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OSTRACODA FROM THE LOUISIANA CONTINENTAL SHELF

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I. ABSTRACT

There have been no published comprehensive studies of the Ostracoda of the Louisiana Continental Shelf west of the Mississippi River Delta. This paper presents a study of that area and includes taxonomic and environmental data. Ostracode specimens were taken from 123 bottom samples of Holocene age, collected on the continental shelf and slope.

Five distinct ostracode assemblages are recognized and related to water depth and sediment grain size. Several individual species are also recognized as useful indicators of water depth. Water depth and salinity ranges of several species are extended in relation to previous reports.

Sixty species are identified, with nine species and two subspecies considered new. The following new taxa are described: *Actinocythereis vandenboldi, Basslerites vokesi, Cytherella vermilionensis, Cytheropteron morgani, Cytheropteron tumulosimilis, Loxoconcha moralesi, Luvula gigartonoides,*

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Macrocyprina skinneri, Puriana krutaki, Protocytheretta montezuma louisianensis, and *Munseyella bermudezi louisianensis.*

II. INTRODUCTION

There have been no comprehensive studies of the Ostracoda of the Louisiana Continental Shelf that include taxonomic and ecological treatment. This project was undertaken to present such a study for the region from the Mississippi River Delta and the Louisiana Continental Shelf. Many papers have been published on the ostracodes of other regions of the Gulf of Mexico as indicated in the bibliography of this study.

The current study considers the taxonomy of all ostracodes recovered from bottom samples; the systematic descriptions include several new species and subspecies, in addition to revision of the classification of certain previously described forms.

The concept of facies faunas is clearly demonstrated by the several distinct assemblages of ostracodes. It will be shown that even in apparently similar habitats, such as a narrow depth range, there are distinct and sometimes mutually exclusive assemblages.

The distribution of valves and carapaces (adult and juvenile) is no less important than the study of living specimens. Regardless of post-mortem transportation, a specimen can be useful as an environmental indicator if the usual site of deposition is known.

The specimens used were taken from 123 samples; 100 were bottom grab samples provided by a major oil company as washed material. Twenty-three samples were taken from the top few centimeters of cores collected on the Louisiana State University-United States Geological Survey Cruise II, Dr. James P. Morgan, Scientist in Charge.

III. ACKNOWLEDGMENTS

The writer expresses his gratitude to Dr. Hubert C. Skinner, Tulane University, who suggested this study and secured all samples used. Dr. Skinner's constant encouragement allowed the completion of the study. Dr. Harold E. Vokes and Dr. Emily H. Vokes, Tulane University, offered much useful advice and criticism that was incorporated into this report.

Twenty-three bottom samples were provided by Dr. James P. Morgan, Director of Louisiana State University-United States Geological Survey Cruise II. These materials make up a substantial part of the total samples utilized.

Special appreciation is expressed to Dr. W. A. van den Bold, Louisiana State University (Baton Rouge), for his detailed evaluation of the manuscript. His pertinent suggestions and criticisms especially in regard to taxonomy, were extremely useful in improving this study.

Dr. R. E. Nadeau, Department of Communications, Purdue University, assisted by offering advice regarding the proper usage of the new species and subspecies names.

The members of the Editorial Committee are thanked for their useful comments in review of this study.

IV. THE STUDY AREA

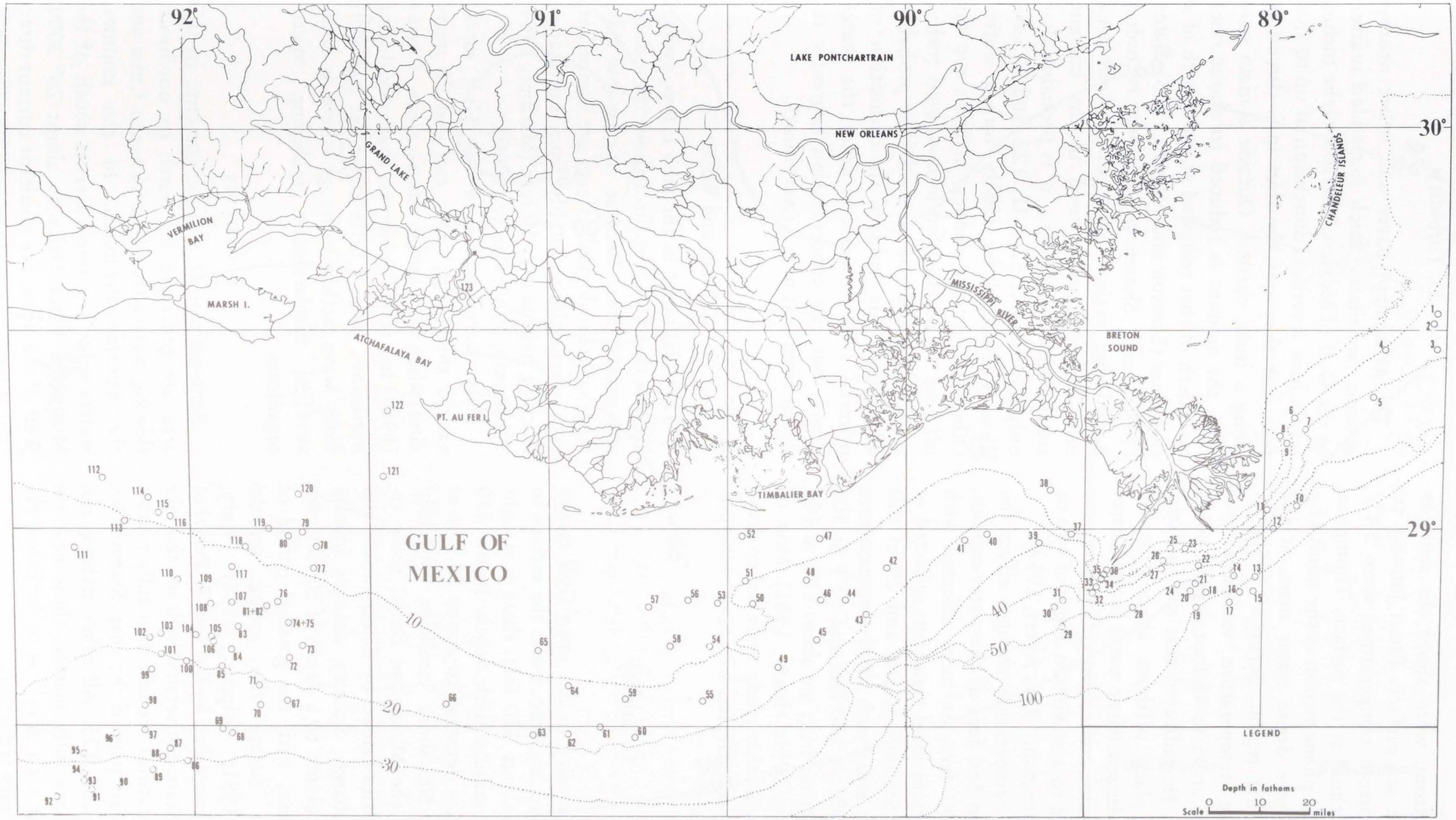
A. Introduction

The samples used in this study were collected from the Louisiana continental shelf and slope between 88° 30' and 92° 30' W. The northern limit of the sampled area is the coast of central Louisiana and about 29° 30' N to the east of the Mississippi River Delta. Samples were obtained as far south as 28° 18' N in the area off the central Louisiana coast (see Text Figure 1 and Appendix 1).

The shelf, west of the delta, is less than 50 miles wide at 90° W, but widens to more than 125 miles off western Louisiana and eastern Texas. The modern delta extends across the shelf nearly to the edge of the continental slope (Gealy, 1955; Murray, 1961).

B. Sea Temperature

The average July and February sea surface temperatures are approximately 84°F and 66-68°F, respectively, as indicated on Text Figure 2. Thompson (1951) measured water temperatures at offshore oil platforms located in 11 feet of water about 4.9 miles west-southwest of Point Au Fer Island. Temperatures from August to November, at



Text figure 1. Study area and collection locations.

the gulf bottom, were about the same as those at the sea surface. From January to May, the bottom temperatures were 3-4°F higher than those at the surface. Thompson explained this phenomenon as the result of a warm but more dense water mass, at the bottom in that region. Scruton (1956) recorded large temperature variation over short periods at 36 to 48 foot depths, north of the delta. He indicated that similar variations take place offshore at comparable depths. Mississippi River water temperatures exert the major control on gulf waters near the delta and to a maximum depth of two or three feet (Scruton, 1956; Akers, 1952).

Seasonal temperature changes affect the upper 250 to 550 feet of the water column; the upper 90 feet are most affected with even short term local variations reflected at this depth. Stations 6,7,8,9 and 29 of this study are in areas with winter temperatures of about 68°F at 100 feet and 63°F at 300 feet. Summer readings are about 81°F at 100 feet (Phleger, 1951; Henry, 1961). Most of the samples in this study were taken from depths that are affected by annual temperature variations.

C. Salinity

Surface salinity in the open Gulf ranges from 36.25 to 36.36‰. From the surface to a depth of about 330 feet, there is a slight increase in salinity with depth. Below 330 feet, salinities decrease to about 34.9‰ at 2000 feet. Nearshore localities, especially those near the Mississippi Delta, show reduced salinities caused by direct runoff and stream discharge. Salinity changes involve the water column to a depth of 50 feet over long duration, with the greatest period of variability during the spring months (Phleger, 1951; Leipper, 1954; Henry, 1961). Data supplied by Dr. Ray E. Ferrel of Louisiana State University indicate that the following stations are less than fully marine during at least part of the year: Stations 52, 121, 122, and 123. All other stations not mentioned are fully marine; those near the delta are at such depth as to be below the zone of salinity reduction.

D. Turbidity

The Mississippi River and other nearby streams contribute much suspended matter to the Gulf of Mexico. Nearshore, the turbid layers have a vertical dimension of up to five feet, but they quickly thin in a direction along a main current. Outside a main current, the amount is reduced to about one-twentieth of that recorded at the mouth of a river pass (Scruton and Moore, 1953). Bates (1953) and Shoemaker (1954) recorded Secchi disc extinction depths for the area near several stations used in the current study. From those data, it is probable that only Stations 47, 52, 121, 122, and 123 are directly affected by highly turbid water. Other stations are deeper, in areas too far offshore to be engulfed in undiluted turbid waters. It should be stressed that probably all stations are subject to deposition of material from suspension from the water above, but the concentration is greatly reduced from that near a river mouth.

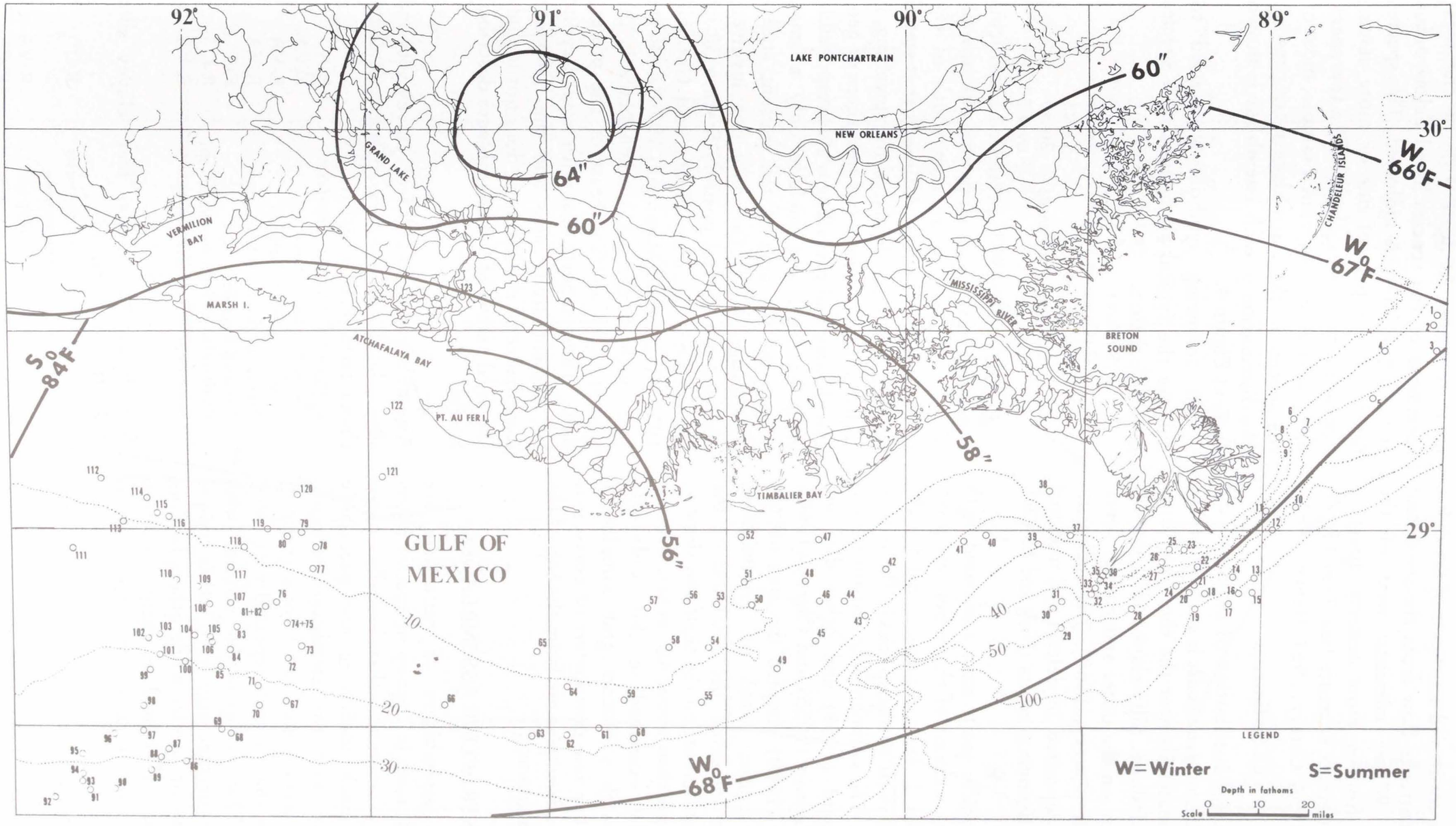
E. Tides and Waves

The tidal range in the area is low, averaging less than two feet throughout the Louisiana coastal area. Because of the low tidal range, meteorological effects are important, with storm tides, notably from hurricanes, reaching heights over 10 feet (Marmer, 1954; Thompson, 1955; Curray, 1960).

Deep water waves in the Gulf rarely exceed three feet; these can and do move sand when they reach shoal areas. Curray (1960) has stated, however, that even during hurricanes there is little or no net transport from wave action although there is some vertical displacement including microorganisms.

F. Currents

Semi-permanent surface currents in this area are generated by north or northwest flowing waters that pass between Cuba and the Yucatán Peninsula. In the summer, waters split into two currents south of the Mississippi River Delta at about 26° 30'N. West of the delta, the resultant current direction is from the south or southeast. Immedi-



Text figure 2. Average sea surface temperatures and average precipitation (after Dyke, 1941; Leipper, 1954).

ately to the south and southeast of the delta, the main currents flow from the south and southwest. Winter currents, west of the delta, are from a more easterly direction than the summer currents (see Text Fig. 3) (Leipper, 1954; Curray, 1961; Henry, 1961).

G. Sediments

The general distribution of sediments off the central Louisiana coast is such that there are sandy materials near the shore and finer sediment offshore. Silty clays and clayey silt zones occur on the outer and middle continental shelf (Curray, 1960). The sediments are facies deposited in deltaic and marginal deltaic shelf environments (Fisk and McClelland, 1959).

The specific grain sizes associated with each of the stations of this report are given in Appendix I and are summarized for the location of each of the species in the text of this study. The sediment size classification is after Shepard (1954) and other data are after Thompson (1955) and Curray (1960).

Phleger (1960) sampled the area off the Louisiana coast; based on Foraminifera faunas, he indicated the thickness of the Holocene sediments on the shelf and slope as being no less than about 40 inches. Because all material examined in this study was obtained with a bottom grab sampler or from the top few centimeters of cores, it is clear that all samples are from the top of the Holocene sequence.

V. OSTRACODE ASSEMBLAGES

Several assemblages of ostracodes are recognized; each is a group of species represented by remains that usually occur together. Each station is not necessarily included in one of the assemblages because a particular station may not have a group of ostracodes that is seen repeatedly at other stations. That is, particular stations with ostracodes present may have rather unique associations of species while others have an association represented at many localities. The latter are those herein referred to as assemblages.

The assemblages are restricted to the water depths indicated and in most cases each is restricted to a limited range of sediment textures. At least 95% of the total specimens of the species listed below occur at the depth intervals indicated. The species listed may be part of one or more assemblages. Even in cases where only a few specimens were recovered from a sample, most of the species in the assemblage were present. The distribution of each assemblage is shown in Text Figure 4.

The following symbols were used to indicate the typical abundance of a species in an association.

R(Rare)	1-4 valves
C (Common)	5-10
A(Abundant)	11-25
VA(Very abundant)	26-50
F(Flood)	over 50

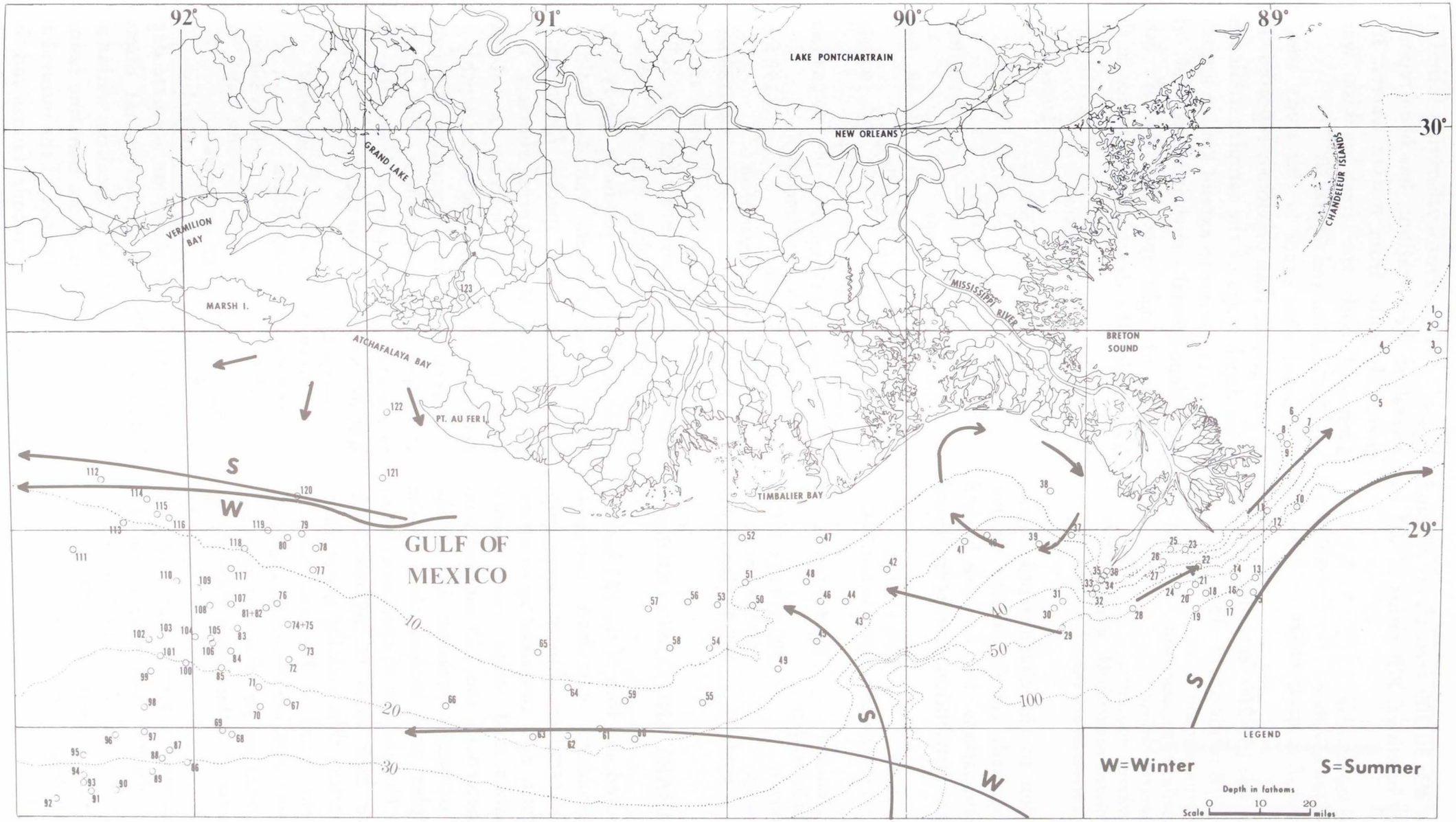
Bouma *et al.* (1971) presented convincing arguments that "a quasi-permanent upwelling zone" exists in an area south of the Mississippi River Delta. Although it is stated that sediments are displaced by upwelling, it is clear that the unique circumstances of geomorphology and prevailing winds responsible must be local and include only a small portion of the area of the present study. Assemblage #3 is the only one involved, with Station 28 and possibly Station 32 included. Other studies (Huang and Goodell, 1970, Walker and Massingill, 1970) indicate that much slumping has taken place in the regions south and southeast of the present delta. Those reports deal with areas beyond the present study area and the described disturbance of the sediment does not include the areal extent of the assemblages described herein.

Assemblage #1; 50-200 feet; clayey silts and silty clays; foraminifera planktonic benthonic ratio (P/B) of .01 to .15.

Echinocythereis margaritifera	R-A
Hulingsina ashermani	R-VA
Protocytheretta karlana	R-VA
Pterygocythereis miocenica	R-VA
Puriana krutaki n. sp.	R-C
Cytherella vermilionensis n. sp.	R-C
Loxoconcha moralesi n. sp.	R-VA

Assemblage #2; 50-200 feet; clayey silts, P/B ratios of .01 to .15.

Actinocythereis gomillionensis	R-C
Protocytheretta montezuma louisianensis n. subsp.	R-VA
Pterygocythereis miocenica	R-C



Text figure 3. Semipermanent surface currents (after Leipper, 1954; Thompson, 1951).

Assemblage #3; 50-300 feet; clayey silt and sand-silt-clay mixtures; P/B ratios of .01 to .26.

Basslerites vokesi n. sp.	R-C
Cytheropteron hamatum	R-C
Loxoconcha cf. *L. matagordensis*	R-A

Assemblage #4; 150-200 feet; silty clays and clayey silts; P/B ratios of .13-.35.

Cytheropteron morgani n. sp.	R-C
Henryhowella ex. gp. *asperrima*	R-VA
Protocytheretta karlana	R-C
Pterygocythereis miocenica	C
Actinocythereis vandenboldi n. sp.	R-VA
Pterygocythereis americana	R

In addition to the characteristic assemblages recognized, certain species do not occur in associations, but do have limited depth range distribution; these are listed below.

