at its cardinal bend; an interterminal shallow serrate groove; and a posterior small perhaps crenulate tooth.

Occurrence: Upper Miocene, Esso Standard Oil Co. Hatteras Light well no. 1, 160–170 feet, U.S.N.M. 560722. Described from the Duplin marl, Lumberton, N. C.

Genus Pellucistoma Coryell and Fields, 1937

Pellucistoma cf. P. magniventra Edwards

Pellucistoma magniventra Edwards, 1944, Jour. Paleontology, vol. 18, p. 528, pl. 88, figs. 33–35.

Occurrence: An imperfect specimen of this species was obtained from the upper Miocene, North Carolina Esso well no. 2, 130–140 feet, U.S.N.M. 560723. The species was described from the Duplin marl near Lumberton, N. C.

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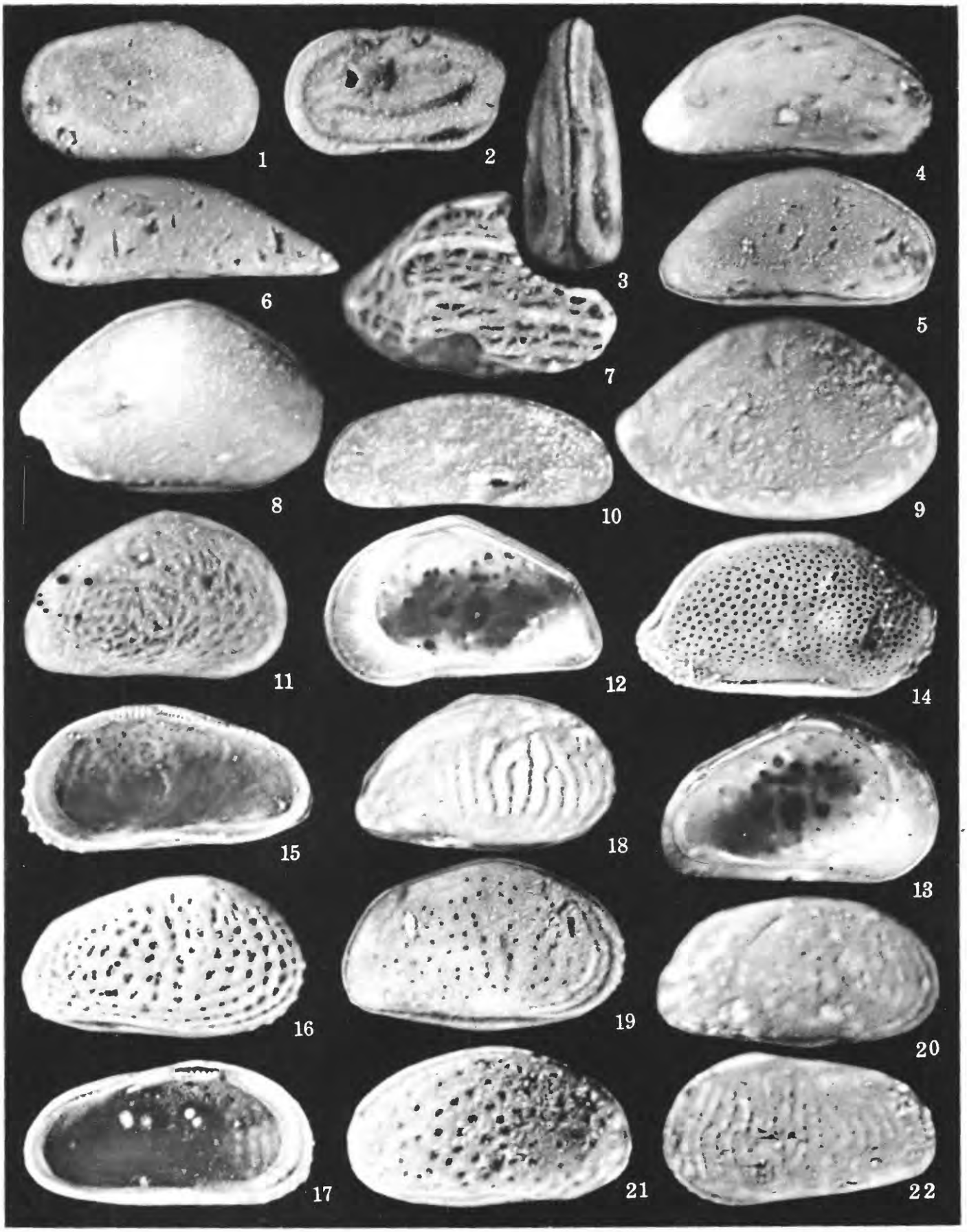
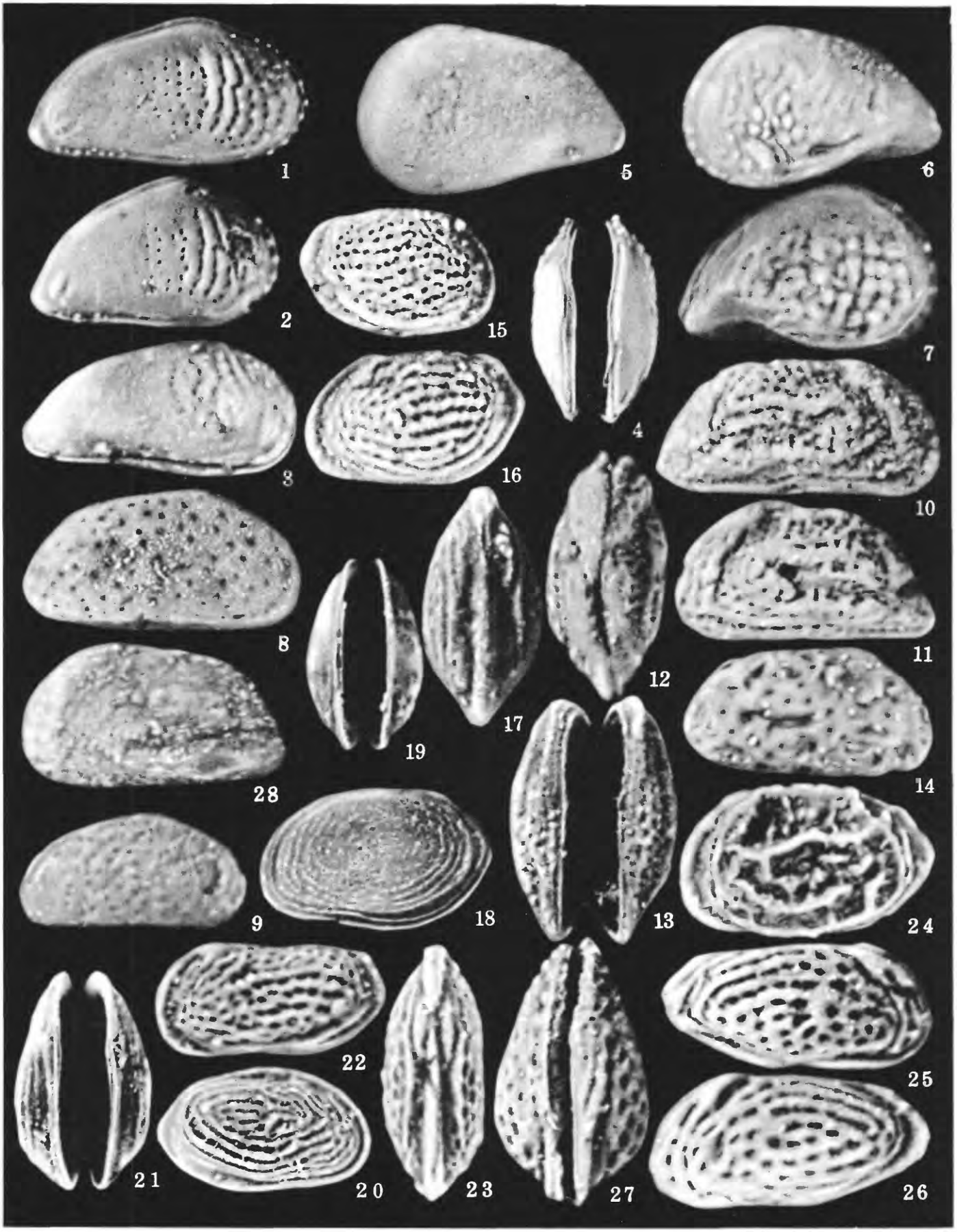