Aurila floridana	100-150 feet	R-C
Pellucistoma magniventra	100-150 feet	R-C
Argilloecia posterotruncata	300-800 feet	R
Munseyella bermudezi louisianensis	300-350 feet	R-C
Neonesidea sp.	350-425 feet	R
Krithe cf. *K. producta*	100-800 feet	R-A

VI. SUMMARY AND CONCLUSIONS

One-hundred and four of the 123 bottom samples examined contained ostracode valves and/or carapaces. Samples away from the delta front, each contained up to several hundred valves and often over twenty species. Nineteen of the 123 samples contained no ostracode remains; 18 of the barren samples were located close to the delta front. The absence of specimens is not because the high rates of sedimentation result in dilution, thus yielding sparse ostrocodal content; some of the same samples contained over 800 benthonic foraminifers. No explanations can be offered at this time for the absence of ostracodes in these particular samples.

The total fauna is diverse, but does yield evidence of distinct assemblages that are useful in paleoecological interpretation.

Stations 52, 121, and 122, located in the open gulf, undergo salinity reduction for at least part of the year. The ostracodes in these samples are known to tolerate salinities below 35‰. *Protocytheretta* found at several of these stations, has been reported previously only from marine waters. It is associated with the fresh-brackish water genera *Candona* and *Cyprideis.*

Several taxa occur in this study area at depths greater than previously reported. The wide depth range of the samples studied has allowed the writer to extend known limits of the depositional environments for the remains of eight species. These are listed below with the depth of occurrence in this study.

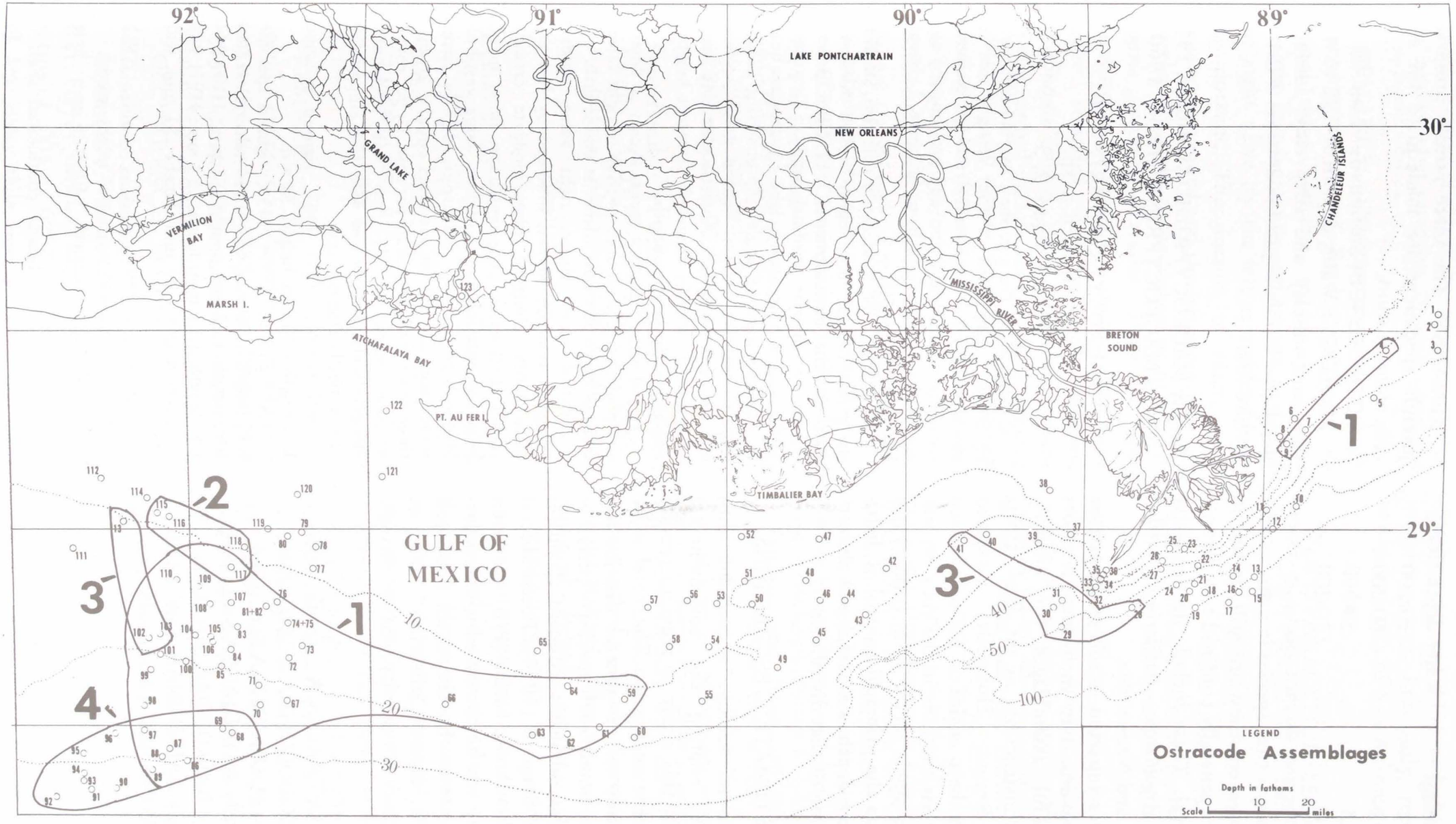
Candona aff. *C. patzcuaro* Tressler	50 feet
Haplocytheridea cf. *H. bradyi* (Stephenson)	204 feet
Perissocythereidea excavata Swain	54-102 feet
Perissocytheridea rugata Swain	54-88 feet
Pumilocytheridea cf. *P. sandbergi* van den Bold	54-192 feet
Aurila floridana Benson and Coleman	99-204 feet
Actinocythereis gomillionensis (Howe and Ellis)	54-192 feet
Echinocythereis margaritifera (Brady)	42-788 feet

Certain deep water forms are not abundant in occurrence, but are reliable depth indicators when present. These include *Krithe* cf. *K. producta* Brady, *Argilloecia posterotruncata* van den Bold and *Neonsidea* sp. The species *Krithe* cf. *K. producta* and *Macrocyprina skinneri* n. sp. show a systematic increase in absolute abundance with increasing water depth.

Several taxa are characteristically found in limited types of sediment. This factor is interpreted as important in controlling their distribution. The forms are:

Munseyella bermudezi louisianensis n. subsp.	silty clay
Echinocythereis margaritifera (Brady)	clayey silt or silty clay
Henryhowella ex. gr. *asperrima* (Reuss)	silty clay

Particular assemblages are accurate depth indicators. There may be several discrete assemblages at different localities within any depth interval, thus, more than one faunule is recognized as indicative of the interval and the usefulness of ostracodal faunas and their reliability as ecologic indicators is enhanced.



Text figure 4. Distribution of ostracode assemblages 1, 2, 3, and 4.

Assemblage	Water depth (feet)
#1	50-200
#2	50-200
#3	50-300
#4	150-200

Some species do not occur in association with any other species in a discernable manner; however, they are still useful, in that they are generally confined to a definite depth interval. These include deeper water species of *Argilloecia, Basslerites, Krithe, Munseyella,* and *Neonesidea.*

Ostracodes reported in this study consist of dead remains, but such material does provide useful assemblages for environmental reconstruction, as the final resting place of Recent (Holocene) carapaces provides the best evidence for comparison with faunal associations in the rock record. Although no single factor in the ecology can be isolated as the principal control of distribution, water depth is a useful and convenient expression of that distribution.

VII. SYSTEMATIC DESCRIPTIONS

A section on ecology is included with each species relating the environmental conditions in this study to previous reports from Holocene sediments. The total valve count is given on a general distribution chart. Unless noted, each species occurred in normal marine salinities; sediment classification is after Shepard (1954). Foraminiferal planktonic/benthonic ratios (P/B) are given so that group can be compared to the occurrence of ostracodes. Specimens are deposited in the H. V. Howe Collection (HVH) at Louisiana State University, Baton Rouge, Louisiana.

Subclass OSTRADOCA Latreille, 1806
Order PODOCOPIDA Müller, 1894
Subclass PODOCOPINA Sars, 1866
Superfamily BAIRDIACEA Sars, 1866
Family BAIRDIIDAE Sars, 1866
Subfamily BAIRDIINAE, Sars, 1888
Genus NEONESIDEA Maddocks, 1969

NEONESIDEA sp.
Plate 1, figure 1

DIMENSIONS: ?Juvenile, left valve, length .59 mm; height .39 mm.

REMARKS: The three poorly preserved juvenile specimens are inadequate for specific identification.

OCCURRENCE: Stations 7, 9, and 20.

ECOLOGY: Water depths of 192 to 480 feet; sand-silt-clay and silty clay; foraminiferal planktonic/benthonic ratios (P/B) of .005 to .02.

Family MACROCYPRIDIDAE Müller, 1912
Genus MACROCYPRINA Triebel, 1960

MACROCYPRINA SKINNERI
Kontrovitz, n. sp.
Plate 1, figure 2, 3

DIAGNOSIS: Distinguished by its highly arched dorsum, composed of four straight line segments in lateral view, broadly rounded posterior, narrowly rounded anterior, and pronounced overlap of the right valve in front of hinge. Left valve highest at mid-length.

DESCRIPTION: Moderately calcified, small for the genus. Lateral view, highly arched dorsum of four straight line segments, (1) from anterior margin to anterior cardinal angle, (2) anterior cardinal angle to greatest height, (3) greatest height to posterior cardinal angle, (4) posterior cardinal angle to posterior margin. Ventral margin, concave and with slight sinuosity. Anterior narrowly rounded; posterior broadly rounded. Greatest height at mid-length. Surface is smooth.

Dorsal view: Carapace tapers evenly to anterior and posterior, pronounced overlap of right valve in front of hinge, left valve higher at mid-length.

Internal view: Hinge, right valve, anterior, elongate crenulate socket, followed by low crenulate tooth, elongate ridge, elongate crenulate socket. Left valve complementary. Inner margin, broad at anterior and posterior, large vestibules. Marginal pore canals, numerous, slightly curved, some false. Central muscle scars circular group of three rows with three scars per row. Upper row has irregular scars, middle row has horizontally elongate scars, bottom row with two elliptical and one vertically elongate scar.

HOLOTYPE: HVH 9437, figured specimen, LV, length 1.13 mm, height .51 mm.

PARATYPES: HVH 9438, figured specimen, RV, length 1.26 mm, height .55 mm; HVH 9439, RV, length 1.13 mm, height .51 mm; HVH 9440, LV, length 1.13 mm, height .53 mm; HVH 9441, carapace, length 1.05 mm, height .51 mm, width .50 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°29.4'N, 92°08.4W, station 97 of this study.

DIMENSIONS: Length 1.05-1.26 mm; height .50-.59 mm.

MATERIAL: Louisiana continental shelf, 16 specimens including nine adult valves and four

juvenile valves. Florida Keys, 30 specimens, including two adult carapaces, 20 adult valves, and seven juvenile valves.

REMARKS: This species differs from *Macrocypris decora* Brady, 1880, by its lateral dorsal outline, made up of four straight line segments, and by the overlap of the right valve by the left at mid-length on the dorsum. The dorsum of *Macrocypris decora* is rounded and the left valve does not overlap the right at the highest point. *Macrocypris schmitti* Tressler, 1949, is more elongate, is higher at the anterior, and has a more rounded posterior. *Macrocyprina propinqua* Triebel, 1960, differs in the shape of the central muscle scars, is more rounded posteriorly, in dorsal view, and lacks dorsal overlap by the left valve. *M. propinqua* also has a higher length/height ratio.

This species is named in honor of Dr. Hubert C. Skinner of Tulane University for his patient supervision of this research.

OCCURRENCE: Stations 70, 97, 98, and 103; Florida Keys.

ECOLOGY: Water depths of 108 to 138 feet; silty clays and clayey silts; foraminiferal P/B ratios of .02 to .13.

Superfamily CYPRIDACEA Baird, 1845
Family CANDONIDAE Kaufman, 1900
Genus CANDONA Baird, 1845

CANDONA sp.
Plate 1, figure 4

Candona lactea Baird. SWAIN, 1955, p. 608, pl. 59, figs. 2a-c; text fig. 38: 1. BYRNE *et al.*, 1959, p. 24, pl. 6, fig. 7. (Not *Candona lactea* Baird, 1850, p. 225, pl. 18, figs. 25-27.)

DIMENSIONS: Right valve, length .70 mm; height .41 mm; left valve, length .77 mm; height .40 mm.

REMARKS: This species is similar to forms previously identified on the Gulf Coast by Swain (1955) and Byrne *et al.* (1959). *Candona lactea* Baird is more rectangular in lateral outline than this species.

OCCURRENCE: Stations 46, 119, and 120.

ECOLOGY: Water depths of 14 to 78 feet; clayey silts and sand; foraminiferal P/B ratios of .005 to .02. Two of the stations are in waters with fully marine salinities (Stations 46 and 119) and the other is in brackish water. Previously reported from brackish waters of San Antonio Bay, Texas.

Family PARACYPIDIDAE Sars, 1925
Genus PARACYPRIS Sars, 1866

PARACYPRIS sp.
Plate 1, figure 7

Paracypris polita Sars. CURTIS, 1960, p. 478, pl. 1, fig. 28. (Not *Paracypris polita* Sars, 1866, p. 12.)

DIAGNOSIS: Characterized by its large size, evenly rounded anterior, pointed posterior, broadly arched dorsum, poorly developed dorsal flange on the left valve, numerous complex marginal pore canals, and wide anterior and posterior vestibules.

DESCRIPTION: Thinly calcified, large, elongate subtriangular in lateral view, greatest height at mid-length, Dorsal margin is broadly arched with slight concavity in posterior one-fourth. Anterior margin broadly rounded, posterior bluntly pointed. Ventral margin is concave at mid-length, slightly concave behind. Dorsal view: greatest width just in front of mid-length. Surface is smooth.

Internal view: Hinge, left valve, a shallow groove receives sharp edge of right valve. A poorly developed extension of flange of left valve is just in front of hinge groove, opposite weak concavity of right valve. Duplicature, wide at anterior and posterior, narrow ventrally. Wide anterior and posterior vestibules. Marginal pore canals, numerous, short, complex. Central scars not observed.

DIMENSIONS: Adult left valve, length 1.02 mm; height .40 mm.

REMARKS: The six poorly preserved specimens recovered do not justify the naming of a new species at this time. *P. franquesi* Howe and Chambers, 1935, does not have bifurcating marginal pore canals or the greatest height at mid-length. *P. rosefieldensis* Howe and Law, 1936, is smaller, has the hinge groove in the right valve, not in the left, and has the greatest height anterior to mid-length. *P. choctawhatcheensis* Puri, 1953, has a few simple marginal pore canals and a large projection of the flange in front of the hinge of the left valve. *P. polita* Sars, 1866, is lower and less arched with the greatest height anterior of mid-length. *P. kaesleri* Pooser, 1965, differs in having a denticulate margin, being smaller, and having a higher length/height ratio.

OCCURRENCE: Stations 91 and 92.

ECOLOGY: Water depth of 198 and 204 feet; silty clay; foraminiferal P/B ratios of .25 and .35. Previously reported from depths greater than 90 feet under low energy, stable conditions, east of the Mississippi River Delta.

Family PONTOCYPRIDIDAE Müller, 1894
Genus ARGILLOECIA Sars, 1866

ARGILLOECIA POSTEROTRUNCATA
van den Bold, 1966
Plate 1, figure 6

Argilloecia sp.KEIJ (part), 1954, p. 218, pl. 3, fig. 8a; pl. 6. fig. 1, (not pl. 3, fig. 8b).
Argilloecia posterotruncata VAN DEN BOLD, 1966a, p. 18, 19, pl. 1, figs. 1a, b.

DIMENSIONS: Length .43 mm; height .22 mm; width .17 mm.

REMARKS: Curtis (1960) reported *Argilloecia cylindrica* Sars and *A. minor* Müller from the area east of the Mississippi Delta. Those species do not have a distinct posterior cardinal angle and are therefore easily distinguished from *A. posterotruncata.*

OCCURRENCE: Stations 2, 17, 20, 29, 93.

ECOLOGY: Water depths of 150 to 780 feet; silty clays; foraminiferal P/B ratios of .13 to .42. Previously reported from the Gulf of Paria at depths of 216 to 510 feet.

Superfamily CYTHERACEA Baird, 1845
Family BYTHOCYTHERIDAE Sars, 1926
Genus JONESIA Brady, 1866

REMARKS: Van den Bold (1966a) has indicated that this genus does not include *Luvula* Coryell and Fields, 1937, as a junior synonym, as stated by Kesling *in* Moore *et al.* (1961).

JONESIA cf. J. SIMPLEX
(Norman, 1865)
Plate 2, figure 6

?Cythere simplex NORMAN, 1865, *in* BRADY (ed.), 1865, p. 17, pl. 5, figs. 1-4.

DIMENSIONS: Left valve (damaged), length .90 mm; height .35 mm.

REMARKS: The lateral outline, muscle scars, and size of these specimens are similar to *J. simplex* Norman. The damaged condition and limited number of the valves preclude exact identification at the species level.

OCCURRENCE: Stations 7, 9, 71, and 102.

ECOLOGY: Water depths of 114 to 198 feet; sand-silt-clay, clayey silt, and silty clay; foraminiferal P/B ratios of .02 to .41.

Genus PUMILOCYTHERIDEA
van den Bold, 1963

PUMILOCYTHERIDEA cf. P. SANDBERGI
van den Bold, 1963
Plate 2, figure 7

Pumilocytheridea sandbergi VAN DEN BOLD, 1963, p. 382, 383, pl. 4, figs. 3a-d; pl. 12, figs. 1a-d, 2a, b.

DIMENSIONS: Carapace, ?female, length .38 mm; height .17 mm; width .15 mm; ?male, length .40 mm; height .17 mm; width .15 mm.

REMARKS: These specimens do not have the strongly developed horizontal ridges present on the figured specimen in van den Bold's study (1963, Plate 4, Figure 3a). The horizontal ridges are variably developed but the subvertical ridge is distinct. This species differs from *Pumilocytheridea ayalai* Morales, 1966, by its distinct posterior cardinal angle and the four ridges parallel to the anterior and ventral margins.

This species was collected near the Louisiana coast, previously, by Philip Sandberg (van den Bold, 1963).

OCCURRENCE: Stations 7, 25, and 115.

ECOLOGY: Water depths of 54 to 192 feet; sand-silt-clay and silty clay; foraminiferal P/B ratios of .04 and .10.

Subfamily KRITHINAE Mandelstam
in Bubikan, 1958
Genus KRITHE Brady, Crosskey, and Robertson, 1874

KRITHE cf. K. PRODUCTA
Brady, 1880
Plate 3, figure 3

Krithe producta BRADY (part), 1880, p. 114, 115, pl. 27, figs. 1a-d (*not* figs. 1e-j). KEIJ (part), 1954, p. 220, pl. 4, fig. 3; pl. 6, fig. 3b (*not* fig. 3a). CURTIS, 1960, p. 478, pl. 1, fig. 23. VAN MORKHOVEN, 1963, p. 344. YASSINI, 1969, p. 82, Not *Krithe* aff. *K. producta* Brady. VAN DEN BOLD, 1958, p. 398, pl. 2, fig. 3a-d.

DIMENSIONS: Right valve, female, length .60 mm; height .35 mm; left valves, male, length .62-.66 mm; height .33-.34 mm.

REMARKS: These specimens differ slightly from *K. producta* Brady by their parallel dorsal and ventral margins and less convex venter. In juveniles, there appears to be a slight overlap of the left valve, unlike *K. producta*. *K. bartonensis* (Jones), *K. morkhoveni* van den Bold, and *K. cubensis* van den Bold differ in lateral outline. *K. reversa* van den Bold has a different outline of the anterior vestibule. This species differs from *K. dolichodeira* van den Bold by having a sinuous inner margin at the posteroventral region, a more highly arched dorsal margin, longer radial pore canals (twice as long) at the anterior, in being larger and in having the greatest height in front of mid-length.

OCCURRENCE: Stations 17, 20, 64, 92, 94, and 98.

ECOLOGY: Water depths of 69 to 788 feet; silty clays; foraminiferal P/B ratios of .05 to .60. Previously reported from depths of about 90 to 11,000 feet.

Genus PARAKRITHELLA Hanai, 1961

PARAKRITHELLA sp.
Plate 3, figure 5

DIAGNOSIS: Distinguished by its long, low, lateral outline, evenly rounded anterior, posterior obliquely rounded above mid-height, and large rounded anterior vestibule.

DESCRIPTION: Fragile, subcylindrical. Dorsal and ventral margins sub-parallel, both slightly convex, venter has minor concavity in front of mid-length. Anterior broadly rounded; posterior obliquely rounded above, evenly rounded below. Surface is smooth.

Internal view: Hinge, right valve, a shallow longitudinal groove with crenulations at the posterior cardinal angle. Marginal area, wide at anterior, narrow at posterior. Anterior vestibule is wide, with serrated dorsal edge and smooth ventral edge. Apparently there is no posterior vestibule. Radial pore canals are few, simple, some false. Central muscle scars, a vertical row of four; upper three elongate, bottom scar triangular; "U"-shaped frontal scar and elongate madibular scar.

DIMENSIONS: Adult, right valve; length .57 mm; height .23 mm.

REMARKS: This species is similar to *Krithe* sp. McKenzie and Swain, 1967, but differs by having an evenly rounded anteroventral outline, simple radial pore canals, and in the shape of the frontal muscle scar. *Krithe vicksburgensis* Howe and Law, 1936, differs in lateral outline and muscle scar pattern. *Parakrithella* sp. van den Bold, 1963, has a similar outline but a ventrally constricted anterior vestibule.

OCCURRENCE: Stations 70, 89, 91, and 96.

ECOLOGY: Water depths of 138 to 198 feet; silty clays; foraminiferal P/B ratios of .10 to .41.

Subfamily NEOCYTHERIDEINAE Puri, 1957
Genus NEOCYTHERIDEIS Puri, 1952

NEOCYTHERIDEIS cf. N. CYLINDRICA (Brady, 1868)
Plate 3, figure 6

Cytherideis cylindrica BRADY, 1868, p. 113, pl. 13, figs. 11, 12. *Sahnia* aff. *S. subulata* (Brady). CURTIS, 1960, p. 478, pl. 1, fig. 34.

DESCRIPTION: Elongate, subcylindrical, fragile. Left valve, lateral view, dorsal margin is nearly straight with slight convexity just behind mid-length. Ventral margin nearly straight and sub-parallel to dorsum. Anterior margin evenly rounded; posterior acutely rounded with greatest length in lower one-third. Small denticulations on lower posterior margin. Surface has poorly defined horizontal ribs; pits below some ribs give reticulate appearance, especially on posterior one-third of valve. A vertical sulcus is near center of valve; shallow depression below posterior cardinal angle.

Internal view: Some internal features are destroyed by poor preservation. Hinge, left valve, apparently a medial anti-slip bar as described by van Morkhoven (1963); terminal elements not seen. Marginal areas damaged, but selvage is clearly parallel to margin at posterior. Radial pore canals and muscle scars not observed.

DIMENSIONS: Left valve, length .62 mm; height .21 mm.

REMARKS: Curtis reported a similar form from the Mississippi Delta area but considered the form to be a species of the genus *Sahnia* Puri. Van Morkhoven (1963) stated that "In *Sahnia* the posterior end is longest in its upper half, in *Neocytherideis* the maximum length lies in the ventral half." Curtis's figured specimen (1960, Plate 1, Figure 34) and those examined here have the greatest length below mid-height; they are herein considered to be a species of *Neocytherideis*.

OCCURRENCE: Station 7.

ECOLOGY: Water depth of 192 feet, sand-silt-clay; foraminiferal P/B ratio of .07.

Genus CUSHMANIDEA Blake, 1933

CUSHMANIDEA sp.
Plate 3, figure 4

DIAGNOSIS: Distinguished by its arched dorsum, weak anterior denticulations, low anterior and ventral ribs concentric with the margins, weak reticulations, and absence of dorsal sulcus; small size.

DESCRIPTION: Elongate, fragile, small. Dorsal margin arched; ventral margin concave near middle; greatest height at mid-length. Anterior margin, obliquely rounded above, broadly rounded below, weakly denticulate. Posterior margin, broadly rounded. Surface has low weak ribs on anterior and venter, ribs concentric with margins; poorly defined reticulations on posterior one-third of carapace above ventral ribs.

Internal view: Hinge weakly developed; right valve, an anterior curved bar that is the culmination of the selvage and terminates at mid-length. A shallow groove extends from mid-length to posterior cardinal angle. (More posterior elements were not seen as single ?adult specimen is broken). Left valve, an anterior shallow groove to mid-length, followed by a low bar, and shallow elongate socket to posterior cardinal angle. Marginal areas are narrow; no vestibules observed. Marginal pore canals, few and widely spaced. Central muscle scars, a sub-vertical row of four ovate scars with a "V"-shaped frontal scar.

DIMENSIONS: ?Adults, right valve, length .39 mm; height .19 mm; left valve, length .42 mm; height .20 mm.

REMARKS: The small size and weakly developed hingement indicates that all specimens may be juveniles. It is certain they are not juveniles of any other species reported in this study as comparisons with juveniles of each species were made.

Cushmanidea echolsae (Malkin) of Williams (1966) and of McLean (1957) are similar in lateral outline but are much larger and not reticulate on the posterior. The forms reported by Williams and McLean differ from Malkin's original description (1953) and Doris Malkin Curtis (1960) did not positively identify *C. echolsae* from the Mississippi Delta region.

OCCURRENCE: Stations 1, 3, 4, 7, 9, 51, 112, and 115.

ECOLOGY: Water depths of 42 to 174 feet; sand-silt-clay and clayey silt; foraminiferal P/B ratios of .01 to .13.

Genus HULINGSINA Puri, 1958

HULINGSINA ASHERMANI
(Ulrich and Bassler, 1904)
Plate 2, figure 5

Cytherideis ashermani ULRICH and BASSLER, 1904, p. 126, pl. 37, figs. 10-16.

Cushmanidea ashermani (Ulrich and Bassler). HALL, 1965, p. 39, pl. 12, figs. 14-18.

Hulingsina ashermani (Ulrich and Bassler). PURI, 1958a, p. 173, table 2. POOSER, 1965, p. 45, pl. 6, fig. 5; pl. 8, figs. 1-3. HULINGS and PURI, 1965, p. 323, fig. 12a. MCLEAN, 1966, p. 74, pl. 23, fig. 4. GROSSMAN, 1967, p. 68. pl. 14, fig. 2; pl. 20, figs. 13, 14 (with synonymy).

Pontocythere ashermani (Ulrich and Bassler). HULINGS, 1966, p. 51, figs. 2a-g, 6n. SWAIN, 1968, p. 10, pl. 2, figs. 1a-d; pl. 6, fig. 4; text fig. 8. HULINGS, 1967, p. 645, fig. 5e.

DIMENSIONS: Carapaces, length .75-.82 mm; height .35-.37 mm; width .32-.36 mm.

REMARKS: These specimens are generally smaller than the type material of Ulrich and Bassler (1904) and the specimens recovered by Benson and Coleman (1963) from the eastern Gulf of Mexico. The dimensions given for this species by Pooser (1965) agree with the range reported here.

OCCURRENCE: Stations 4, 7, 9, 25, 45, 62, 70-75, 79, 81-84, 87-92, 97-107, 112, and 114.

ECOLOGY: Water depths of 42 and 204 feet; clayey silt and silty clays; foraminiferal P/B ratios of .01 to .41. Previously reported from brackish and marine conditions to depths of 300 feet.

HULINGSINA TUBERCULATA Puri, 1958
Plate 2, figure 8

Hulingsina tuberculata PURI, 1958, p. 173, pl. 2, figs. 5-8. HOWE, 1961, *in* MOORE *et al.* p. Q290, fig. 217, 1a-c.

Cushmanidea tuberculata (Puri). HALL, 1965, p. 39, pl. 13, figs. 1-10.

DIMENSIONS: Right valves, length .73-.80 mm; height .32-.35 mm; left valves, length, .71-.78 mm; height .31-.34 mm.

REMARKS: In the original description of this species, Puri (1958) indicated that the line of concresence coincided with the inner margin. Hall, 1965, reported specimens having a small anterior vestibule; those in this study have a vestibule also. As that is

the only described difference, these specimens are considered to be conspecific with *H. tuberculata* (Puri). In juveniles, even early stages can be identified because this species has small tubercles whereas *H. ashermani* has pits.

OCCURRENCE: Stations 49, 62, 63, 70, 87, 89, 91-93, 95, 96, 98 and 109.

EOCLOGY: Water depths of 72 to 204 feet; clayey silt and silty clays; foraminiferal P/B ratios of .01 to .60. Previously reported from shallow marine waters of less than 10 feet in depth.

Family CYTHERURIDAE Müller, 1894
Genus CYTHERURA Sars, 1866

CYTHERURA SANDBERGI Morales, 1966
Plate 3, figure 1

Cytherura johnsoni Mincher. SWAIN, 1955, p. 627, pl. 64, figs. 8a-c; text figs. 35b, 38: 8a-b; 39: 1a-c. PURI and HULINGS, 1957, p. 187, pl. 87, fig. 11. PURI, 1960, p. 114, pl. 4, figs. 14, 15. BENSON and COLEMAN, 1963, p. 31, pl. 6, figs. 1-5; text figs. 18a, b. (Not *Cytherura johnsoni* Mincher, 1941, p. 343, pl. 47, figs. 1a-d).

Cytherura johnsoni Mincher?. VAN DEN BOLD, 1963, p. 395, pl. 9, fig. 3.

Cytherura sandbergi MORALES, 1966, p. 50, 52, pl. 4, figs. 6a-d. KRUTAK, 1971, p. 20, 21, pl. 2, figs. 3a, b.

DIMENSIONS: Carapace ?male, length .47 mm; height .28 mm; width .24 mm.

REMARKS: Morales (1966) stated that "*Cytherura johnsoni* differs from *C. sandbergi* by having nearly straight, subparallel dorsal and ventral margins, broadly rounded anterior, ornamentation mostly reticulate without strong longitudinal ridges, caudal process in the left valve, and by lacking a loop of the inner lamella in the posterior region." Specimens in this study have caudal processes that are unequal in the right and left valve as described by Morales for *C. johnsoni* Mincher. All other characters, listed above for *C. johnsoni,* can be used to distinguish that form from the specimens reported here.

C. johnsonoides Swain, 1967, differs from this species by its coarsely reticulate surface and position of the caudal process at mid-height. The dorsum of *C. luciae* van den Bold, 1966, is more highly arched and the caudal process is in a medial position, in contrast to *C. sandbergi.*

OCCURRENCE: Stations 1, 54, 56, 59, 114, and 115.

ECOLOGY: Water depths of 44 to 144 feet; clayey silt and sand; foraminiferal P/B ratios of .01 to .02. Previously reported from brackish and marine waters at depths of 10 to 180 feet.

CYTHERURA SWAINI
van den Bold, 1963
Plate 3, figure 2

Cytherura swaini VAN DEN BOLD, 1963, p. 396, pl. 9, figs. 4a, b. MORALES, 1966, p. 53, pl. 4, fig. 2.

DESCRIPTION: Internal view, left valve; anterior hinge element damaged; medial element, a thin bar at mid-length, displaced toward interior at posterior cardinal angle where it forms a small elongate knob, followed by a small elongate socket that tapers to a point posteriorly. Inner lamella, widest at anterior, narrow near oral region, widens behind mid-length and merges into caudal process. Line of concrescence coincides with inner margin. A few scattered marginal pore canals were seen at the anterior; they are apparently straight. Muscle scars not seen.

DIMENSIONS: Left valve, length .34 mm; height .14 mm.

MATERIAL: Two right valves.

REMARKS: A partial description of the internal features of the left valve is included here to supplement previous reports of this species.

OCCURRENCE: Stations 98 and 115.

ECOLOGY: Water depths of 54 and 138 feet; clayey silts; foraminiferal P/B ratios of .01 to .07. Previously reported from brackish and marine waters at depths of 10 to 180 feet.

CYTHERURA sp. A
Plate 3, figure 7

DIAGNOSIS: Distinguished by its long low carapace, high and narrow longitudinal ribs, and the small pointed caudal process.

DESCRIPTION: Fragile, medium size. Lateral view, elongate ovoid. Dorsal margin, low, smooth, convex. Ventral margin, sinuate, concave in front of mid-length, convex behind. Greatest height at mid-length. Anterior margin acutely rounded; posterior margin more broadly rounded above and below caudal process. Caudal process is pointed, upturned, located just above mid-height. Surface has about 12 high and narrow longitudinal ribs;

dorsal and ventral ribs are high and distinct, and continuous with anterior rim; dorsal rib continues onto caudal process, ventral rib less distinct at extreme posterior; several lateral ribs continue to posterior; first and third below dorsal rib, and fourth and seventh ribs join near anterior, then proceed as a single rib to join anterior rim. Several lateral ribs join near posterior to form a broad loop. Faint vertical ribs give the appearance of reticulations at high magnification (about 150X).

Internal view: Hinge, right valve, typical of genus; terminal teeth are crenulate; medial groove long, smooth, widens and deepens anteriorly, slightly expanded posteriorly. Inner lamella narrow; line of concrescence coincides with inner margin. Selvage is low, parallel to outer margin, sharply turned upward just in front of mid-length at venter. Muscle scars not seen.

DIMENSIONS: Right valve, length .50 mm; height .25 mm.

MATERIAL: Two right valves, one left valve.

REMARKS: This species differs from *C. forulata* Edwards, 1944, by having a higher length/height ratio, non-parallel dorsal and ventral margins, the caudal process above mid-height, and an acutely rounded anterior margin. This species is not named because of the limited number of specimens.

OCCURRENCE: Stations 4, 5, and 9.

ECOLOGY: Water depths of 108 to 186 feet; sand-silt-clay; foraminiferal P/B ratios of .02 to .13.

CYTHERURA sp. B
Plate 3, figure 8

DIAGNOSIS: Distinguished by its long low carapace with subparallel dorsal and ventral margins, and posteroventral rib forming an alate-like projection that obscures the margin in lateral view.

DESCRIPTION: Subrectangular in lateral view, delicate, small. Dorsal margin nearly straight, ventral margin sub-parallel with slight concavity just behind anterior margin. Anterior margin evenly rounded above and below. In the left valve, the caudal process forms most of the posterior margin from about mid-height to the dorsum; in the right valve the caudal process is smaller and pointed. Surface is ornamented by low ribs on the dorsal area, high delicate ribs and cross ribs forming reticulations on posteromedial surface; the posteroventral rib is high, delicate, and undulating and obscures the margin in lateral view. An undulating vertical rib in front of the highly produced posterior connects the posteroventral rib with several lateral ribs. A few lateral ribs reach the thin anterior rim. An eyespot is present. ?Males are lower than ?females (length/height ratios are 2.6 and 2.0 respectively).

Internal view; Hinge, right valve, an anterior knob-like tooth and long shallow crenulate medial groove with expanded ends opening into interior of valve. Inner lamella is wide at anterior, narrow elsewhere. Radial pore canals and muscle scars obscured.

DIMENSIONS: ?Female, right valve, length .50 mm; height .25 mm; ?male, right valve, length .45 mm; height .21 mm.

MATERIAL: Five valves.

REMARKS: Although muscle scars and the marginal areas were obscured because of the opaque nature of the valves, the shape of the valves and dentition are characteristics of the genus *Cytherura.* Ornamentation and outline easily distinguish this form from *Cytherura* sp. A. of this report. *Cytherura wardensis* Howe and Brown, 1935, has a finely reticulate surface but neither high ribs nor an ala-like posteroventral rib. *C. forulata* Edwards, 1944, and *C. elongata* Edwards, 1944, differ by having weak ornamentation, no strong posteroventral or subvertical ribs. This species is not named because of the limited number of specimens.

Curtis (1960) reported *Cytherura* cf. *paradoxa* Müller from the delta region, but that species is not ribbed over the entire surface.

OCCURRENCE: Stations 3 and 7.

ECOLOGY: Water depths of 174 to 192 feet; sand-silt-clay; foraminiferal P/B ratios of .05 and .07.

Genus CYTHEROPTERON Sars, 1866

CYTHEROPTERON HAMATUM Sars, 1866
Plate 3, figure 8

Cytheropteron hamatum SARS, 1866, p. 172. BRADY and NORMAN, 1889, p. 212, pl. 20, figs. 13-15. SARS, 1927, p. 226, pl. 104, fig. 2. YASSINI, 1969, p. 101, pl. 21, fig. 9; pl. 22, fig. 6.

Cytheropteron aff. *C. alatum* Sars. CURTIS, 1960, p. 478, pl. 1, fig. 13. (Not *Cytheropteron alatum* Sars, 1866, p. 82).

?Cytheropteron sp. aff. *hamatum* Sars. VAN DEN BOLD, 1966a, p. 33, 34, pl. 3, figs. 2a, b.

?Cytheropteron sp. aff. *hamatum* Sars. VAN DEN BOLD, 1966b, p. 171, figs. 6a,b.

DIAGNOSIS: Distinguished by its reticulate and furrowed medial and posterior surface, alae with sharp lateral spines, and a single sharp spine on posterior edge of each ala.

DESCRIPTION: Lateral view, elongate ovate; moderately calcified, small. Dorsal margin general-

ly convex but slightly sinuous with concavity about one-fourth of length from posterior. Ventral margin is sinuous, being concave just in front of mid-length, broadly convex behind. Anterior margin, acutely rounded. Posterior margin has bluntly rounded caudal process above mid-height, broadly rounded below. Right valve more highly arched than left: left valve higher at anterior portion of caudal process and forms carapace outline at caudal process. Caudal process in right valve is upturned and in left is straight. Left valve is larger than right except at dorsum where right valve is higher.

Dorsal view: Arrow shaped, alar margins nearly parallel. Sharp spines at greatest width (on posterolateral edge of alae) are nearly perpendicular to carapace. A sharp spine is on posterior edge of ala. Anterior acutely rounded, extreme posterior highly compressed. Greatest length formed by left valve; right valve higher at dorsum but left valve overlaps right at anterior cardinal angle. An elongate depression exists left of dorsal valve contact. A large broad pit is on top of ala surface. Ventral view, line of contact sinuous in front of mid-length; alar surfaces have low narrow ridges that join to form loops pointing to posterior.

Surface: Punctate to reticulate and furrowed. Anterior marginal area has low rim. Anterior one-third with punctae increasing in coarseness toward alae. Median lateral and alar surfaces are coarsely punctate to reticulate; reticulations are elongate vertically with vertical ridges dominant; cross ridges distinct but delicate. Posterodorsal surface, sub-vertical furrows with small indistinct cross ridges. A large irregular pit at middle of upper ala surface.

Extreme forward edge of ala has two low ridges that form a loop just in front of greatest width. Lateral and posterior spines on alae are sharp and joined to lateral surface by a ridge. Dimorphic features, females are higher than males.

Internal view: Valves deep with an oval pit in muscle scar area. Hinge, right valve, anterior element is a large oval tooth; medial element an arched, coarsely crenulate groove, enlarged at both ends; posterior element, an elongate-ovate weakly crenulate tooth. Anterior and posterior teeth appear to be extentions and enlargements of selvage. Above medial groove and forming its dorsal border is a heavy ridge; bottom of medial groove closed with a weak ridge in some specimens. Hinge, left valve, anterior element is a large oval socket that is closed ventrally with a thin ridge; medial element, a coarsely crenulate ridge that thickens at each end. Posterior end of medial ridge has a large rounded positive element followed by a deep oval socket.

The inner lamella is wide at the anterior and posteroventral areas. There is a small anterior vestibule; line of concresence is parallel to the outer margin. Marginal pore canals, few, simple, most are false. The inner opening of a marginal pore canal is enlarged, often with two canals joining at line of concresence. Selvage, submarginal except anteroventrally where it is displaced, forming a high raised edge. Muscle scars not clear because of ornamentation; seems to be a subvertical row of four, upper three elongate, lowest is circular and divided. Frontal scar horizontal "U"-shaped, open to front.

DIMENSIONS: ?Females, right valve, length .40-.43 mm; height .22-.25 mm.

REMARKS: This species differs from *Cytheropteron morgani* Kontrovitz, n. sp., by having two spines on each ala, nearly parallel sides in dorsal view, a more coarsely ornamented carapace, and heavier dentition. *Cytheropteron* sp. van den Bold, 1967, does not have two spines on each ala, is not reticulate, and is larger (length .47 mm; height .25 mm).

C. paralatissimum Swain, 1963, is similar in lateral outline but does not have two spines on each ala. Swain's species is larger, has less pronounced ornamentation, and has a different muscle scar pattern. *C. alatum* Sars, 1866, has a different lateral outline and appears to have a smooth surface.

OCCURRENCE: Stations 1, 7, 9, 25, 28-31, 41, 44, 50, 64, 67, 86, 103, 113.

ECOLOGY: Water depths of 66 to 306 feet; sediments varied from sand-silt-clay to silty clay and clayey silt; foraminiferal P/B ratios of .01 to .26. Previously reported from depths of about 90 to 10,000 feet.

CYTHEROPTERON MORGANI
Kontrovitz, n. sp.
Plate 3, figures 10-11

?Cytheropteron aff. *C. latum* Müller, CURTIS, 1960, p. 478, pl. 1, fig. 13. (Not *Cytheropteron latum* Müller, 1894, p. 300, 301, pl. 20, figs. 3, 9; pl. 21, figs. 10-11).

DIAGNOSIS: Distinguished by its sharply pointed alae, furrowed and pitted medial and posterior surfaces, divided lower adductor muscle scar, and a "U"-shaped frontal muscle scar with the open end forward.

DESCRIPTION: Carapace ovate in lateral view, strongly alate, small, moderately calcified. Dorsal margin slightly arched, anterior cardinal angle indistinct; ventral margin sinuate with concavity just in front of mid-length. Anterior margin acutely rounded below mid-height, broadly rounded above. Posterior margin, caudal process above mid-height and slightly upturned; margin broadly rounded below process. Left valve is larger than right; right valve is convex at anterior cardinal angle, left valve is smoothly arched. Caudal process of left valve forms carapace outline, the process of the right valve has less vertical extent and is more pointed.

Dorsal view: Arrow shaped, extremities of alae are nearly perpendicular to carapace. Anterior is compressed, posterior is bluntly rounded. Distinct overlap by left valve at anterior cardinal angle. A low ridge on right valve is nearly parallel to hinge area.

Ventral view: Distinct overlap by right valve just in front of mid-length. A series of ridges, especially prominent in mid-ventral area, are nearly parallel to outer edge of valves.

Surface: Ornamentation, behind middle, subvertical pitted furrows. Some specimens have weak cross ridges forming reticulations. Anterior edge of ala has low rounded ridges parallel to that edge. A few low ridges on posterior surface of ala; one ridge sometimes follows posterior edge of ala to a position below posterior cardinal angle, there forming a loop. There is a large vertical pit on upper anterior ala surface (below and posterior to central muscle scars).

Internal view: Hinge, right valve, anterior element small, rounded; a medial, slightly sinuate, crenulate groove with coarser crenulations at each end; posterior tooth is elongate, crenulate, and part of selvage. Dorsal part of medial groove is closed by a heavy ridge, bottom is closed by weak ridge. Left valve, complementary, with an anterior indistinct rounded socket, followed by a sinuous crenulate bar, and posterior elongate socket (apparently not crenulate).

Inner lamella, wide at anterior and posterior. Anterior vestibule is moderately wide and with a scalloped line of concrescence; elsewhere line of concrescence equals inner margin. Marginal pore canals are few, simple, and some are clustered about indentations in line of concrescence. Selvage is low at anterior and parallel to margin, closer to anteroventral margin; it turns inward just behind mid-length and diverges from outer margin in posterior portion of valve. Central muscle scars form a subvertical row of four scars; top three are elongate-ovate, bottom is divided into two ovate scars: Frontal scar, "U"-shaped, open to front. Apparently, a single rounded mandibular scar is located just above anterior edge of ala.

HOLOTYPE: HVH 9471, figured specimen, LV, length .52 mm, height .28 mm.

PARATYPES: HVH 9472, LV, length .51 mm, height .28 mm; HVH 9473; figured specimen, RV, length .48 mm, height .28 mm; HVH 9474, damaged carapace, length .46 mm; height .26 mm, width .36 mm; HVH 9475, LV, length .52 mm, height .28 mm.

TYPE LOCALITY: Louisiana continental shelf, 29°27.0'N, 88°40.2'W, station 4 of this study.

DIMENSIONS: Carapaces, ? female, length .48 mm; height .28 mm, width .35 mm (alae damaged); ?male, length .50 mm; height .27 mm; width .38 mm.

MATERIAL: Adults, three carapaces, 62 valves; juveniles, two carapaces, seven valves.

REMARKS: *Cytheropteron paralatissimum* Swain, 1963, differs by having only weak crenulations of the medial hinge groove of the right valve, fewer marginal pore canals, its larger size, and different central muscle scar pattern. *Cytheropteron* sp. van den Bold, (1967b) has a smoother surface and persistent ridges related to the anterior and posterior edges of the alae.

C. alatum Sars, 1866, has a smooth lateral surface, is larger, and has several distinct elongate depressions on the forward edge of each ala. *C. latum* Müller has a pitted but unfurrowed surface.

This species is named in honor of Dr. James P. Morgan of Louisiana State University; he provided 23 of the samples used in this study.

OCCURRENCE: Stations 4, 5, 7, 25, 46, 69-71, 73, 76, 81, 83, 88, 91, 92, 96, 97, 102, 106, 107, 109, and 111.