CYTHERELLIDAE, CYPRIDAE, BAIRDIIDAE, CYTHERIDAE

PLATE 2



CYTHERIDAE

PLATE 3

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FIGURES 1–3. *Trachyleberis evax* (Ulrich and Bassler) 1,3, Exterior of a male left valve and interior of a female left valve, ×53. 3 slightly retouched. Middle Miocene, Esso Standard Oil Co. Hatteras Light well no. 1, 840–850 feet. U.S.N.M. 560632. 2, Exterior of an immature left valve, ×53. Middle Miocene, Hatteras Light well no. 1, 900–910 feet. U.S.N.M. 560633 28

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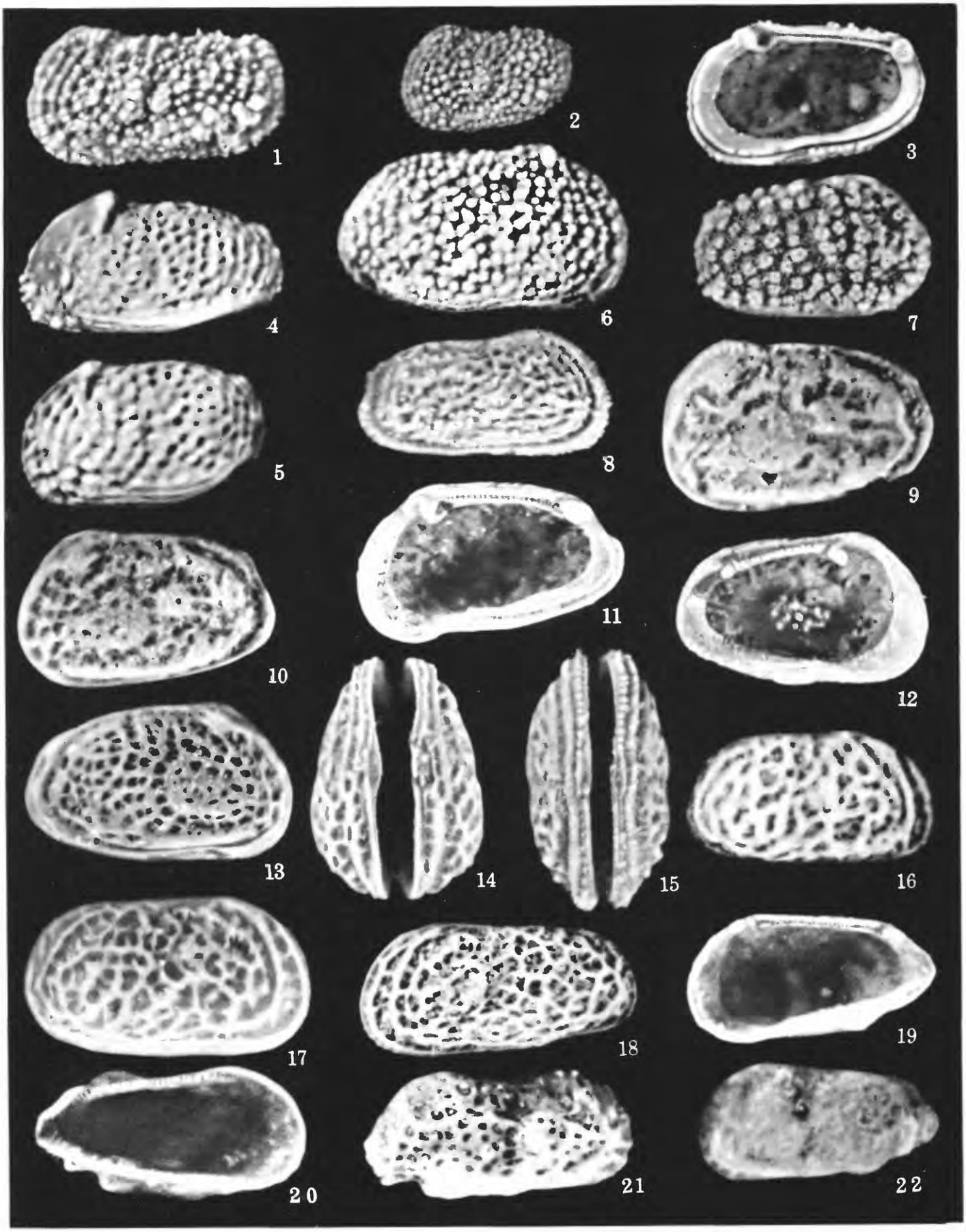
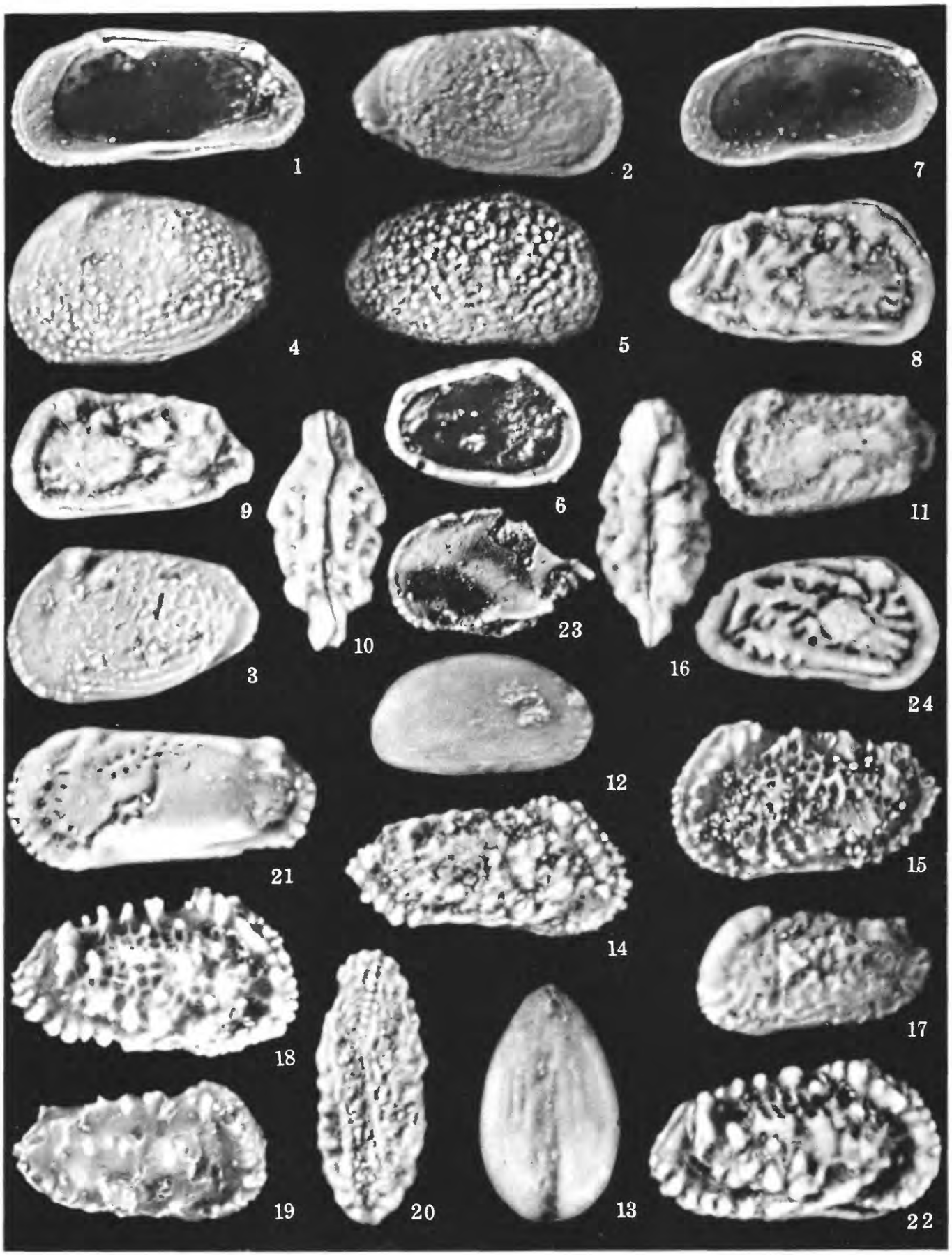