ECOLOGY: Water depths of 78 to 204 feet; sediments varied from clayey silt to

PLATE 1

Figure Page

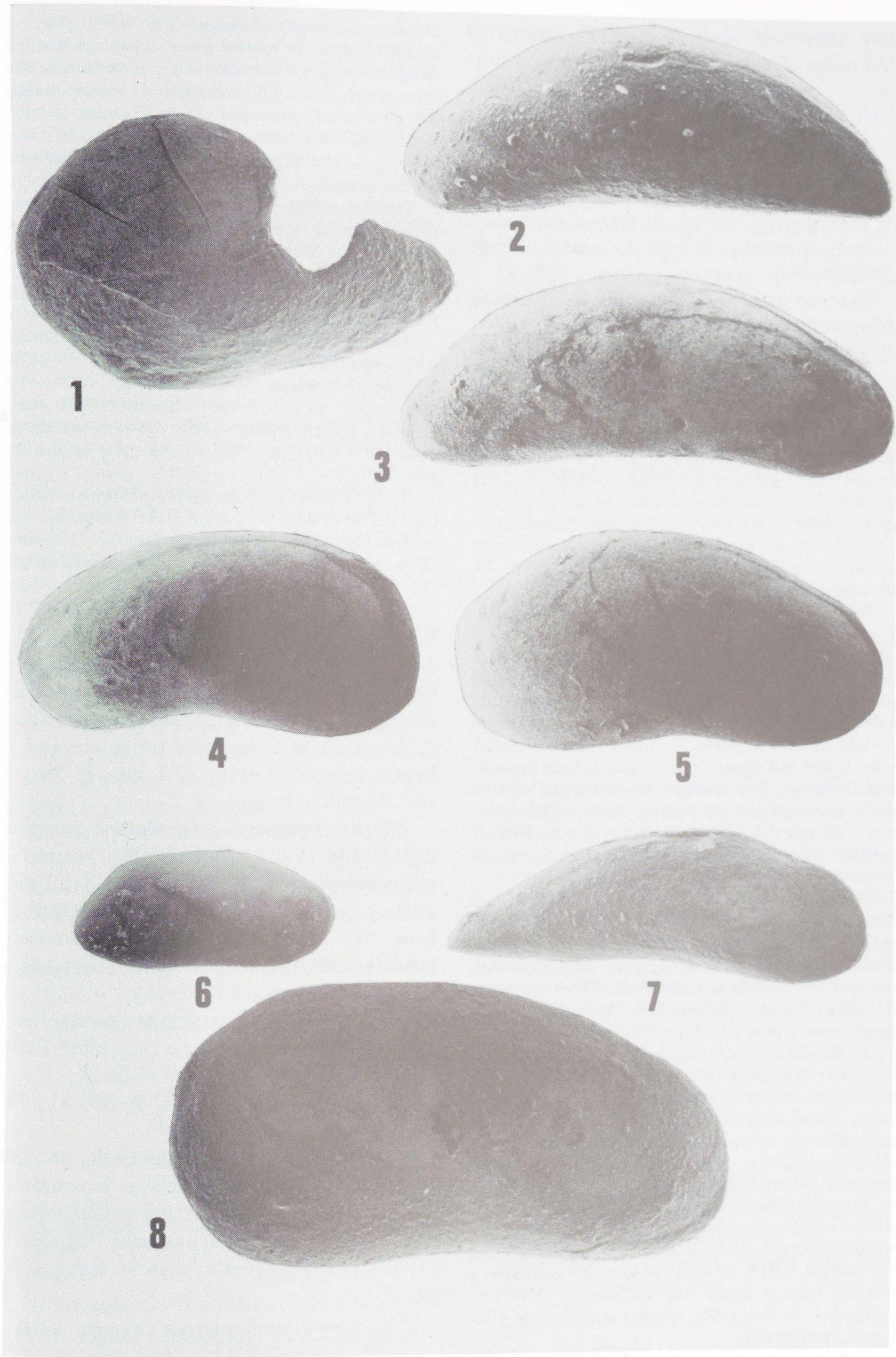


PLATE 1

silty clay and sand-silt-clay; foraminiferal P/B ratios of .01 to .60.

CYTHEROPTERON TUMULOSIMILIS Kontrovitz, n. sp.
Plate 4, figures 1, 2

Cytheropteron leonensis Puri. CURTIS, 1960, p. 478, pl. 1, fig. 12. (Not *Cytheropteron leonensis* Puri, 1954, p. 242, pl. 4, figs. 11, 12; text figs. 6a, d).

DIAGNOSIS: Distinguished by its dome-like (triangular) lateral shape, reticulate lateral surface, and low length/height ratio of less than 1.55.

DESCRIPTION: Dome-like or triangular in lateral view with low alae; moderately calcified, small. Dorsal margin highly arched; ventral margin is nearly straight with concavity just in front of mid-length; greatest height is just in front of mid-length. Anterior and posterior margins, acutely rounded below mid-height, more broadly rounded above. Extreme posterior is compressed and slightly produced. Left valve is larger than right except at dorsum behind mid-length. Sexual dimorphism not observed.

Dorsal view: sub-ovate, sides subparallel. Anterior and posterior are bluntly rounded; left valve overlaps right at one-third of length from anterior; right valve overlaps left just in front of mid-length. Greatest width is just behind middle.

Surface: Striate, reticulate. Upper surface of low ala has about three low ridges parallel to alar edge; a few indistinct cross ridges. Lower posteromedial surface is reticulate; posterodorsal surface has low subvertical ridges giving a furrowed appearance. Anterior half of valve has low indistinct irregular ridges. Flattened ventral surface is striate; striae are parallel to nearest outer edge.

Internal view: Hinge, right valve, anterior element an elongate crenulate tooth (in front of greatest height of valve); medial element, a curved crenulate groove that widens at each end with coarsest crenulations at the ends. There is a separate short, narrow, deep groove above the anterior four crenulations of the medial groove. Edge of valve forms a sharp ridge above medial groove. Posterior element is an elongate, slightly crenulate tooth just below posterior cardinal angle. Left valve, complementary, with a large anterior crenulate socket, a medial crenulate bar, and a posterior elongate slightly crenulate socket just below posterior cardinal angle.

Inner lamella moderately wide at anterior, elsewhere narrow. Anterior vestibule, about one-half width of inner lamella. Radial pore canals are short and simple, seven to eight at anterior vestibule; a few are false at upper anterior margin, above the vestibule. A few radial pore canals below mid-height at posterior.

Selvage, right valve, at middle of the anterior portion of inner lamella; displaced upward in front of mid-length at venter, subparallel to margin behind mid-length. Selvage, left valve, postero-ventral area, more toward inner margin. A distinct flange forms a narrow groove for reception of selvage of right valve. (A similar groove seen in medial ventral area of right valve receives selvage of left).

Muscle scars, adductors form a row of four, uppermost is elongate and sloping toward antero-ventral margin, middle two are elongate and point to anterior margin, lowermost is small and subcircular. Frontal scar obscure but appears to be elongate oval. Two elongate mandibular scars are in front of and below the adductors.

HOLOTYPE: HVH 9476, figured specimen, RV, length .34 mm, height .22 mm.

PARATYPES: HVH 9477, figured specimen, LV, length .34 mm, height .22 mm; HVH 9478, RV, length .34 mm, height .24 mm; HVH 9479, RV, length .34 mm, height .23 mm; HVH 9480, carapace, length .34 mm, height .23 mm, width .20 mm; HVH 9481, LV, length .33 mm, height .21 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°33.0'N, 91°48.6'W, station 70 of this study.

DIMENSIONS: Carapace, length .33 mm; height .22 mm; width .21 mm; right valves, length .32-.35 mm; height .22-.24 mm.

MATERIAL: Adults, one carapace, 12 valves; juveniles, one valve.

REMARKS: This species is similar in outline to *C. leonensis* Puri, 1954, but is easily distinguished by its reticulate lateral surface. *C. leonensis* is striate not reticulate and is larger, measuring about .51 mm in length and .24 mm in height.

?Cytheropteron subreticulatum van den Bold, 1946, has "a forked ridge bordering the posterior side of the ala" (van den Bold, 1966a) not found on the species described here. *?C. subreticulatum* is not coarsely reticulate on the lateral surface and has a length/height ratio of 1.66.

This species is named for its characteristic lateral outline; tumulus is a masculine Latin noun meaning mound, hill, or hillock.

OCCURRENCE: Stations 9, 70, 71, 74, and 82.

ECOLOGY: Water depths of 84 to 138 feet; clayey silts and silty clays; foraminiferal P/B ratios of .02 to .13. Previously reported from the "offshore biofacies" of Curtis (1960), at depths greater than 90 feet.

Genus PARACYTHERIDEA Müller, 1894

PARACYTHERIDEA sp.
Plate 4, figure 3

DESCRIPTION: ?Juveniles, right valve; alate, small. Subtriangular in lateral view. Dorsal margin is nearly straight with slight concavity in middle; ventral margin is sinuous and strongly converging with dorsum. Anterior margin, broadly rounded above, abruptly truncated by ventral margin below. Posterior margin is a long pointed caudal process with a coarse spine below and in front of process. Surface is ornamented by a few coarse ridges and nodes and dominated by a prominent alate process with a sharp point. A sharp ridge extends from anteroventral area to alar process, another ridge from a node at the anterior margin across mid-height and down just in front of ala where it joins the more ventral ridge. After joining, the two ridges then form the forward edge of the ala. There is a coarse node with a few irregular ridges just below posterior cardinal angle.

Internal view: Hinge, right valve, anterior element is a faintly crenulate tooth followed by a medial weakly crenulate groove and posterior weakly crenulate tooth. Inner lamella and muscle scars not observed because of poor preservation of interior.

DIMENSIONS: Right valve, length .38 mm; height .19 mm.

MATERIAL: Five ?juvenile right valves.

REMARKS: The specimens are apparently juveniles and are described for the purpose of comparison with future studies. There is some similarity to *Paracytheridea tschoppi* van den Bold, 1946, but that species has more distinct ornamentation and is larger (.53 mm in length).

OCCURRENCE: Stations 7, 9, and 25.

ECOLOGY: Water depths of 108 to 192 feet; sand-silt,clay and clayey silt; foraminiferal P/B ratios of .04 to .13.

Family HEMICYTHERIDAE Puri, 1953
Subfamily HEMICYTHERINAE Puri, 1954
Genus AURILA Pokorný, 1955

AURILA FLORIDANA
Benson and Coleman, 1963
Plate 4, figure 6

Aurila conradi (Howe and McGuirt) *floridana* BENSON and COLEMAN, 1963, p. 35, 36, pl. 8, figs. 10-12, text fig. 21.

Aurila floridana Benson and Coleman. MORALES, 1966, p. 56, 57, pl. 5, figs. 5a-d (with synonymy).

DIMENSIONS: Carapaces, ?females, length .60-.62 mm; height .41-.42 mm; width, .35-.40 mm; left valve, length .64 mm; height .42 mm.

REMARKS: Morales (1966) stated that *Aurila conradi* (Howe and McGuirt) *littorala* Grossman, 1965, and *A. floridana* are conspecific. *Aurila floridana* has a distinct high, fluted, central rib that is not present on *A. conradi littorala*, thus the two forms can be differentiated. Grossman (1965) also used difference in size as a character to distinguish the two forms just mentioned; specimens in this study are intermediate in size, thus negating the use of that character.

OCCURRENCE: Stations 4, 7, 68-72, 86-88, 92, and 96-99.

ECOLOGY: Water depths of 99 to 204 feet; silty clays and clayey silts; foraminiferal P/B ratios of .02 to .60. Previously reported from depths of less than 135 feet in brackish and marine salinities.

Subfamily THAEROCYTHERINAE Hazel, 1967
Genus PURIANA Coryell and Fields, *in* Puri, 1953

PURIANA RUGIPUNCTATA
(Ulrich and Bassler, 1904)
Plate 4, figure 5

Cythere rugipunctata ULRICH and BASSLER, 1904, p. 118, pl. 38, figs. 16, 17.

Cythereis rugipunctata (Ulrich and Bassler). HOWE *et al.*, 1935, p. 23, pl. 1, figs. 18, 20-22; pl. 4, figs. 22, 23.

Favella rugipunctata (Ulrich and Bassler). EDWARDS, 1944, p. 524, pl. 88, figs. 5, 6. VAN DEN BOLD, 1950, p. 797, pl. 83, fig. 24.

Trachyleberis? rugipunctata (Ulrich and Bassler). SWAIN, 1952, p. 38, pl. 6, fig. 8.

Puriana rugipunctata (Ulrich and Bassler). PURI, 1953, p. 571. PURI, 1954, p. 257, 258, pl. 12, figs. 16, 19; text fig. 8k. MCLEAN, 1957, p. 89, pl. 11, figs. 5a-d. PURI and HULINGS, 1957, p. 174, 176, 183. BROWN, 1958, p. 63, pl. 4, fig. 10. PURI, 1960, p. 126, pl. 6, fig. 18. BENSON and COLEMAN, 1963, p. 43, 44, pl. 8, figs. 1, 2, 5; text fig. 27. POOSER, 1965, pl. 17, figs. 4-7, 9. HULINGS and PURI, 1965, p. 321, fig. 12. VAN DEN BOLD, 1965, p. 399. MCLEAN, 1966, p. 69, 70. WILLIAMS, 1966, p. 33, fig. 18, no. 9; fig. 27. GROSSMAN, 1967, p. 77, pl. 14, fig. 8; pl. 21, figs. 11-13. SWAIN and ENGEL, 1967, p. 419, pl. 1, fig. 6. SWAIN, 1968, p. 18, 19, pl. 5, figs. 8a-c; pl. 7, fig. 4; text figs. 16, 17.

DIMENSIONS: Carapace, length .62 mm; height .33 mm; width .36 mm.

REMARKS: This is one of the most widely distributed species in the Tertiary and Quaternary sediments of the eastern United States. The specimens in this study

are smaller than those of Ulrich and Bassler (1904), but are in the size range reported by later authors (Edwards, 1944; Puri, 1954; Swain, 1968).

OCCURRENCE: Stations 7, 53, and 71.

ECOLOGY: Water depths of 60 to 192 feet; sediments were varied from sand-silt-clay to clayey silt and silty clay; foraminiferal P/B ratios of .005 to .07. Previously reported from the Gulf of Mexico in depths to 240 feet and in shoaler brackish and marine waters.

PURIANA KRUTAKI Kontrovitz, n. sp.
Plate 4, figures 9-10

Puriana sp. SWAIN, 1955, p. 635, pl. 63, fig. 10.
Puriana sp. KRUTAK, 1971, p. 15, pl. 4, figs. 4a, 4b.

DIAGNOSIS: Distinguished by its large anterolateral node, sharp anteroventral ridge, sharp anterior rim, nearly smooth anterodorsal margin, isolated spines on posterior half of valves, and absence of any rugose or plicate surface.

DESCRIPTION: Subquadrate, moderately calcified, medium size. Dorsal margin is nearly straight; ventral margin, subparallel, with a convexity in front of mid-length. Anterior margin broadly rounded below mid-height, more acutely rounded above; about five small triangular denticles below mid-height. Posterior margin, broadly rounded below with five heavy elongate denticles in lower two-thirds; upper part acutely rounded. A small spine is above denticulations and a small pointed spine at posterior cardinal angle. Sexual dimorphism was not observed.

Dorsal view: Widest in front of mid-length, corresponding to anterolateral nodes (about two-fifths of length behind anterior); acutely rounded anterior with a rim. Carapace tapers gently from greatest width to posterior cardinal angle; highly compressed behind. Posterolateral areas are spinose in dorsal view.

Ventral view: Elongate depression just in front of mid-length, formed by divergence of distal portions of each valve (flanges). Left valve is slightly larger than right.

Surface: Ornamentation of sharp ridges and blunt lateral spines or tubercles. Sharp, high anterior rim, from small eye tubercle, extends parallel to anterior margin to the convexity on ventral margin and extends to about mid-length. Large rounded anterolateral swelling; highest part of swelling is the most posterior part, lower forward. Some specimens show two short ridges from the swelling toward lower anterior margin, but on other specimens the ridges are not clearly defined. Behind eyespot and above anterolateral swelling, surface is smooth. Posterior half of valves have short, heavy spines that are aligned on some specimens as a lateral row and a posteroventral row. Subdued indistinct spines occur in front of posterior cardinal angle; on a few specimens these are subvertically elongate but are never plicate or rugose.

Internal view: Valves are deep, with a rounded depression that corresponds to external swelling. Marginal areas are moderately wide at anterior and lower posterior; small anterior and posterior vestibules; line of concrescence is serrate in vestibules. Some marginal pore canals enter serrations; a few serrations have more than one marginal pore canal; a few canals are false. Muscle scars are obscured by the opaqueness of the valves.

HOLOTYPE: HVH 9487, figured specimen, carapace, length .55 mm, height .28 mm, width .30 mm.

PARATYPES: HVH 9488, RV, length .58 mm, height .30 mm; HVH 9489, figured specimen, LV, length .55 mm, height .30 mm; HVH 9490, RV, length .53 mm, height .27 mm; HVH 9491, juvenile RV, length .44 mm, height .24 mm; HVH 9492, carapace, length .55 mm, height .28 mm, width .28 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°28.8'N, 91°03.0'W, station 93 of this study.

DIMENSIONS: Carapaces, length .58-.59 mm; height .28-.30 mm; width .28-.31 mm.

PLATE 2

Figure Page

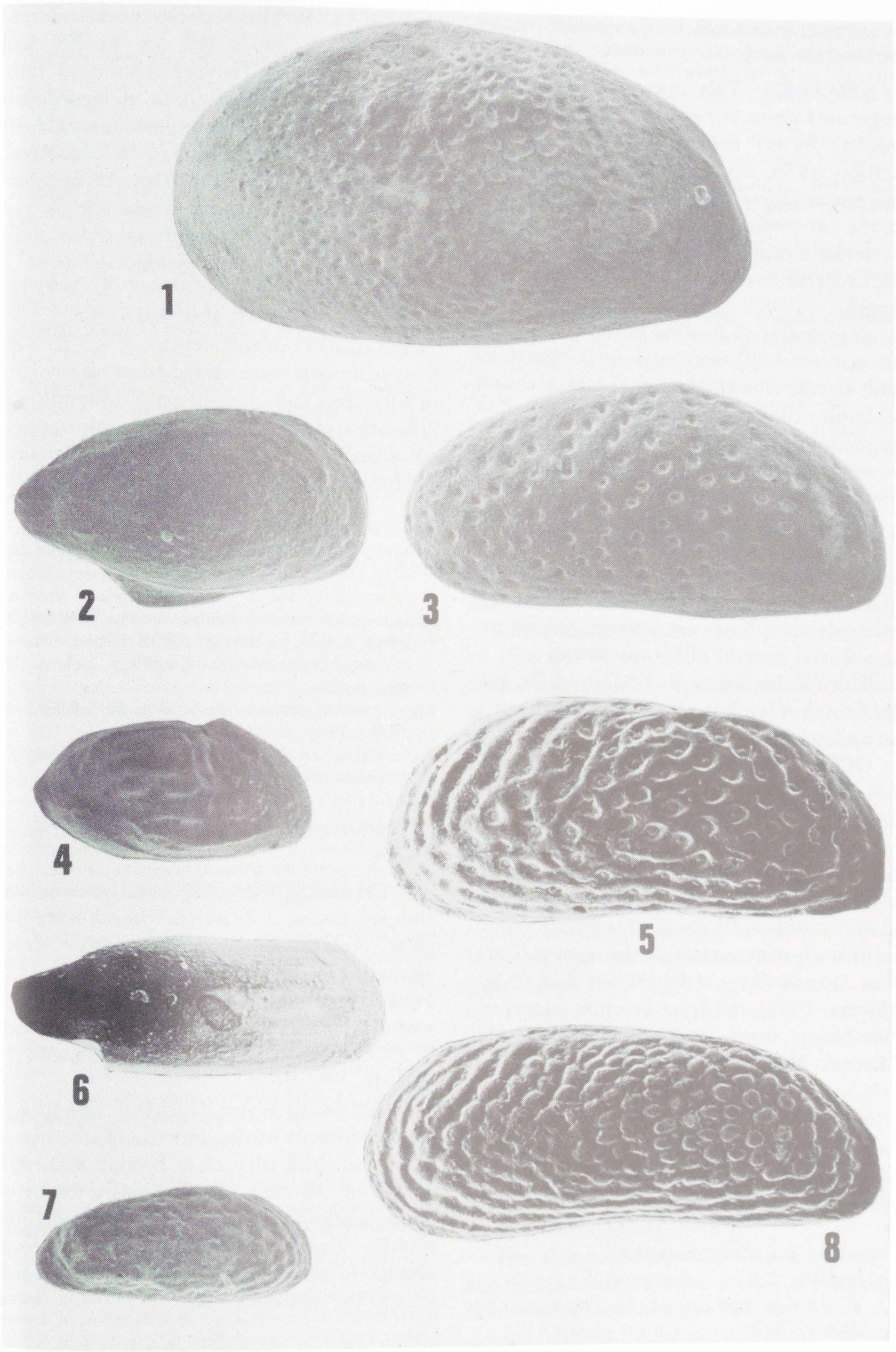


PLATE 2

MATERIALS: Adults, six carapaces, 35 valves; juveniles, two carapaces, four valves.

REMARKS: This species is easily distinguished from *P. rugipunctata* (Ulrich and Bassler) by its ornamentation. *P. pacifica* Benson, 1959, has heavier ornamentation in the posterodorsal area, lacks the sharp ridge at the anteroventral area, is larger, has more posterior denticles, and is more concave on the ventral margin in front of the mid-length.

In juveniles of *Puriana krutaki,* n. sp. the anteroventral rib continues to the posterior and several ribs that cross the central area resemble those of adult specimens of *P. mesocostalis* (Edwards, 1944). Adults of *P. mesocostalis* have distinct ornamentation, however.

Difference in preservation causes varying numbers of posterior denticles to be preserved. Thus, Krutak (1971) reported "four blunt" posterior spines, but it is evident that other denticle bases are present on the posteroventral margins of his specimens.

This species is named in honor of Dr. Paul R. Krutak who first recognized this form as an undescribed species.

OCCURRENCE: Stations 1, 4, 56, 57, 63, 64, 66, 67, 70, 73, 79, 82, 84, 105, 109, 115, and 119.

ECOLOGY: Water depths of 42 to 144 feet; sediments were varied from sand-silt-clay to clayey silt and silty clay; foraminiferal P/B ratios of .01 to .10. Previously reported from marine waters in the open gulf near San Antonio Bay, at depths less than 60 feet (Swain, 1955) and from brackish waters at a five foot depth near Veracruz, Mexico (Krutak, 1971).

Family LOXOCONCHIDAE Sars, 1925
Genus LOXOCONCHA Sars, 1866

LOXOCONCHA cf. L. MATAGORDENSIS Swain, 1955
Plate 5, figure 1

Loxoconcha matagordensis SWAIN, 1955, p. 629, pl. 63, figs. 9a-b; pl. 64, figs. 1a, b; text figs. 36b, 39:7a, b.

DIMENSIONS: ?Male, carapace, length .50 mm; height .29 mm; width .13 mm; ?female, left valve, length .55 mm; height .35 mm.

REMARKS: These specimens resemble *L. matagordensis* Swain but are smaller and poorly preserved. The ornamentation indicates they are related to *L. matagordensis* and perhaps all are juveniles; it would be unusual for only juveniles to be recovered. Grossman (1967) stated that transitional ornamentation on some forms "joins the two species" *L. purisubrhomboidea* (Edwards, 1944) and *L. matagordensis.*

OCCURRENCE: Stations 4, 5, 7, 9, 14, 20, 28-31, 47, 48, 92, 100, and 103.

ECOLOGY: Water depths of 45 to 420 feet; sediments were varied from clayey silts to silty clays and sand-silt-clay; foraminiferal P/B ratios of .005 to .60. Previously reported from shallow, brackish and marine environments, at depths less than 60 feet.

LOXOCONCHA aff. L. PURISUBRHOMBOIDEA Edwards, 1953
Plate 5, figure 2

?*Loxoconcha subrhomboidea* Brady. EDWARDS, 1944, p. 527, pl. 88, figs. 28-32. (Not *Loxoconcha subrhomboidea* Brady, 1880, p. 121, pl. 28, figs. 4a-d.)

?*Loxoconcha purisubrhomboidea* EDWARDS *in* PURI, 1953, p. 270.

Loxoconcha cf. *L. purisubrhomboidea* Edwards. CURTIS, 1960, pl. 1, fig. 21; pl. 2(bottom), fig. 16.

DIMENSIONS: ?Female, length .45 mm; height .29 mm.

REMARKS: The shape and ornamentation are similar to *L. purisubrhomboidea* but poor preservation does not allow exact identification. These species do not have the faint ridges and reticulations of *L.* cf. *L. matagordensis,* reported above.

OCCURRENCE: Stations 30, 31, 33, 39 and 40.

ECOLOGY: Water depths of 130 to 270 feet; sediments varied from sand-silt-clay to clayey silt and silty clay; foraminiferal P/B ratios of .01 to .11. Previously reported from brackish and marine waters at shallow depths; Curtis (1960) reported a form similar to this from depths up to 550 feet east of the modern delta.

LOXOCONCHA MORALESI Kontrovitz, n. sp.
Plate 5, figures 3, 4

Loxoconcha australis Brady. SWAIN, 1955 (part), p. 630, pl. 63, fig. 11 (*not* pl. 64, fig. 2). ENGEL and SWAIN, 1967, p. 413, pl. 1, fig. 12. (Not *Loxoconcha australis* Brady, 1880, p. 119, 120, pl. 28, figs. 5a-f; pl. 29, figs. 3a-c).

?Loxoconcha australis Brady. CURTIS, 1960, p. 478, pl. 2, (top) fig. 12, (bottom) fig. 15.

?*Loxoconcha* cf. *L. australis* Brady. CURTIS, 1960, pl. 3, (top) fig. 4.

Loxoconcha subrhomboidea Brady. CURTIS, 1960, p. 478, pl. 2, (bottom) fig. 12; pl. 3, (top) fig. 5 (Not *Loxoconcha subrhomboidea* Brady, 1880, p. 121, pl. 28, figs. 4a-d).

Loxoconcha sp. aff. *L. sarasotana* Benson and Coleman. MORALES, 1966, p. 71, 73, pl. 6, figs. 2a, b.

DIAGNOSIS: "A species of *Loxoconcha* distinguished by its nearly straight dorsal and ventral margins, short caudal process more noticeable in females, and evenly reticulate surface." (Morales, 1966). It is also distinguished by a spine or knob on postventral margin of males.

DESCRIPTION: Subovate, moderately, calcified, medium size. Lateral view, female, dorsal and ventral margins nearly straight and subparallel. Anterior margin is evenly rounded below mid-height, sloping and straightened above up to anterior cardinal angle. Posterior margin rounded below with an acutely rounded caudal process in females just above mid-height; above caudal process the posterior margin is straight and sloping to the posterior cardinal angle; posteroventral margin is compressed into keel-like edge. Well preserved specimens have a delicate frill-like extension at the anterior and posterior margins beyond the rim. Males differ by being longer and relatively lower; males also have slightly converging dorsal and ventral margins (toward anterior), a blunt posteroventral spine, and a less prominent caudal process.

Dorsal view: Females are subovate, tumid, anterior and posterior compressed, greatest width at middle. Males are more elongate, sides are subparallel. All specimens, left valve slightly larger than right.

Surface: Reticulate, a mesh-like network of low narrow ridges. Reticulations nearly equidimensional in central area, near margins they are elongate and parallel to nearest margin. A low narrow rim is anterior, ventral, and posterior margins. Eye tubercle, indistinct.

Internal view: Hinge, right valve, anterior element is a crescent-shaped socket with an inclosed rounded tooth; medial groove formed by two weakly crenulate ridges; a posterior crescent shaped tooth continues down as selvage. Left valve, hinge, anterior element a small round tooth, followed by a small half circular socket that is open to the inside; medial element is a weakly crenulate bar, slightly enlarged at each end; posterior crescent shaped socket with inclosed small round tooth. Above posterior socket is an enlarged continuation of the selvage. Inner lamella, moderately wide at anterior, narrow but obvious at posteroventral and posterior areas. Anterior vestibule equals about one-half width of inner lamella; marginal pore canals are few, slightly curved to straight. Selvage is narrow, prominent at anterior and posterior; high, sharp, and sinuous at ventral area. Flange of right valve is thickened to form a posteroventral blunt spine or knob. Central muscle scars, four elongate adductors in subvertical row; frontal scar "U"- or "V"-shaped.

HOLOTYPE: HVH 9495, figured specimen, male carapace, length .59 mm, height .33 mm, width .31 mm.

PARATYPES: HVH 9496, female carapace, length .51 mm, height .30 mm, width .28 mm; HVH 9497, figured specimen, female carapace, length .55 mm, height .36 mm, width .27 mm, HVH 9498, ?juvenile female, length .50 mm, height .35 mm; HVH 9499, male RV, length .54 mm, height .36 mm; HVH 9500, male LV, length .53 mm, height .35 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°57.0'N, 91°51.0'W, station 118 of this study.

DIMENSIONS: Females, carapaces, length .51-.59 mm; height .30-.37 mm; width .27-.32 mm.

MATERIAL: Adults, 60 carapaces, 337 valves; juveniles, 11 carapaces, 68 valves.

REMARKS: Morales (1966) first suggested that this form should be recognized as a separate species. The specimens in this paper are somewhat larger than those reported by Morales, but he had few specimens to examine.

Loxoconcha wilberti Puri, 1954, is similar in external shape but differs in the internal morphology. *L. wilberti* has a nearly circular posterior hinge socket in the right valve, a crescent-shaped frontal muscle scar that is open downward, and does not have a blunt spine on the posteroventral margin of the right valve. Puri (1954) stated that *L. wilberti* has a posteroventral spine, but his illustrations (Plate 10, figure 1,2) indicate that the spine is on the lateral surface. *Loxoconcha sarasotana* Benson and Coleman, 1963, differs by having a sharp ridge that is parallel to the posterior and ventral margins, a non-crescentic posterior element of the right valve hinge, and in lacking the posteroventral spine.

The shape and ornamentation of *Loxoconcha australis* Brady, 1880, distinguish that species from the one described here. *L. australis* differs by having ventral and dorsal margins that are not straight and that do not converge in the male; it also has a large eyespot and lacks a posteroventral spine.

Loxoconcha avellana Brady, 1866, was reported and illustrated by van den Bold (1966a) who included several forms from the Gulf of Mexico in synonymy. This writer cannot disagree with van den Bold's identification of the specimens from Venezuela, but does believe that the Holocene forms of Swain (1955), Puri (1960), and Curtis (1960) are not *L. avellana. L. avellana* has a convex dorsum, is punctate but not reticulate and apparently does not have a postero-ventral spine in the male, and the original specimens were larger (length of .74 mm). These characters are summarized from a copy of the original illustrations and descriptions, not any of the original specimens.

This species is named in honor of Dr. Gustavo A. Morales, who first recognized this form to be an undescribed species.

OCCURRENCE: Stations 1, 3, 4, 6, 25, 37-42, 49, 50, 52-54, 56-61, 63, 64, 66-69, 73-78, 80-85, 87, 92, 93, 100-105, 107-114, 117-120, and 122.

ECOLOGY: Water depths of 14 to 204 feet; sediments were varied from sand to sand-silt-clay to clayey silt and silty clay; foraminiferal P/B ratios of .005 to .60. Previously reported from brackish and marine waters at depths of about five to 90 feet.

Family LEPTOCYTHERIDAE Hani, 1957
Genus LEPTOCYTHERE Sars, 1925

LEPTOCYTHERE PARACASTANEA
Swain, 1955
Plate 5, figure 9

Leptocythere paracastanea SWAIN, 1955,p. 640, pl. 62, fig. 7; ?pl. 63, figs. 1a-c; ?text figs. 39:5a, b. CURTIS, 1960, p. 478, pl. 2, (top) fig. 13. DARBY, 1965, p. 20, pl. 3, figs. 1-10; pl. 4, figs. 1-9. ENGEL and SWAIN, 1967, p. 413.

Cytheromorpha paracastanea (Swain). MORALES, 1966, p. 66, pl. 6, fig. 20.

DIMENSIONS: ?Female carapace, length .47 mm; height .25 mm; width .20 mm.

REMARKS: Only one adult specimen was undamaged and measurable. Darby (1965) conclusively demonstrated that this species should be assigned to the genus *Leptocythere* Hanai. Morales (1966) suggested that the specimens described by Swain (1955) may represent two species. As with Morales' specimens, those in this study are similar to the ?female on Plate 62, figure 7, of Swain (1955). The specimens collected and reported here are smaller than the holotype, a ?male, but similar in size and other features to the ?female paratype.

OCCURRENCE: Stations 1, 7, 58, 59, 61, 64, 69, 74, 75, 78, 80, 82, 85, 92, 96, 97, and 11.

ECOLOGY: Water depths of 48 to 204 feet; clayey silts and silty clays; foraminiferal P/B ratios of .01 to .60. Previously report-

PLATE 3

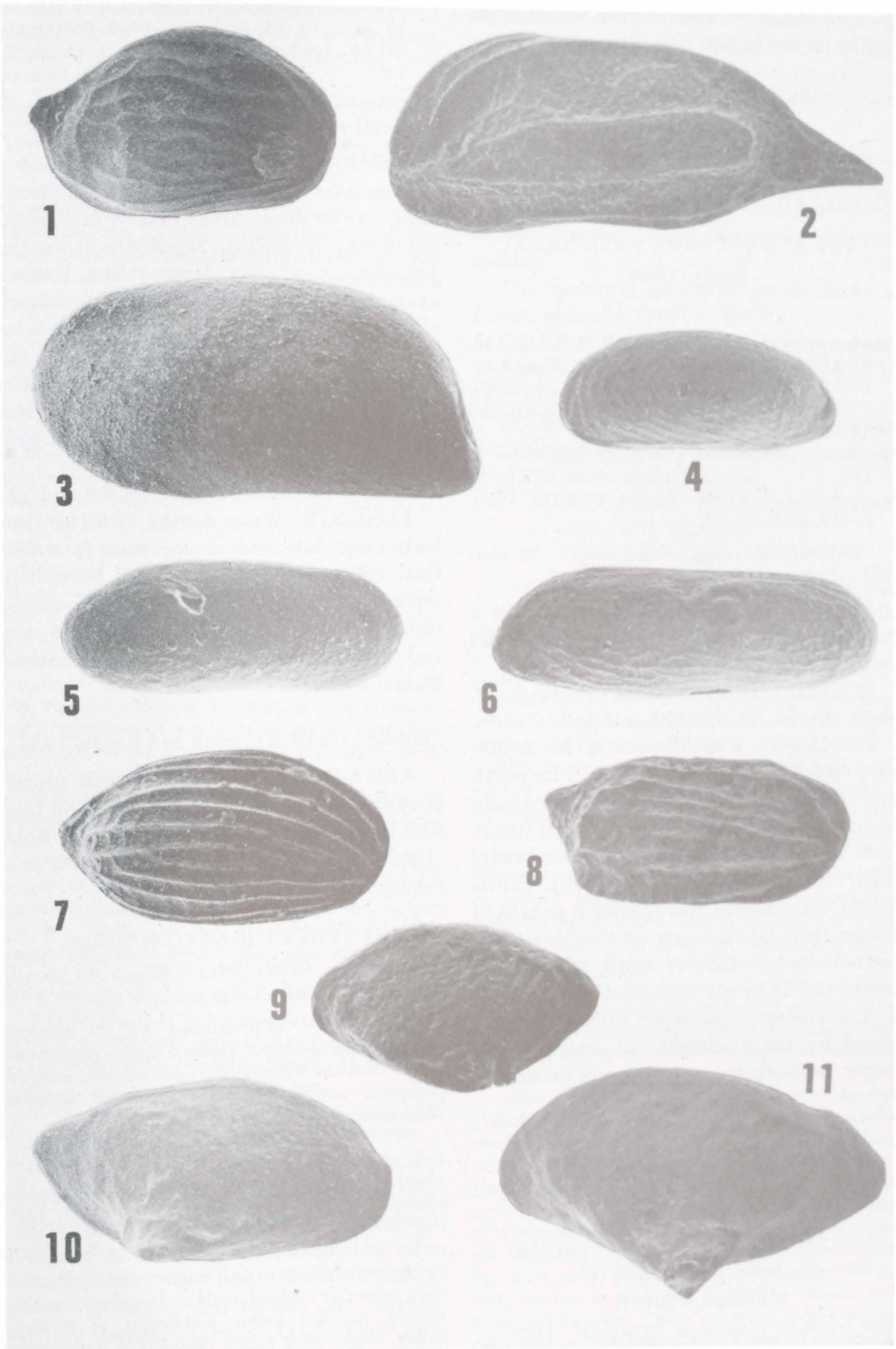


PLATE 3

ed from brackish and marine waters from depths of five to 500 feet.

Family PARADOXOSTOMATIDAE
Brady and Norman, 1889
Subfamily PARADOXOSTOMATINAE
Brady and Norman, 1889
Genus PARADOXOSTOMA Fischer, 1855

PARADOXOSTOMA ENSIFORME
Brady, 1868
Plate 5, figure 10

Paradoxostoma ensiforme BRADY, 1867, p. 198. BRADY, 1868, p. 460, pl. 35, figs. 8-11. BRADY, 1880, p. 150, pl. 35, figs. 3a-d. SARS, 1928, p. 258, pl. 67, fig. 1. ENGEL and SWAIN, 1967, p. 418, pl. 2, fig. 18.

Paracytherois ensiforme (Brady). PURI, 1960, p. 119.

Paracytherois ensiformis (Brady). CURTIS, 1960, p. 478, pl. 1, fig. 29.

DIMENSIONS: Right valve length .78 mm; height .32 mm.

REMARKS: Curtis (1960) illustrated a specimen that is identical to the juveniles found in this study.

OCCURRENCE: Stations 4, 6, 7, 9, 39-41, 43, 63, 64, 75, 103, and 113.

ECOLOGY: Water depths of 84 to 204 feet; clayey silt and sand-silt-clay; foraminiferal P/B ratios of .01 to .17. Previously reported from depths of less than 70 feet in both brackish and marine salinities (Brady, 1880; Swain, 1955; Puri, 1960). Curtis (1960) encountered this species at depths of greater than 90 feet east of the Mississippi River Delta. In Curtis's study and in this paper, the apparent extended depth-ranges of this species, and some others, may be caused by the availability of samples from deeper water than any previously examined.

Genus MACHAERINA
Brady and Norman, 1899

MACHAERINA cf. M. TENUISSIMA
(Norman, 1869)
Plate 5, figure 8

?*Bythocythere tenuissima* NORMAN, 1869, p. 294.

Machaerina tenuissima (Norman). CURTIS, 1960, p. 478, pl. 1, fig. 27.

?*Xiphichilus tenuissimoides* SWAIN, 1967, p. 98, 99, pl. 2, fig. 11; pl. 9, figs. 14a-c. SWAIN and GILBY, 1967, p. 331, pl. 32, fig. 6; pl. 34, fig. 12.

DIMENSIONS: Right valve, length .92 mm; height .21 mm.

REMARKS: Swain (1967) described a new species from the Gulf of California using size to differentiate that form from *M. tenuissima* (Norman). Specimens from the Louisiana coast are larger than Swain's examples and smaller than Norman's material. It should be noted that the dimensions given by Swain (1967) for his species are incorrect; from his Plate 9, Figure 14a, it is evident that the length is about .72 mm and height .25 mm (not length .72 mm and height .88 mm).

OCCURRENCE: Stations 29, 68 and 72.

ECOLOGY: Water depths of 99 to 306 feet; silty clays and clayey silts; foraminiferal P/B ratios of .125 to .17. Previously reported from brackish and marine conditions in water as deep as 126 feet by Swain and Gilby (1967) and at depths greater than 90 feet by Curtis (1960).

Genus LUVULA Coryell and Fields, 1937

REMARKS: This genus has been placed in synonymy with *Jonesia* Brady, 1866 (see Kesling, 1961, page Q268). Van den Bold (1963, 1966a, 1967b) regarded *Luvula* as a valid genus and he is followed here.

LUVULA GIGARTONOIDES
Kontrovitz, n. sp.
Plate 5, figures 5, 6

DIAGNOSIS: Distinguished by its greatest height at the posterior cardinal angle, right valve higher than the left at mid-length, acutely rounded posterior, and horizontal "U"-shaped anterior hinge element in the right valve.

DESCRIPTION: Elongate, ovate, lightly calcified, small. Dorsal margin is nearly straight from anterior cardinal angle to posterior cardinal angle, acutely rounded at posterior cardinal angle. Ventral margin is slightly sinuate with a weak concavity in front of mid-length. Anterior margin is evenly rounded; posterior margin, slightly convex from posterior cardinal angle to below mid-height, acutely rounded below mid-height at greatest length. Right valve higher than left at mid-length; left valve slightly overlapping at anteroventral margin. Surface is smooth, shiny on translucent specimens.

Dorsal view: Greatest width is just behind mid-length, evenly convex to anterior and posterior. Anterior margin acutely rounded, posterior more broadly rounded but also acute.

Sexual dimorphism: A few specimens that are lower at the posterior cardinal angle were found. These may represent males of this species (see remarks below).

Internal view: Hinge, right valve, anterior element is positive and "U"-shaped, with the closed portion forward; a medial bar is very thin and extends to the area beyond the posterior cardinal area. The selvage at the posterior margin is heavy and expanded below cardinal angle into a "Y"-shaped socket. There is a distinct groove that extends above the medial bar. (The dentition of the right valve is similar to that of *Luvula palmerae* Coryell and Fields, 1937, as described by van den Bold, 1967b; see remarks below). Left valve, a bar is greatly expanded anteriorly into an elongate element and posteriorly into a rounded element that seem to fit into the "U"-shaped and "Y"-shaped terminal portions of the right valve hinge. Marginal area, wide at anterior and posteroventral regions; very narrow at oral area. Anterior vestibule is large and not constricted dorsally or ventrally; line of concrescence in the vestibule is non-serrate, that is, nearly smooth; in the posteroventral area, line of concrescence is well removed from the inner margin. A small posterior vestibule has a slightly serrate line of concrescence. Radial pore canals, few, straight, and rarely bifurcating. Central muscle scars composed of a subvertical row of four elongate scars; frontal scar is variable, but usually vertically elongate.

HOLOTYPE: HVH 9504, figured specimen, ?female carapace, length .48 mm, height .26 mm, width, specimen is damaged.

PARATYPES: HVH 9505, ?female right valve, length .46 mm, height .25 mm; HVH 9506, figured specimen, ?male carapace, length .48 mm, height .23 mm, width .19 mm; HVH 9507, ?male LV, length .46 mm, height .23 mm; HVH 9508, ?female LV, length .44 mm, height .23 mm; HVH 9509, ?female RV, length .48 mm, height .26 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°52.8'N, 89°12.6'W, station 14 of this study.

DIMENSIONS: ?Females, length .46-.51 mm; height .25-.26 mm; width .18-.21 mm.

MATERIAL: Adults, 10 carapaces, 24 valves; juveniles, five carapaces, five valves.

REMARKS: A few specimens tentatively placed in this species may be males; the ?males are lower at the posterior cardinal angle and have more fragile hinges than the ?females. Van den Bold (1960) noted a similar possible dimorphism in *Luvula gigarton; Luvula gigarton* differs from this species in the hinge by having "a short groove which widens at each end" in the right valve and by having a dorsal and ventral constriction of the anterior vestibule. *Luvula palmerae* Coryell and Fields, 1937, differs by having a pointed posterior in lateral view and a more complex group of central muscle scars.

In summary, *Luvula* sp. has the external lateral outline of *L. gigarton* and the hingement of *L. palmerae.* All characters, considered together, clearly distinguish the three species.

This species is named for its similarity to *Luvula gigarton.*

OCCURRENCE: Stations 3, 7, 9, 14, 20, 25, 38, 40, 41, 46, 64, 75, 85, 104, 105, 111, 113, 115, 118, and 119.

ECOLOGY: Water depths of 54 to 420 feet; clayey silts and sand-silt-clay; foraminiferal P/B ratios of .005 to .26.

LUVULA? sp.

Plate 5, figure 7

DIAGNOSIS: Distinguished by its rounded posterodorsal outline, large elongate, rounded anterior hinge element (right valve), pointed posterior margin, and elongate compressed area at posteroventral postion of each valve.

DESCRIPTION: Carapace somewhat bairdioid, lightly calcified, small. Dorsal margin is slightly convex to posterodorsal area where outline is broadly convex; ventral margin sinuate with broad shallow convexity in front of and at mid-length. Anterior margin evenly rounded; posterior margin slightly convex from posterior cardinal angle to below mid-height where greatest length exists. Greatest length is at a pointed caudal process-like extension; below greatest length, posterior is broadly convex. Right valve is slightly higher than left from anterior to posterior cardinal angles; left valve overlaps right at posteroventral area. Surface is generally smooth, with an elongate shallow depression at posteroventral surface of each valve. A long narrow rim is at anterior from about mid-height to bottom of anterior margin. (visible only at about 150 magnifications or higher).

Internal view: Hinge, right valve, anterior element is an elongate rounded tooth, connected above to a medial bar by a thin loop (closed portion forward); loop forms a shallow socket. Medial bar is thin but high and lies above a shallow groove that is closed to posterior. Raised thin edge of selvage extends up from posterior and is expanded, forming a "V"-shaped socket with the medial bar. Left valve, a medial bar is expanded at each end; anterior is high and blade-like; posterior is small and rounded. There is a weak socket beyond each end of the medial bar, a low shelf extends below the bar. Inner lamella is wide; widest at anterior. Inner margin, evenly curved at anterior but sinuate at posteroventral area. Line of con-

crescence is far removed from inner margin at anterior and posteroventral areas. Marginal pore canals are few, apparently simple, slightly curved anterodorsally, and a few are false. Central muscle scars, composed of a compact subvertical, curved row of four, top and bottom scars are oval; middle scars are elongate. Frontal scar is large and round; two small mandibular scars are below and anterior to adductors.

DIMENSIONS: Right valve, length .47 mm; height .23 mm; (see remarks below).

MATERIAL: One carapace, nine valves.