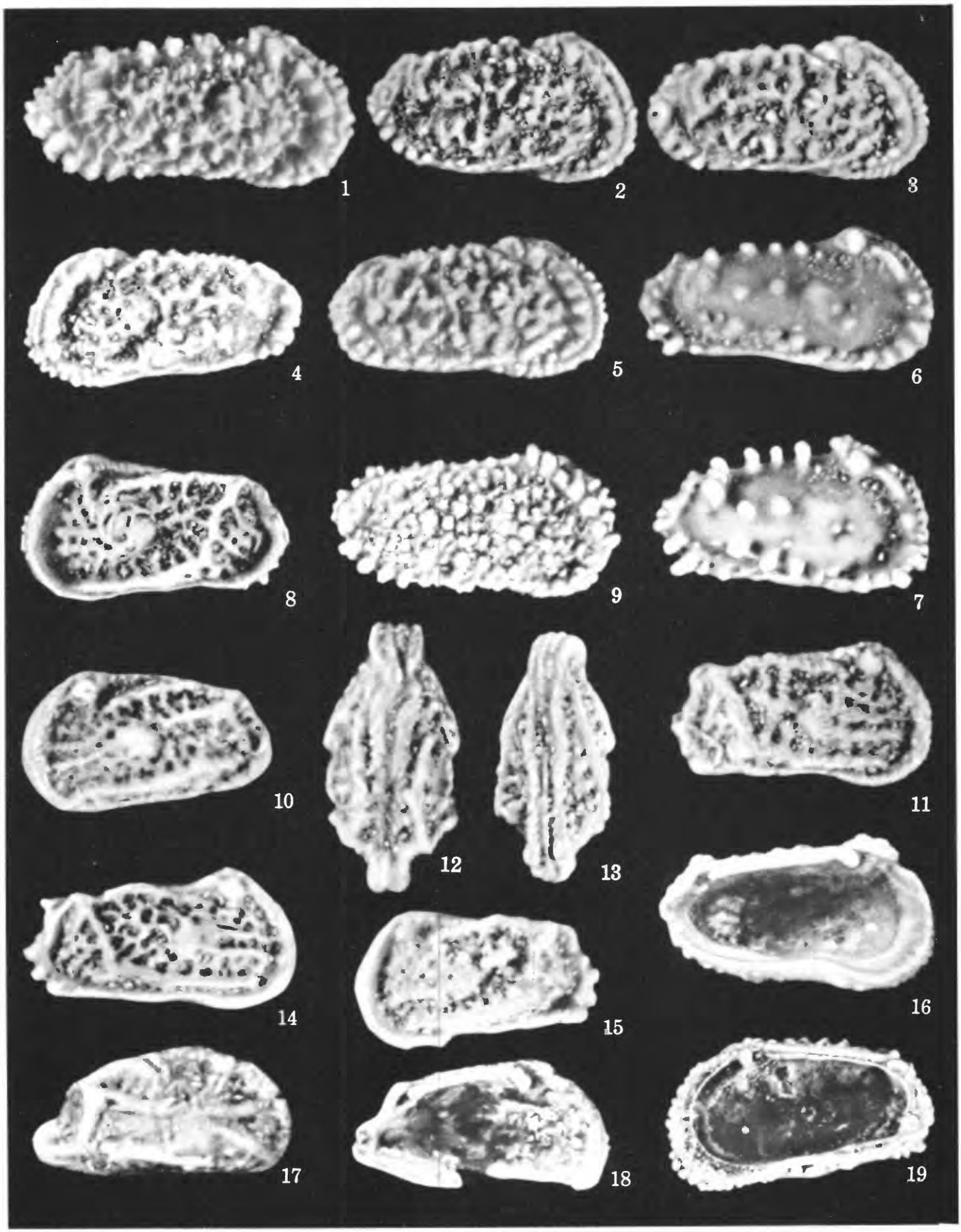
CYTHERIDAE

PLATE 4



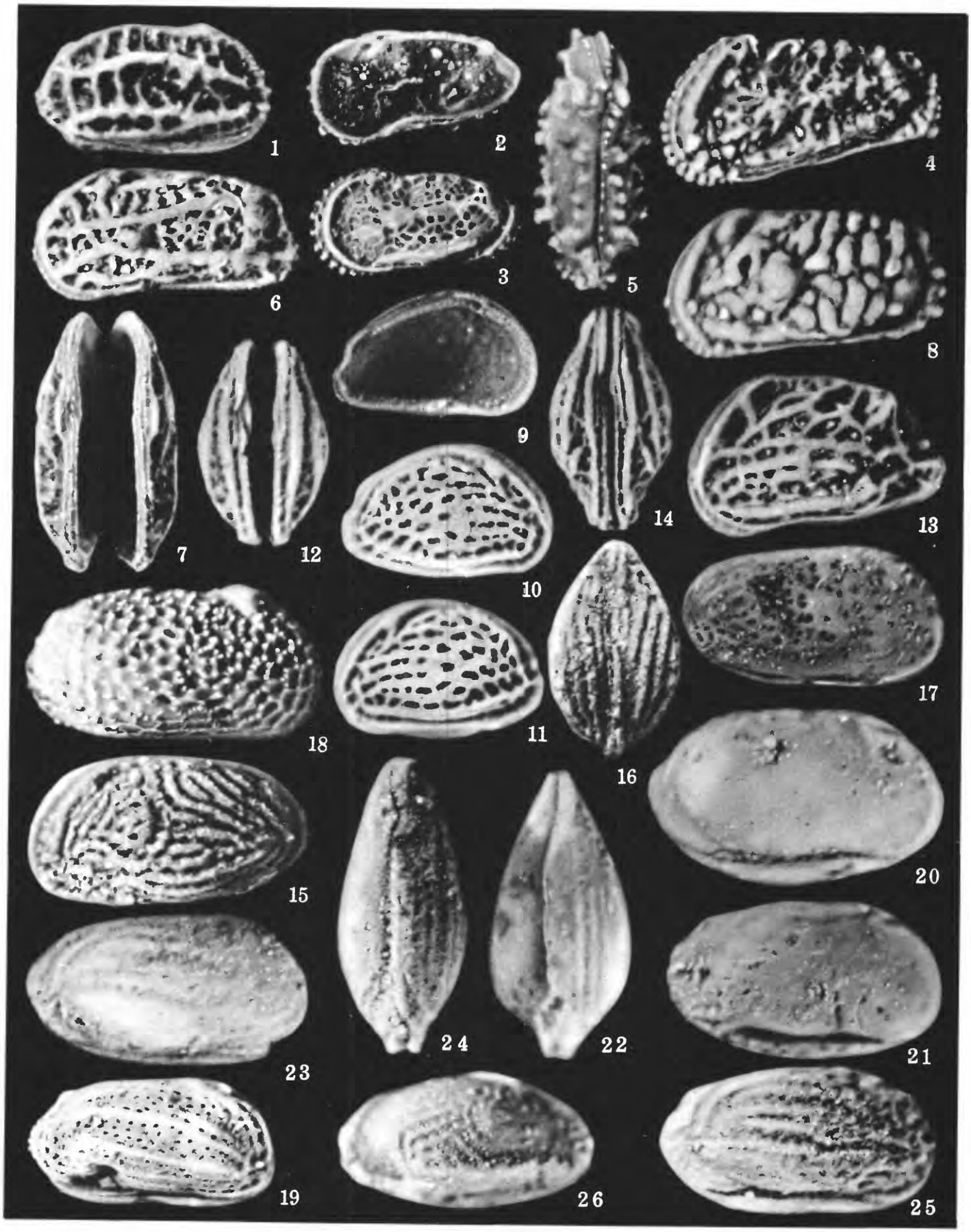