REMARKS: The single carapace has become disarticulated, therefore, the measurement of width cannot be given. This species is tentatively classified in the genus *Luvula* because the anterior hinge element of the right valve and the shape of the frontal muscle scar are somewhat different than in the type species *L. palmerae* Coryell and Fields, 1937. Van den Bold, 1967b, redescribed *L. palmerae* and presented a description (of internal features) used here. The lower portion of the frontal hinge element of the right valve of *L. palmerae* is not as heavy as in the species described here; the frontal scar of *L. palmerae* is irregular in shape (van den Bold, 1967b).

Luvula gigarton van den Bold, 1966a, is not pointed at the posterior and also differs in dentition and muscle scar pattern.

Subfamily CYTHEROMATINAE Elofson, 1939

Genus PELLUCISTOMA Coryell and Fields, 1937

PELLUCISTOMA MAGNIVENTRA Edwards, 1944
Plate 6, figure 5

Pellucistoma magniventra EDWARDS, 1944, p. 528, pl. 89, figs. 33-35. VAN DEN BOLD, 1950, p. 86. PURI, 1954, p. 289, pl. 15, fig. 8; text fig. 12a. PURI and HULINGS, 1957, p. 187, fig. 11:6. VAN DEN BOLD, 1957, p. 246. PURI, 1960, p. 119, pl. 2, figs. 10, 11; text figs. 8, 9. BENSON and COLEMAN, 1963, p. 41, 42, pl. 6, fig. 11; text fig. 26. HALL, 1965, p. 48, pl. 17, figs. 9-15. MORALES, 1966, p. 77, pl. 7, figs. 4a-d. GROSSMAN, 1967, pl. 14, fig. 5; pl. 20, figs. 1, 3. HULINGS, 1967, p. 651, fig. 6m. Not *Pellucistoma magniventra* Edwards. VAN DEN BOLD, 1963, p. 404, pl. 10, fig. 6.

?*Pellucistoma* aff. P. *howei* Coryell and Fields. CURTIS, 1960, p. 478, pl. 2, (top) fig. 3, (bottom) fig. 10. (Not *Pellucistoma howei* Coryell and Fields, 1937, p. 17, figs. 19a-c).

Paradoxostoma ensiforme Brady. SWAIN, 1955, p. 633, pl. 63, fig. 7. (Not *Paradoxostoma ensiforme* Brady, 1867, p. 198).

DIMENSIONS: Carapaces (two), length .61-.64 mm; height .31-.33 mm; width .22-.26 mm.

REMARKS: Based on this study and previous reports of this form, it is evident that *Pellucistoma magniventra* shows much intraspecific variation. The convexity of the posteroventral area is variable, especially in juveniles; apparently the convexity increases and the length/height ratio decreases with

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PLATE 4

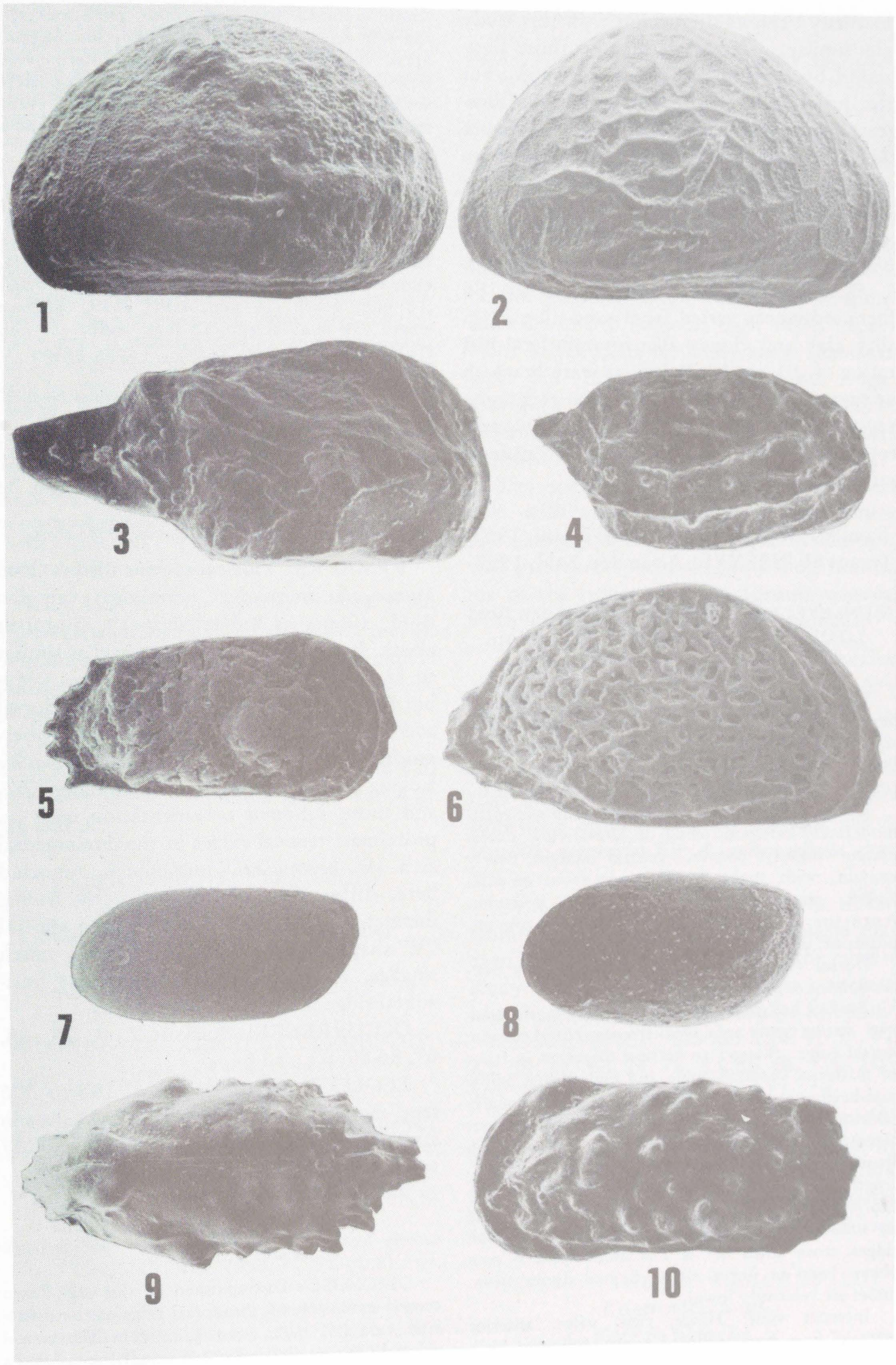

PLATE 4

maturity. The adult specimens in this study are similar in lateral outline to those illustrated by Benson and Coleman (1963), but the juveniles are closer to a paratype illustrated by Edwards (1944, Plate 88, figure 35). The variety of adults is such that there are insufficient differences to separate the form from *P. magniventra.*

OCCURRENCE: Stations 3-5, 7, 9, 50, 58, 70, 74-76, 106, 113, 118, 121, and 123.

ECOLOGY: Water depths of 20 to 186 feet; sediments varied from sand-silt-clay to silty clay and clayey silt; foraminiferal P/B ratios of .01 to .13. Salinities were brackish at two stations and marine at the remaining seventeen collection locations. Previously reported from five feet or less to 550 feet; salinities were brackish to marine.

Family PECTOCYTHERIDAE Hanai, 1957
Genus MUNSEYELLA van den Bold, 1957

MUNSEYELLA BERMUDEZI van den Bold LOUISIANENSIS Kontrovitz, n. subsp.
Plate 6, figures 3, 4

DIAGNOSIS: Distinguished from *Munseyella bermudezi* by a blunt spine on a horizontal ridge at the posterior cardinal angle, prominence of the horizontal ornamentation, two prominent vertical ridges in the dorsomedial area, and its small size.

DESCRIPTION: Carapace subtriangular, moderately calcified, small. In lateral view, dorsal margin slightly convex, ventral margin nearly straight, with slight concavity in front of mid-length, strongly converging toward posterior. Anterior margin evenly rounded, spinose; posterior, truncate with two blunt spines.

Dorsal view: Greatest width at posterior one-third, ends compressed.

Surface has ridges and intervening pits. Anterior rim strong upper area, weaker near ventral margin; dorsal ridge, changes to vertical direction in front of posterior cardinal angle and ending just below mid-height on lateral surface. There are two nearly horizontal ridges connected by weaker but distinct ridges; the upper horizontal ridge starts just in front of posterior vertical ridges and ends at mid-length; lower horizontal ridge is connected to venter by a downward sloping extension, forming an indistinct "V" with apex toward rear. Small ridges cross limbs of "V". A blunt spine is seen above bend in dorsal ridge. Sexual dimorphism, males are relatively lower.

Internal view: Hinge, right valve, anterior element is a small pointed tooth, followed by a large socket; medial crenulate groove; large posterior socket and large oval posterior tooth oriented vertically. Left valve and anterior socket, small tooth, crenulate bar, large tooth, small socket; in the left valve, sockets open to interior. Marginal areas, anterior and posterior wide; anterior vestibule wide, posterior distinct and widest at postero-ventral area. Marginal pore canals are evenly spaced, very short and simple, most correspond to marginal spines. Muscle scars are obscured.

HOLOTYPE: HVH 9516, figured specimen, carapace, length .31 mm, height .18 mm, width .13 mm.

PARATYPES: HVH 9517, figured specimen, carapace, length .30 mm, height .18 mm, width .13 mm; HVH 9518, carapace, length .30 mm, height .18 mm, width .14 mm; HVH 9519, carapace, length .31 mm, height .18 mm, width .14 mm; HVH 9520, carapace, length .31 mm, height .19 mm, width .17 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°48.0'N, 89°21.8'W, station 28 of this study.

DIMENSIONS: Females, carapaces, length .30-.32 mm; height .18-.19 mm; width .13-.17 mm; male (one carapace), length .30 mm; height .15 mm; width .13 mm.

MATERIAL: Sixteen carapaces, four valves.

REMARKS: This subspecies differs from *Munseyella bermudezi bermudezi* van den Bold, 1966a, as indicated in the diagnosis above. Both subspecies are somewhat similar to *M. atlantica* Hazel and Valentine, 1969, but differ by having more converging dorsal and ventral margins. *M. bermudezi bermudezi* also differs from *M. atlantica* by lacking a posterodorsal spine, its smaller size, and more subdued ornamentation with no prominent vertical ridges in the dorsomedial area. *M. bermudezi louisianensis,* reported here, differs from *M. atlantica* by having distinct vertical cross ridges in the ventral "V"-shaped ornamentation, in being much smaller, and by having a prominent horizontal ridge in the dorsomedial area.

OCCURRENCE: Stations 7, 9, 28, 68, 69, 86-89, 93, and 94.

ECOLOGY: Water depths of 198 to 306 feet; mostly in silty clay with a few valves in sand-silt-clay; foraminiferal P/B ratios of .07 to .42.

MUNSEYELLA sp.
Plate 6, figure 8

DIAGNOSIS: Distinguished by the large down turned extension of the dorsal ridge at the posterior cardinal angle, two prominent subvertical ridges in the medial and posteromedial areas, and a blunt spine at the posterior cardinal angle.

DESCRIPTION: Trapezoidal, moderately calcified, small. Dorsal margin is straight; ventral margin

slightly convex converging posteriorly. Greatest height at anterior cardinal angle. Anterior margin is evenly rounded below mid-height, more obliquely rounded above. (The specimens recovered have the remnants of spines at the anterior). Posterior margin is obliquely rounded with two blunt spines, one just above mid-height, other below.

Dorsal view: Elongate, spatulate, greatest width at middle. Anterior compressed, posterodorsal ridges form a "V", with apex forward to about middle. Spines at posterior cardinal angles prominent, knob-like. Left valve slightly larger than right.

Surface, has ridges and intervening pits; narrow anterior rim continues as a dorsal ridge (or rim) that widens at posterior cardinal angle terminating just below mid-length. A vertical ridge is located in front of downward flexure of dorsal ridge; another vertical ridge at about mid-length; neither vertical ridge touches dorsal ridge. Anterior lateral surface with several connected, low, curved ridges. Interior features not seen, except a few anterior radial pore canals that correspond in position to the remnants of marginal spines.

DIMENSIONS: Carapace, length .32 mm; height .20 mm; width .14 mm.

REMARKS: This species differs from *Munseyella atlantica* Hazel and Valentine, *M. bermudezi bermudezi* and *M. bermudezi louisianensis* (of this report) by the presence of prominent vertical ridges.

OCCURRENCE: Stations 20 and 91.

ECOLOGY: Water depths of 198 and 420 feet; silty clays; foraminiferal P/B ratios of .26 and .41.

Framily TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948
Genus ACTINOCYTHEREIS Puri, 1953

ACTINOCYTHEREIS GOMILLIONENSIS (Howe and Ellis, 1935)
Plate 6, figure 6

Cythereis exanthemata var. *gomillionensis* HOWE and ELLIS, 1935, p. 19, pl. 1, figs. 6-12; pl. 4, fig. 3. EDWARDS, 1944, p. 521, 522, pl. 87, figs. 31, 32. VAN DEN BOLD, 1946, p. 88, pl. 10, fig. 2.

Trachyleberis exanthemata gomillionensis (Howe and Ellis). MALKIN, 1953, p. 792, pl. 81, figs. 15, 17, 18.

Actinocythereis exanthemata gomillionensis (Howe and Ellis). PURI, 1953, p. 173, 180, pl. 2, figs. 4-8; text figs. e, f. PURI, 1954, p. 253, pl. 13, figs. 16, 17. MCLEAN, 1957, p. 83, pl. 10, figs. 2a-d. HALL, 1965, p. 33, pl. 7, figs. 12-17. MCLEAN, 1966, p. 66, pl. 20, fig. 6, pl. 21, fig. 1.

Actinocythereis gomillionensis (Howe and Ellis). WILLIAMS, 1966, p. 30, figs. 18:6a-c; text figs. 24a-c.

DIMENSIONS: Carapaces, female, length .79 mm; height .42 mm; width .42 mm; male, length .82 mm; height .42 mm; width .41 mm.

REMARKS: Williams (1966) believed this form should be distinguished as a species. He stated that it "is easily recognized by its row of fine pustules above dorsal row of spines and adjacent to hinge of right valve." Specimens in the current study show that character but do not have a "smooth ridge" extending from the eye tubercle parallel to the anterior margin, as described by Williams (1966).

The specimens examined here are variable, with some smooth and others spinose just behind the anterior margin. In addition, well preserved specimens show some branching of the spines near the dorsum, whereas worn individuals retain only blunt spines.

Actinocythereis triangularis Morales, 1966, is differentiated from *A. gomillionensis* by the latter's "larger size, subquadrate outline and stronger ornamentation." Unfortunately, Morales' illustrations indicate that the specimens in that study have been somewhat eroded on their surfaces just as Morales suggested for *A. subquadrata* Puri, 1960.

Cythere bahamenis Brady, 1870, differs from this species by being less spinose than even the most worn specimens of the current study, in not having three distinct rows of lateral spines, and in being smaller (.50 mm).

OCCURRENCE: Station 1, 4, 7, 37, 41, 43, 50, 56, 63, 74, 78, 83, 86, 88, 102, 105, 107, 109-111, 113, 115, and 117-119.

ECOLOGY: Water depths of 54 to 192 feet; sediments varied from clayey silt to silty clay and sand-silt-clay; foraminiferal P/B ratios .01 to .26. Previously reported from shallow depths with marine salinities.

ACTINOCYTHEREIS VANDENBOLDI Kontrovitz, n. sp.
Plate 6, figures 1, 2

DIAGNOSIS: Distinguished by its highly compressed anterior and posterior, long curved antero-

ventral and posteroventral denticles, median row of spines that bifurcates anteriorly forming a "Y"-shaped ornamentation, and in internal view the acutely rounded, nearly pointed, posterior of the right valve.

DESCRIPTION: Subtrapezoidal, sloping toward posterior, heavily calcified, medium size. Dorsum nearly straight as is ventral margin, but latter has slight convexity behind mid-length, converging. Anterior margin is broadly rounded below mid-height, acutely rounded above and denticulate; posterior margin acutely rounded below mid-height with a straight outline from greatest length to posterior cardinal angle. Greatest length is below mid-height.

Surface: Heavy spines in rows, prominent, anterior rim, marginal denticles. Denticles are long, delicate, and curved. Lateral spines are in rows, becoming blade-like on ventral and dorsal margins; some bifurcate at posterodorsal area; one lateral row of spines extends from one-third of length behind anterior and down to near ventral margin; center row forms a "Y" with the open end forward; subdorsal row has some blade-like and bifurcating spines; dorsal row is deflected downward at posterior cardinal angle and often reaches the central row. A large eye tubercle is at anterior cardinal angle. Some specimens also have a distinctly spinose posteroventral margin.

Sexual dimorphism: Males are lower, therefore they appear to be longer than females.

Internal view: Hinge, right-valve, anterior tooth is high and rounded and becomes curved, forming the lower rim of a circular socket; narrow median groove is shallow; posterior tooth is large, low, rounded. Hinge, left valve, anterior socket is indistinct and open to front; behind socket is a long low tooth that merges with a low bar; bar is expanded at posterior and is followed by a circular socket that opens inward. Inner lamella is wide at posterior and anterior but narrow at anteroventral area. Line of concrescence coincides with inner margin. Selvage is peripheral and low. Some specimens have low concentric striae on inner lamella at anterior. Marginal pore canals are numerous, clustered, sinuate, and most pass through denticles. Muscle scars are obscured by ornamentation.

HOLOTYPE: HVH 9510, figured specimen, carapace, length .78 mm, height .45 mm, width .40 mm.

PARATYPES: HVH 9511, figured specimen, RV, length .73 mm, height .40 mm; HVH 9512, LV, length .72 mm, height .41 mm; HVH 9513, RV, length .78 mm, height .39 mm; HVH 9514, LV, length .79 mm, height .44 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°19.2'N, 92°23.4'W, station 92 of this study.

DIMENSIONS: Carapaces, female length .78 mm; height .45 mm; width .40 mm; male, length .78 mm; height .42 mm; width .40 mm.

MATERIAL: Three carapaces, 29 valves.

REMARKS: The ornamentation is variable on the specimens examined here. Although well preserved specimens are distinct from other species, poorly preserved specimens resemble forms mentioned below:

Actinocythereis davidwhitei (Stadnichenko, 1927) is similar in size and shape to worn specimens of the current study; *A. davidwhitei* (Stadnichenko) of Puri, 1953a, is more similar to this material than those of the original description (note that Plate 39, figure 24, in Stadnichenko, 1927, is inverted).

Pooser (1965) considered *A. gibsonensis* (Howe and Chambers, 1935), and *A. davidwhitei* to be conspecific. The specimens used to describe *A. gibsonensis* are not as highly

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PLATE 5

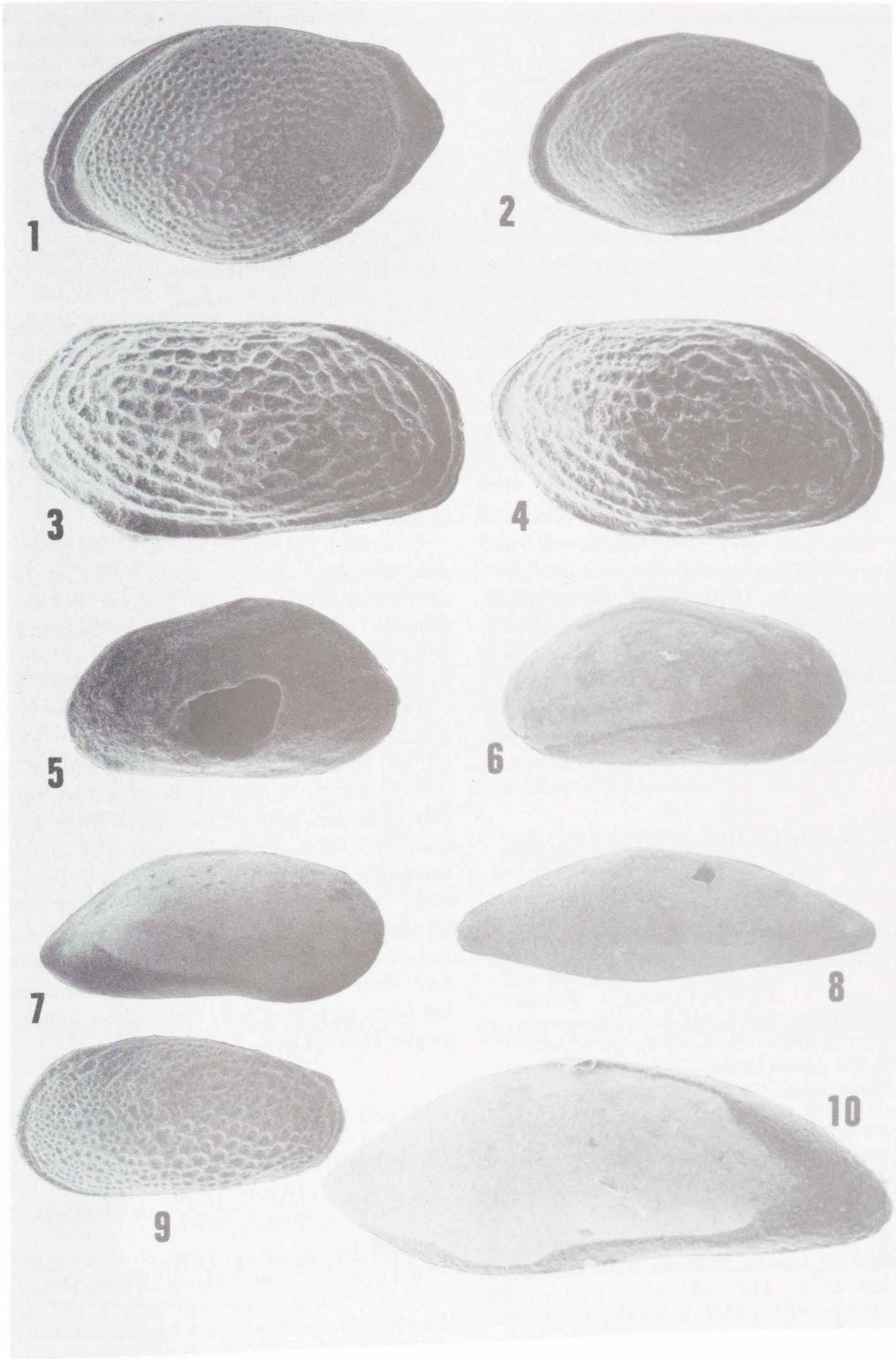


PLATE 5

ornamented as those reported in the current study.

This species is named in honor of Dr. W. A. van den Bold for his kind suggestions and criticism that greatly improved this study.

OCCURRENCE: Stations 69, 89, 91-93, and 118.

ECOLOGY: Water depths of 60 to 205 feet, with all but two valves from depths greater than 186 feet and in silty clays; foraminiferal P/B ratios of .01 to .60.

Subfamily BUNTONIINAE Apostlescu, 1961
Genus BUNTONIA Howe, 1935

BUNTONIA? sp.
Plate 6, figure 7

MATERIAL: One damaged valve.