CYTHERIDAE

PLATE 5



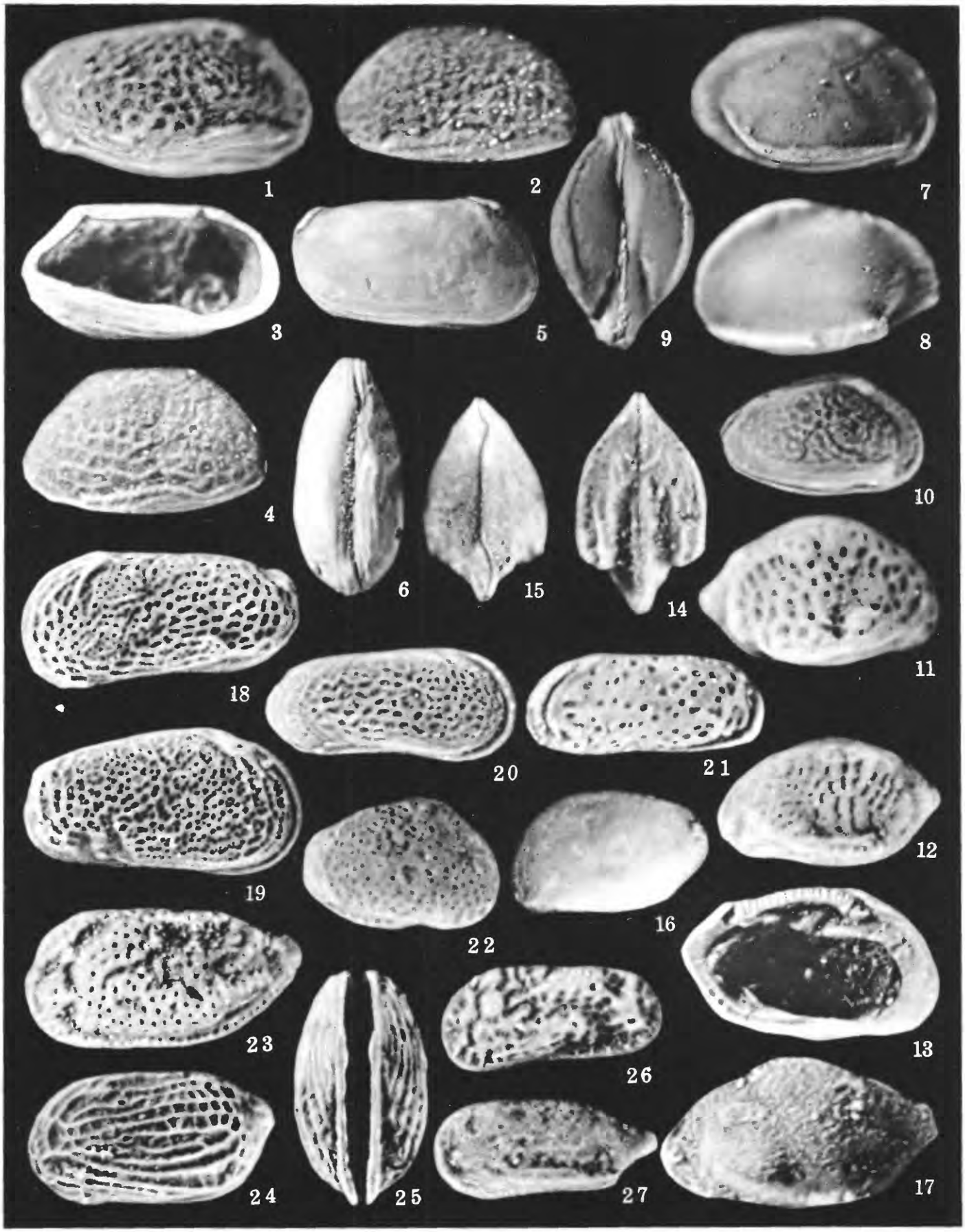
CYTHERIDAE

PLATE 6



CYTHERIDAE

PLATE 7



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