REMARKS: This species is represented by a single damaged valve; it is recorded and illustrated to allow comparison in future studies. Curtis (1960) reported a species of *Butonia* east of the Mississippi River Delta, but a comparison cannot be carried out unless more specimens are available.

OCCURRENCE: Station 64.

ECOLOGY: Water depth of 69 feet; clayey silt; foraminiferal P/B ratio of .05.

Subfamily ECHINOCYTHEREIDINAE
Hazel, 1967
Genus ECHINOCYTHEREIS Puri, 1953

ECHINOCYTHEREIS MARGARITIFERA
(Brady, 1870)
Plate 7, figure 1

Cythere margaritifera BRADY, 1870, p. 192, pl. 27, figs. 3, 4.

Cythereis garretti HOWE and MCGUIRT, 1935, p. 20, pl. 3, figs. 17-19; pl. 4, figs. 5, 15.

Buntonia? sp. cf. B. ?*garretti* (Howe and McGuirt). SWAIN, 1951, p. 39, pl. 3, fig. 6; pl. 4, figs. 4-6.

Echinocythereis garretti (Howe and McGuirt). PURI, 1954, p. 260, pl. 12, figs. 2-5; text figs. 9a, b. BROWN, 1958, p. 65, pl. 6, fig. 12. BENSON and COLEMAN, 1963, p. 46, pl. 4, figs. 4, 5; text fig. 30. HALL, 1965, p. 34, pl. 8, figs. 15, 16, 18-23. HULINGS, 1967, p. 653, fig. 6q. SWAIN, 1968, p. 15, pl. 4, fig. 12; text fig. 13.

Echinocythereis margaritifera (Brady). CURTIS, 1960, p. 478, pl. 1, fig. 19. HAZEL, 1967, p. 36, 37, pl. 6, figs. 6, 7, 9.

DIMENSIONS: Carapace, female, length .85 mm; height .52 mm; width .49 mm; left valve, females, length .72-.85 mm; height .47-.54 mm.

REMARKS: This species shows much variation of the ornamentation. Well preserved specimens have long spines that are delicate at the distal ends; poorly preserved specimens retain only blunt knob-like projections. Spines near the dorsal margin may bifurcate, but that feature is not seen on poorly preserved specimens.

Benson and Coleman (1963) have used the arrangement of spines to differentiate several species of *Echinocythereis,* but as with individual spines, the pattern of all spines is variable from apparent randomness to alignment in rows. All such arrangements were observed by this writer on specimens of *E. margaritifera.*

It should be noted that in *E. margaritifera,* sexual dimorphism is not well expressed in length/height ratios because the eye tubercle is high in both sexes. The males are, however, much lower in the posterior portion of the carapace.

OCCURRENCE: Stations 4, 5, 7, 9, 17, 20, 29, 31, 43, 44, 50, 59, 62-64, 67-76, 81, 83, 84, 86-89, 91-93, 95-110, 112, and 117.

ECOLOGY: Water depths of 42 to 788 feet with over 98% of the valves from less than 225 feet; clayey silts and silty clays; foraminiferal P/B ratios of .01 to .60. Previously reported from the area east of the Mississippi River Delta, deeper than 90 feet, and in the Atlantic Ocean from 270 to 460 feet. Near southwestern Florida, this species has been identified only from water depths greater than 60 feet.

Genus HENRYHOWELLA Puri, 1957

HENRYHOWELLA ex. gr. ASPERRIMA
(Reuss, 1850)
Plate 7, figure 3

Henryhowella asperrima (Reuss). VAN DEN BOLD, 1957, p. 242, 243. VAN DEN BOLD, 1960, p. 169, pl. 4, fig. 10; pl. 8, fig. 2.

Henryhowella evax (Ulrich and Bassler). POOSER, 1965, p. 59, pl. 19, fig. 1; pl. 20, figs. 2, 7, 9-13.

Henryhowella ex. gr. *asperrima* (Reuss). VAN DEN BOLD, 1966b, p. 169, pl. 2, fig. 9.

DIMENSIONS: Carapaces, females, length .64-.66 mm; height .39-.42; width .39-.40; males, length .64-.70 mm; height .73-.40 mm; width .34-.35 mm.

REMARKS: Van den Bold is followed here because of his familiarity with the European material. Pooser (1965) noted van den Bold's work but retained *H. evax* as a valid name; the present writer agrees with Pooser (1965, p. 59) that *H. echinata* Puri, 1956, and *H. evax* are conspecific. The current study confirms that the ornamentation of this species is variable. Well preserved specimens have closely custered spines whereas poorly preserved examples retain only the three horizontal ridges on the posterior part of the valve. All transitional states of preservation were also observed in the material collected for this study.

The specimens examined from the Louisiana coastal area are smaller than those of Ulrich and Bassler (1904), Puri (1956), and van den Bold (1957, 1960). All other characters are identical and size alone may be the function of the environmental factors.

OCCURRENCE: Stations 68-70, and 86-97.

ECOLOGY: Water depths of 138 to 204 feet, with 99% of all valves from 150 to 204 feet; silty clay; foraminiferal P/B ratios of .13 to .60.

Subfamily PTERYGOCYTHEREIDINAE Puri, 1957
Genus PTERYGOCYTHEREIS Blake, 1933

PTERYGOCYTHEREIS MIOCENICA van den Bold, 1967
Plate 7, figure 2

Pterygocythereis sp. aff. *P. americana* (Ulrich and Bassler). BENSON and COLEMAN (part), 1963, p. 22, 23, pl. 5, figs. 2, 3 (not pl. 5, fig. 1; text fig. 10).

Pterygocythereis miocenica VAN DEN BOLD, 1967a, p. 310, pl. 1, figs. 19a, b.

Pterygocythereis sp. aff. *P. americana* (Ulrich and Bassler). SWAIN, 1968, p. 19, 20, pl. 2, figs. 7a-d; text fig. 18.

DIMENSIONS: Left valve, length .80-.92 mm, height .41-.45.

REMARKS: Benson and Coleman (1963) placed crested and uncrested forms in *P.* cf. *P. americana* (Ulrich and Bassler), stating that the crested specimens were heteromorphs and the uncrested were technomorphs. Hazel (1967) stated that Benson and Coleman's uncrested forms and Curtis's (1960) *Pterygocythere* sp. "represent an undescribed species, whereas the crested forms probably are *Pterygocythereis americana.*" Van den Bold (1967) described the new species, *P. miocenica,* but excluded all of Benson and Coleman's specimens and the crested form reported by Curtis (1960). This writer agrees that the crested forms of Benson and Coleman and Curtis should be excluded from the synonymy of *P. miocenica;* however, the uncrested forms are conspecific with *P. miocenica.* In this study there are distinctly crested and uncrested molts at all stages; these molts can be referred to *P. americana* and *P. miocenica,* respectively, as a growth series for each can be reconstructed.

OCCURRENCE: Stations 4, 7, 37, 43-45, 50, 59, 63, 64, 66, 68, 70, 72-76, 78, 81, 83, 88, 89, 91, 92, 94, 97-99, 102-107, 109-112, 115, 117, and 118.

ECOLOGY: Water depths of 42 to 204 feet; clayey silt and silty clay; foraminiferal P/B ratios of .01 to .35.

PTERYGOCYTHEREIS AMERICANA (Ulrich and Bassler), 1904
Plate 7, figure 7

Pterygocythereis cornuta var. *americana* ULRICH and BASSLER, 1904, p. 122, pl. 37, figs. 29-33.

Pterygocythereis americana (Ulrich and Bassler). HAZEL, 1967, p. 19, 20, pl. 2, figs. 7a-d; text fig. 18.

DIMENSIONS: Length .82 mm; height .46 mm.

REMARKS: The single carapace is damaged, therefore, a width measurement is not meaningful. These specimens are smaller than those examined by Ulrich and Bassler (1904) and Hazel (1967), but are similar to those illustrated by Benson and Coleman (1963).

OCCURRENCE: Stations 3, 4, 7, 9, 68-70, 72, 74, 87, 89, 91, 92, 94, 96, and 98.

ECOLOGY: Water depths of 84 to 204

feet; sediments were of varied textures; foraminiferal P/B ratios of .03 to .35.

Subfamily CYTHERETTINAE
Triebel, 1952
Genus PROTOCYTHERETTA Puri, 1958

PROTOCYTHERETTA KARLANA
(Howe and Pyeatt, 1935)
Plate 7, figure 4

Cytheretta karlana HOWE and PYEATT, 1935, p. 34, 35, pl. 1, figs. 30, 34; pl. 3, figs. 3, 4. SMITH, 1941, p. 279, VAN DEN BOLD, 1946, p. 105, pl. 9, fig. 18. SWAIN, 1951, p. 46, pl. 6, fig. 19.

Cytheretta reticulata EDWARDS, 1944, p. 525, pl. 8, figs. 7-10. BROWN, 1958, p. 67, pl. 6, fig. 13. PURI, 1958b, p. 184, table 1.

Paracytheretta karlana (Howe and Pyeatt). PURI, 1952a, p. 209, pl. 40, figs. 3-5; text fig. 8.

Protocytheretta karlana (Howe and Pyeatt). PURI, 1958b, p. 184, table 1. POOSER, 1965, p. 38, 39, pl. 12, figs. 3, 7-10.

?*Cytheretta danaiana* (Brady). CURTIS, 1960, p. 478, pl. 2, (top) fig. 2 (Not *Cythere danaiana* Brady, 1869, p. 124, pl. 14, figs. 13, 14).

DIMENSIONS: Carapaces, ?female, length .82-.94 mm; height .46-.52 mm; width .36-.45 mm; ?males, length .80-.88 mm; height .44-.48 mm; width .35-.40 mm.

REMARKS: There had been much controversy as to the relationship of *Protocytheretta karlana* (Howe and Pyeatt, 1935), and *P. reticulata* (Edwards, 1944). Swain (1951) considered the two to be conspecific, but Puri (1953c) did not; Pooser (1965) placed *P. reticulata* in synonymy with *P. karlana.* Edwards (1944) stated that *P. reticulata* differs from *P. karlana* "in being less pointed posteriorly and possessing stronger ornamentation." In the current study material, the ornamentation is highly variable from long thin pits to the "elongate rectangular or triangular pits" described by Edwards. Ridges between the pits are also variable from being low and indistinct to prominent. Length/height ratios have not been mentioned previously in regard to sexual dimorphism in these forms; apparent males are relatively lower, perhaps accounting for some fo the previous controversy as to the size ranges of *P. karlana* and *P. reticulata.* Inasmuch as size and ornamentation differences have been used to separate the species, the variations noted here seem to negate the use of those criteria in this case. Left valve dimensions listed by Puri (1952a) for *P. karlana* indicate a size close to Edward's holotype for *P. reticulata* (see Text Figure 5).

The variation in ornamentation is believed to be caused by postmortem erosion of the long thin pits. At the edge of each pit, on well preserved specimens, is a ragged edge of mineral material. The edges tend to cover the center of the pit with a thin layer (note that the edges never touch, however.) As the surface of the specimen is eroded, the thin edge of each pit is removed, thus, each pit appears to be enlarged and less elongate; experimental erosion of the valve surface verifies this process.

This species differs from *P. pumicosa* (Brady, 1866) in not having the central

PLATE 6

Figure Page

1-2. *Actinocythereis vandenboldi* Kontrovitz, n. sp. 81
1. Holotype, HVH 9510, carapace, right view (100X)
2. Paratype, HVH 9511, right valve (100X)

3-4. *Munseyella bermudezi* van den Bold *louisianensis* Kontrovitz, n. subsp. 80
3. Holotype, HVH 9516, carapace, right view (100X)
4. Paratype, HVH 9517, carapace, right view (100X)

5. *Pellucistoma magniventra* Edwards, HVH 9494, left view (100X) 78

6. *Actinocythereis gomillionensis* (Howe and Ellis), HVH 9501, left valve (100X) 81

7. *Buntonia*? sp., HVH 9502, left valve (100X) 84

8. *Munseyella* sp., HVH 9503, damaged carapace, left view (200X) 80

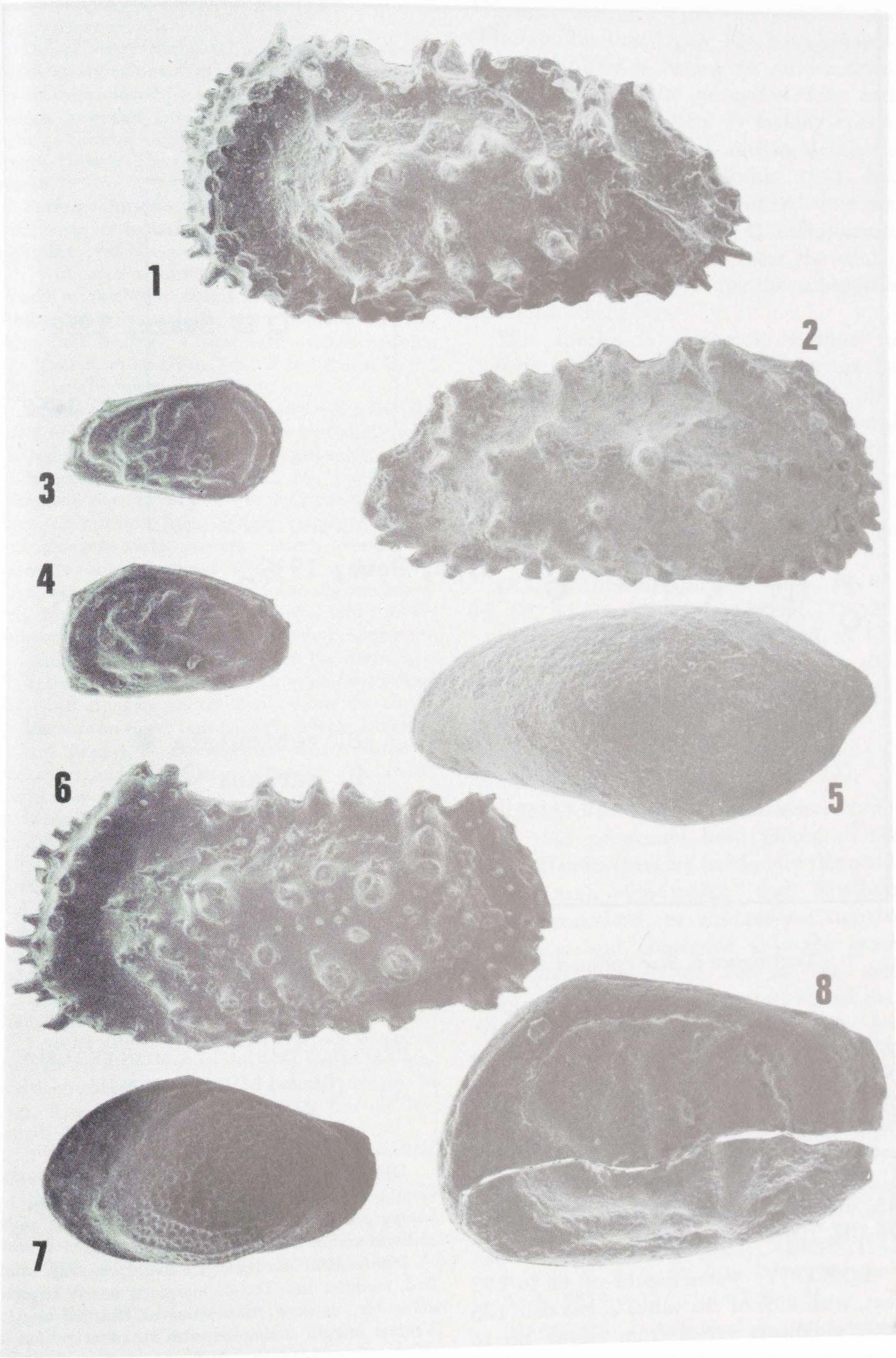
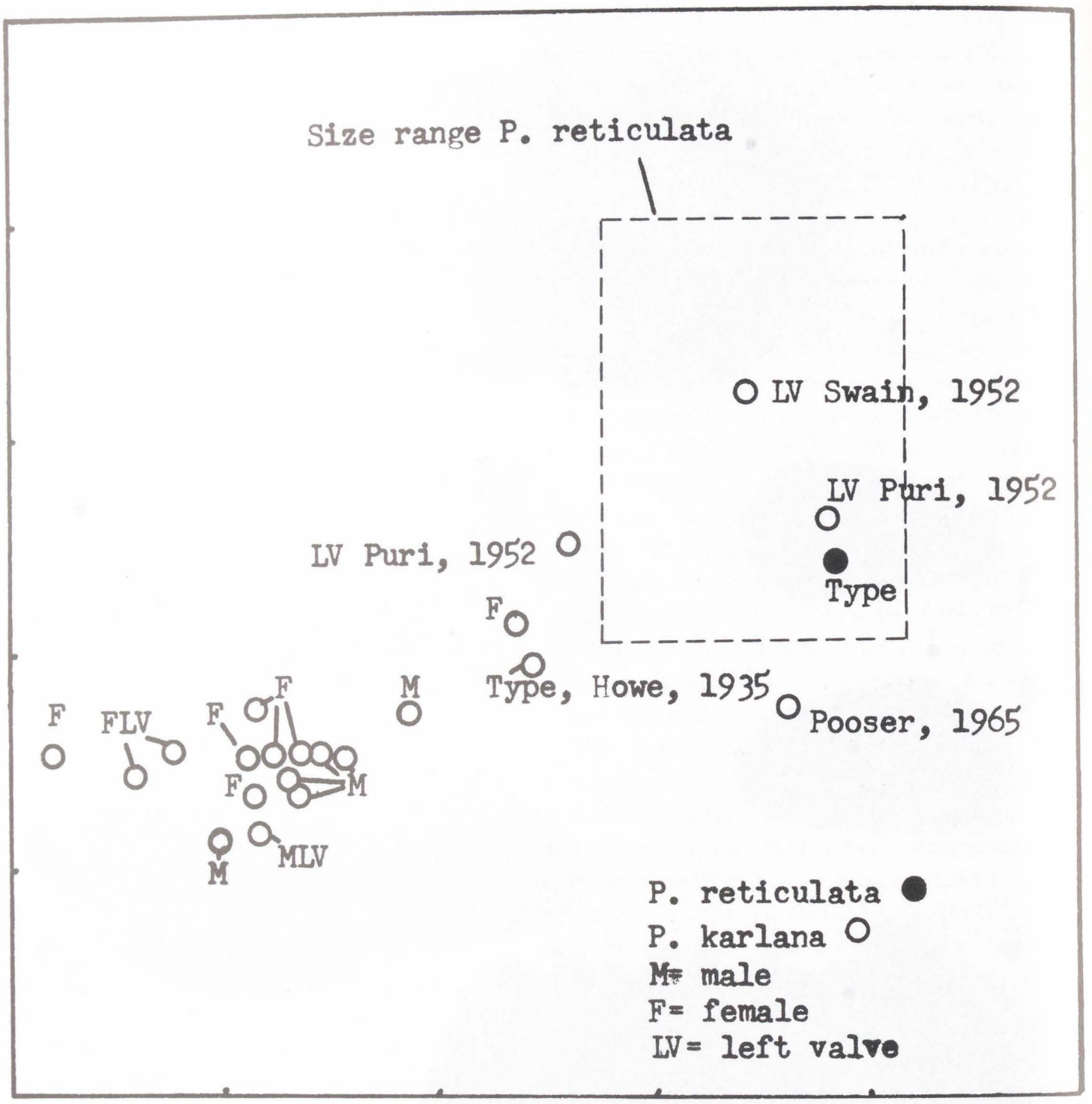


PLATE 6



Text figure 5. Size comparison of *Protocytheretta karlana* and *P. reticulata.*

ridges joined posteriorly to form loops. (*Cythere pumicosa* Brady, 1866, is a senior synonym of *Cythere danaiana* Brady, 1869, *fide* van den Bold, 1971, personal communication).

OCCURRENCE: Stations 4, 7, 40, 43, 45, 60, 63, 64, 67-76, 81-84, 87, 88, 98, 96-102, 104-112, and 117.

ECOLOGY: Water depths of 42 to 192 feet, with 95% of the valves at less than 125 feet; sediments varied from clayey silt to silty clay and sand-silt-clay; foraminiferal P/B ratios of .01 to .60.

PROTOCYTHERETTA MONTEZUMA (Brady) LOUISIANENSIS Kontrovitz, n. subsp.

Plate 7, figures 5, 6

DIAGNOSIS: Distinguished from *Protocytheretta montezuma montezuma* (Brady, 1869), by having reticulations between the lateral ribs, especially at and in front of mid-length.

DESCRIPTION: Elongate-ovoid, heavily calcified, medium size. Dorsal margin is nearly straight at center, marked convexities at cardinal angles. Ventral margin is sinuous with a concavity just in front of mid-length. Anterior margin broadly rounded below mid-height, more obliquely rounded above. Posterior margin broadly rounded

below mid-length, acutely rounded above, greatest length above middle.

Dorsal view: Elongate, arrow-shaped, greatest width at about one-fifth of length from posterior; tapers to produced posterior and with convexity to acutely rounded anterior. Left valve larger than right at cardinal angles; right valve highest at mid-length (this is obscure in left lateral view, however).

Surface: Anterior is smooth, remainder ribbed with some reticulations. Three prominent ridges, including two lateral that may be joined posteriorly with a thin sinuous loop; a dorsal rib that is arched at posterior dorsal area forming carapace outline there; dorsal rib more subdued on right valve, but distinct. Coarse reticulations between ribs (that is, cross ribs). Ventral area below lateral ribs is striate, without cross ribs.

Sexual dimorphism: Apparently males are relatively lower and longer. ?Males are also highly compressed at posteroventral area of right valve.

Internal view: Hinge, right valve, a large pyramidal anterior tooth, followed by a circular socket open to interior, long straight crenulate groove, and elongate-ovate posterior tooth. Hinge, left valve, swelling of selvage at anterior in front of a large socket; socket is enclosed dorsally and anteriorly but open at its posteroventral limit; socket followed by a large smooth tooth that merges into a crenulate median bar; median bar terminates abruptly without swelling at its posterior; behind bar is an elongate socket that follows the curved outline of the valve. Inner margin is wide, irregular, inward flexure at anteroventral area. A large indentation and enlargement forming a knob-like projection of flange of left valve is just in front of mid-length (at venter). Radial pore canals few, sinuous above mid-length at anterior, more numerous and simply curved below; may be enlarged near outer margin; posterior, radial pore canals, many and closely spaced, nearly straight to curved. Central muscle scars are in a small circular depression inside valve; four oval adductors, in a subvertical row; elongate frontal scar.

HOLOTYPE: HVH 9524, figured specimen, ?female RV, length .84 mm, height .43 mm.

PARATYPES: HVH 9525, figured specimen, ?female carapace, length .80 mm, height .44 mm, width .39 mm. HVH 9526, ?male RV, length .84 mm, height .41 mm; HVH 9527, juvenile RV, length .72 mm, height .39 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°49.0'N, 90°36.6'W, station 56 of this study.

DIMENSIONS: Carapace, ?female, length .78 mm; height .46 mm; width .41 mm; carapace, ?male, length .86 mm; height .47 mm; width .40 mm. Left valve, ?male, length .87 mm; height .49 mm.

MATERIAL: Adults, four carapaces, 39 valves; juveniles, two carapaces, 44 valves.

REMARKS: The internal features of this form are much like *Cytheretta sahnii* Puri, 1952a, as illustrated by Benson and Coleman (1963, p. 25, Text Figure 12), but *Cytheretta sahnii* differs in having no surface ornamentation. *Cytheretta alexanderi* Howe and Chambers, 1935, differs in lacking coarse reticulations and has small anterior denticles. *Cytheretta calhounensis* Smith, 1941, has more lateral ribs (four or five) and does not have a finely striate venter; *C. calhounensis* has only four of five ribs near the venter compared to about 15 on the subspecies described here.

This species is similar in outline to *Cytheretta howei* Swain, 1946, but can be distinguished by the smooth anterior one-third of the carapace, the prominent dorsal ridge on the left valve, the distinct reticulations between the two lateral ribs, and the smaller size. This subspecies differs from *Protocytheretta montezuma montezuma* (Brady) as indicated above.

OCCURRENCE: Stations 4, 25, 37, 46, 48, 50, 53, 56, 78, 114, 115, and 117-120.

ECOLOGY: Water depths of 14 to 132 feet; sediments varied from sands to silty clays; foraminiferal P/B ratios of .005 to .05.

Subfamily ?
Genus BASSLERITES Howe, 1937

REMARKS: The genus *Basslerites* Howe, 1937, has previously been placed in the family Hemicytheridae (subfamily Campylocytherinae). Plusquellec and Sandberg (1969) restudied the subfamily Campylocytherinae and concluded that the genus *Basslerites* "does not fit in the subfamily. . ." Indeed, those writers stated that "the carapace details of species of *Basslerites* require placement of that genus among the Trachyleberididae." They did not erect a new subfamily in the Trachyleberididae or assign *Basslerites* to an existing subfamily.

BASSLERITES VOKESI Kontrovitz, n. sp.
Plate 4, figures 7, 8

Basslerites cf. *B. berchoni* (Brady). CURTIS, 1960, p. 478, pl. 1, fig. 5. (Not *Cythere berchoni* Brady, 1879, p. 117, pl. 14, figs. 3, 4).

DIAGNOSIS: Distinguished by the combination of the presence of posterolateral depressions, its small size, convex dorsum and venter in the female, large anterior vestibule, numerous radial

pore canals, and pronounced sexual dimorphism for this genus.

DESCRIPTION: Ovate, moderately calcified, small. Female, lateral view, dorsal margin is smoothly convex; ventral margin convex; convexity increases behind mid-point. Anterior margin is evenly rounded; posterior margin broadly rounded below mid-height, acutely rounded above. Greatest length above mid-height; greatest height is at one-third of total length from the posterior. Left valve is larger than right, except at extreme anterior and posterior. Males differ by having nearly straight, subparallel ventral and dorsal margins, in being relatively lower, and having a more distinct posterior cardinal angle than females.

Dorsal view: Females, elongate-ovate, with greatest width at one-fourth of total length from posterior; sides are convex and taper gently forward and rapidly to posterior. Anterior is acutely rounded; posterior broadly rounded and has lateral depressions. Males, greatest width is just behind mid-point.

Surface is smooth except at about posterior one-fifth where a shallow surface depression forms an asymmetrical "V" with the apex directed forward and positioned below mid-height. Surface in depression is not smooth but is uneven with a beaded appearance and large normal pore canals.

Internal view: Hinge, right valve, a high rounded anterior tooth; elongate oval socket open posteriorly to the interior; a narrow crenulate arched median groove; and a large, curved, weakly crenulate tooth at posterior cardinal angle. In dorsal view, the anterior tooth is elevated on a ramp and slightly pointed at its anterior. Left valve, with a circular anterior socket closed ventrally and anteriorly by a low ridge; medial bar enlarges to a long, slender tooth anteriorly, with a distinct groove positioned just above the tooth; medial bar, arched near mid-length, but straight posteriorly to cardinal angle; a shallow groove is present only above straight portion of the bar; an elongate, curved socket at the posterior cardinal angle, open to interior. Marginal area: Inner lamella, wide at anterior, narrow elsewhere; large vestibule in lower anterior. Radial pore canals are numerous (22 to 26); long and sinuous above vestibule, short and nearly straight below vestibule; funnel-like internal openings and rarely two canals per opening. Selvage, at anterior is low and slightly removed from outer margin; ventrally, selvage is high, sharp, and deflected upward in front of mid-length; near outer margin at posterior. Muscle scars, four adductors and "J"-shaped frontal scar.

HOLOTYPE: HVH 9481, figured specimen, female left valve, length .41 mm, height .23 mm, width .18 mm.

PARATYPES: HVH 9482, figured specimen, male carapace, length .41 mm, height .21 mm, width .16 mm; HVH 9483, female LV, length .41 mm, height .24 mm; HVH 9484, female RV, length .40 mm, height .21 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°43.8'N, 95°05.4'W, station 103 of this study.

DIMENSIONS: Females, carapaces, length .39-.42 mm; height .23-.24 mm; width .17-.19 mm; males, carapaces, length .39-.41 mm; height .20-.21 mm; width .15-.16 mm.

MATERIAL: Adults, 32 carapaces, 26 valves; juveniles, one carapace.

REMARKS: *Basslerites cuspidatus* van den Bold, 1966a, is similar in some characters, but is larger, has less convex dorsal and ventral margins, and different hingement. Van den Bold (1966a) stated that the hinge and margins in *B. cuspidatus* are the same as the type species, *B. miocenicus* (Howe, 1935). Unlike *B. miocenicus,* the species described here has a distinct ridge that closes the anterior socket of the left valve. *B. minutus* van den Bold, 1958, has a small anterior vestibule, no groove above the anterior tooth in the left valve, and does not

PLATE 7

Figure Page

1. *Echinocythereis margaritifera* (Brady), HVH 9515, right valve (100X) 84
2. *Pterygocythereis miocenica* van den Bold, HVH 9521, left valve (100X) 85
3. *Henryhowella* ex. gr. *asperrima* (Reuss), HVH 9522, right valve (100X) 84
4. *Protocytheretta karlana* (Howe and Pyeatt), HVH 9523, right valve (100X) 86

5-6. *Protocytheretta montezuma* (Brady) *louisianensis* Kontrovitz, n. subsp. 88
   5. Holotype, HVH 9524, right valve (100X)
   6. Paratype, HVH 9525, carapace, left view (100X)

7. *Pterygocythereis americana* (Ulrich and Bassler), HVH 9528, left valve (100X) 85

8-9. *Cytherella vermilionensis* Kontrovitz, n. sp. 92
   8. Paratype, HVH 9530, carapace, ?male, left view (100X)
   9. Holotype, HVH 9529, carapace, ?female, left view (100X)

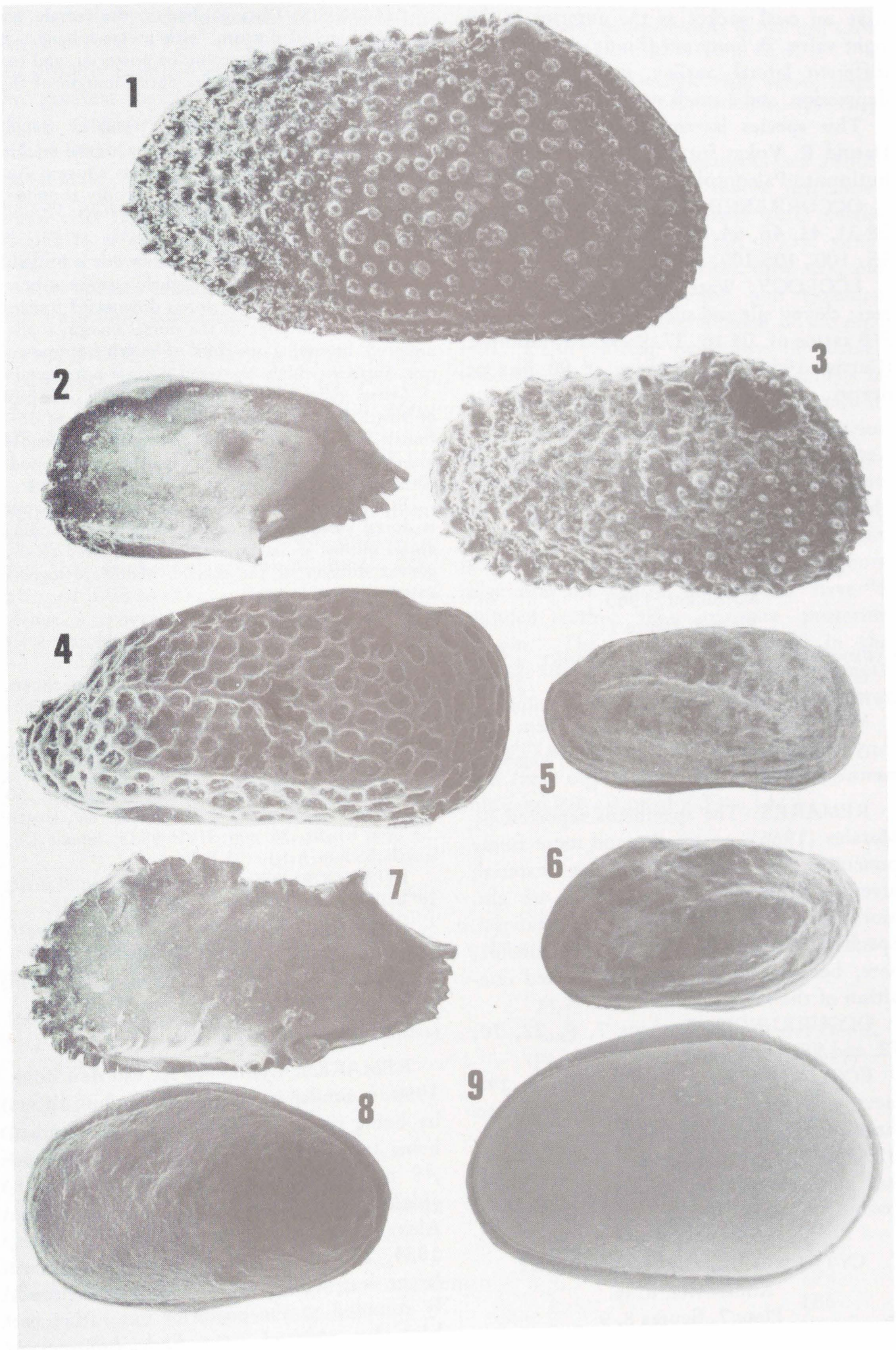


PLATE 7

have an oval socket at the anterior in the right valve. *B. berchoni* (Brady, 1870) has a different lateral outline, no posterolateral depression, and a small vestibule.

This species is named in honor of Dr. Harold E. Vokes for his outstanding contributions to Paleontology.

OCCURRENCE: Stations 4, 5, 9, 14, 25, 28-31, 41, 46, 64, 67, 73-75, 78, 82, 84, 94, 95, 100, 103-107, 109, 110, 113, and 114.

ECOLOGY: Water depths of 48 to 520 feet; clayey silt and silty clays; foraminiferal P/B ratios of .01 to .27. Previously reported (Curtis, 1960) as occurring at 90 feet or deeper.

Suborder PLATYCOPINA Sars, 1866
Family CYTHERELLIDAE Sars, 1866
Genus CYTHERELLA Jones, 1849

CYTHERELLA cf. C. HARPAGO
Kornicker, 1963
Plate 8, figure 1

Cytherella harpago KORNICKER, 1963, p. 67, text. figs. 30-32, 39-42.

Cytherella sp. aff. *C. harpago* Kornicker, MORALES, 1966, p. 20, pl. 1, figs. 2a-c.

DIMENSIONS: Right valve, ?female, length .75 mm; height .42 mm.

REMARKS: The specimens reported by Morales (1966) are smaller and more finely punctate than Kornicker's type material; juveniles from the present study are also more finely punctate than the type material. Specific identification was not possible, here, because of the poorly preserved condition of the valves.

OCCURRENCE: Stations 7, 9, 22, 70, 72, and 98.

ECOLOGY: Water depths of 99 to 148 feet; sediment varied from silty clays to sand-silt-clay; foraminiferal P/B ratios .01 to .13. Previous reports list depths of 1 to 16 feet and salinities that are brackish or marine.

CYTHERELLA VERMILIONENSIS
Kontrovitz, n. sp.
Plate 7, figures 8, 9

?*Cytherella* sp. VAN DEN BOLD, 1950, p. 80, pl. 18, figs. 1a-e.

DIAGNOSIS: Distinguished in the female, by its highly arched dorsum, with greatest height at mid-length, the broadly rounded posterior, and the distinct forward slope of the dorsal margin of the left valve only.

DESCRIPTION: Carapace, female, ovoid, heavily calcified, small. Lateral view, dorsal margin is highly arched; ventral margin less convex. Anterior and posterior margins are broadly rounded. Height about .7 times length. Right valve forms carapaces outline, greatest overlap is at anterodorsal and mid-ventral areas. Left valve is broadly rounded posteriorly, has a slightly convex venter, and a dorsal margin that slopes downward toward the anterior; the slope of the dorsal margin is pronounced, beginning one-third of length from posterior. Surface: widely scattered normal pore canals.

Dorsal view: Spatulate, greatest width one-third of length from posterior, slight concavity at one-fourth length from anterior. Posterior is broadly rounded, anterior compressed and acutely rounded.

Sexual dimorphism: Males are smaller, narrower in dorsal view; with a nearly straight and sloping dorsal outline in lateral view, as compared to the convex dorsum of the female. Males are highest anterior to mid-length.

Internal view: Hinge, right valve, a simple groove to receive edge of left valve. Muscle scars typical of genus, a feather-shaped cluster.

HOLOTYPE: HVH 9529, figured specimen, damaged female carapace, length .60 mm, height .43 mm.

PARATYPES: Figured specimen, HVH 9530, ?male carapace, length .60 mm, height .35 mm, width .25 mm; HVH 9531, female RV, length .60 mm, height .40 mm; HVH 9532, male LV, length .58 mm, height .36 mm; HVH 9533, female LV, length .55 mm, height .35 mm.

TYPE LOCALITY: Louisiana continental shelf, 28°30.0'N, 92°08.4'W, station 98 of this study.

DIMENSIONS: Carapaces, female, length .56-.60 mm; height .39-.43 mm; width .31-.33 mm; males, .52-.58 mm; height .35-.36 mm; width .24-.25 mm.

MATERIAL: Adults, 20 carapaces, 84 valves; juveniles, five carapaces, 14 valves.

REMARKS: *Cytherella* sp. van den Bold, 1950, is similar in lateral outline, but differs by being more tumid in dorsal view and in being larger (female, length .69 mm; height .49 mm; width .39 mm). *Cytherella turgidula* Alexander, 1934, *C. tuberculifera* Alexander, 1929, *C. tumidosa* Alexander, 1934, and *C. ovata* (Roemer, 1840), are larger, less highly arched, and are not broadly rounded at the posterior but rather are bluntly pointed. *C. fredricksburgensis* Alexander, 1932, is not broadly rounded at the posterior and in dorsal view the female is

not anteriorly compressed. *C. guasarensis* van den Bold, 1956, a Paleocene species, is not broadly rounded at the posterior and has the greatest height in front of the mid-length. *C. polita* Brady, 1869, is less highly arched and the left valve does not slope as in the female of the species described here. Benson and Coleman, 1963, described *C. grossmani* with the juveniles appearing similar to the males in this new species.

This species is named for its occurrence near Vermilion Bay, Louisiana.

OCCURRENCE: Stations 4, 6, 9, 28, 43-45, 48, 50, 55, 59-61, 63, 64, 70, 71, 74-76, 78, 81-83, 98, 101, 103, 104, 106, 107, 109, 111, 117, and 118.

ECOLOGY: Water depths of 54 to 294 feet, with 95% of the valves recovered from 54 to 150 feet; sediments varied, from silty clay to sand-silt-clay; foraminiferal P/B ratios of .005 to .17.

Genus CYTHERELLOIDEA
Alexander, 1929

CYTHERELLOIDEA aff.
C. CASTLEBERRYENSIS
Howe and Law, 1936
Plate 8, figure 2

?*Cytherelloidea castleberryensis* HOWE and LAW, 1936, p. 20, pl. 1, fig. 18; pl. 2, fig. 4.

DIMENSIONS: Females, right valves, length .70-.71 mm; height .39-.40 mm; male, right valve, length .65 mm; height .36 mm.

REMARKS: These specimens lack a short longitudinal rib near the venter, just above the concavity, that is present on *C. castleberryensis* Howe and Law, 1935; other aspects of the ornamentation, valve size, and shape are similar. Benson and Coleman (1963) collected *Cytherelloidea* cf. *C. sarsi* Puri, 1960, noting variability in surface reticulations and ribbing. The specimens in the present study display variability only in the reticulations just behind the anterior rim; the areas between the ribs are never reticulate as is *C. sarsi*. Benson and Coleman noted similarities between their *Cytherelloidea* cf. *C. sarsi* and *C. castelberryensis*, but stated that their specimens lack "a short ridge near the ventral margin and" have "a rounded rather than truncate posterior margin." The specimens reported in the present study are poorly preserved and more must be obtained if specific identification is to be made.

OCCURRENCE: Water depths of 120 to 198 feet; clayey silts and silty clays; foraminiferal P/B ratios of .03 to .13.

The species listed below are represented by only a few specimens and are illustrated on the plates indicated for future comparisons.

Species	Plate and Figure	Water Depth (In feet)
Candona cf. *C. marchina* Hartwig	1, 8	40
Candona cf. *C. patzcuaro* Tressler	1, 5	50
Psuedocythere aff. *P. fragilis* Sars	2, 2	108-192
Cyprideis cf. *C. salebrosa* van den Bold	2, 1	14-60
Haplocythereidea cf. *H. bradyi* (Stephenson)	2, 3	204
Perissocytheridea excavata Swain	2, 4	54-102
Perissocytheridea rugata Swain	8, 5	54-88
Hemicytherura cf. *H. sablensis* Benson & Coleman	4, 4	192
Megacythere cf. *M. johnsoni* (Mincher)	8, 6	186
Megacythere cf. *M. stephensoni* (Puri)	8, 7	42-132
Neomonoceratina mediterranea (Ruggieri)	8, 4	54
Eucythere sp.	8, 3	132-135

VIII. STATION LOCATIONS

Station	Latitude North	Longitude West	Water Depth in Feet	Sediment Texture
1	29°32.4'	88°31.8'	144	sand-silt-clay
2	30°12.0'	88°32.4'	150	sand-silt-clay
3	29°29.0'	88°31.8'	174	sand-silt-clay
4	29°27.0'	88°40.2'	132	sand-silt-clay
5	29°19.8'	88°42.0'	186	sand-silt-clay
6	29°16.8'	88°55.2'	120	sand-silt-clay
7	29°15.0'	88°53.4'	192	sand-silt-clay
8	29°14.4'	88°57.6'	720	sand-silt-clay
9	29°13.2'	88°56.4'	108	sand-silt-clay
10	29°03.6'	88°54.6'	282	silty clay
11	29°03.0'	88°59.4'	174	silty clay
12	29°00.0'	88°58.2'	194	silty clay
13	28°52.8'	89°02.4'	630	silty clay
14	28°52.8'	89°12.6'	420	silty clay
15	28°50.4'	89°00.1'	768	silty clay
16	28°50.4'	89°02.4'	660	silty clay
17	28°48.6'	89°06.6'	788	silty clay
18	28°50.4'	89°09.6'	510	silty clay
19	28°48.0'	89°11.4'	600	silty clay
20	28°50.4'	89°10.2'	420	silty clay
21	28°51.6'	89°11.4'	360	silty clay
22	28°54.6'	89°10.8'	198	silty clay
23	28°57.0'	88°13.2'	90	silty clay
24	28°51.6'	89°14.4'	306	silty clay
25	28°57.0'	89°15.6'	108	silty clay
26	28°55.2'	89°16.8'	168	silty clay
27	28°54.0'	89°16.8'	192	silty clay
28	28°48.0'	89°21.8'	300	silty clay
29	28°45.0'	89°33.6'	306	silty clay
30	28°48.0'	89°36.0'	270	silty clay
31	28°49.2'	89°33.6'	264	silty clay
32	28°38.6'	89°28.6'	240	slty-cly; cly-slt
33	28°51.6'	89°28.0'	200	clayey silt
34	28°52.4'	89°27.2'	115	clayey silt
35	28°53.0'	89°26.7'	85	clayey silt
36	28°53.6'	89°26.3'	40	clayey silt
37	28°59.0'	89°32.4'	100	sand-silt-clay
38	29°05.9'	89°36.1'	55	sandy silt
39	28°57.9'	89°37.9'	165	sand-silt-clay
40	28°59.2'	89°43.6'	130	silt, clayey silt
41	28°57.5'	89°50.2'	118	clay, clayey silt
42	28°53.9'	90°03.4'	90	clayey silt
43	28°46.9'	90°06.8'	145	silty clay
44	28°49.2'	90°10.2'	90	clayey silt
45	28°43.2'	90°15.1'	115	clayey silt
46	28°49.2'	90°14.4'	78	clayey silt
47	28°58.4'	90°14.7'	45	?silty clay
48	28°52.2'	90°16.8'	68	clayey silt
49	28°39.0'	90°21.5'	115	clayey silt
50	28°33.0'	91°48.6'	66	sand
51	28°52.2'	90°27.0'	60	clayey silt
52	28°58.8'	90°27.5'	25	silty clay
53	28°48.6'	90°31.8'	60	sand
54	28°42.0'	90°33.0'	54	sand
55	29°33.9'	90°34.2'	107	clayey silt
56	28°49.0'	90°36.6'	60	sand
57	28°48.0'	90°43.2'	60	sand
58	28°42.0'	90°39.6'	54	sand

Station	Latitude North	Longitude West	Water Depth in Feet	Sediment Texture
59	28°34.2'	90°47.4'	72	clayey silt
60	28°28.2'	90°45.6'	114	clayey silt
61	28°30.2'	90°51.5'	108	clayey silt
62	28°28.2'	90°57.0'	108	clayey silt
63	28°28.8'	91°03.0'	108	clayey silt
64	28°36.0'	90°57.0'	69	clayey silt
65	28°41.4'	91°01.8'	42	sand
66	28°32.1'	90°17.5'	103	sand
67	28°33.9'	91°44.1'	100	sand
68	28°28.8'	91°53.4'	162	sand
69	28°94.4'	91°55.2'	156	sand
70	28°33.0'	91°48.6'	138	sand
71	28°36.6'	91°48.6'	126	clayey silt
72	28°40.2'	91°43.8'	99	clayey silt
73	28°42.0'	91°41.4'	90	clayey silt
74	28°45.6'	91°43.8'	84	clayey silt
75	28°45.6'	91°43.8'	84	clayey silt
76	28°48.6'	91°45.6'	72	clayey silt
77	28°54.0'	91°39.6'	60	clayey silt
78	28°54.0'	91°31.6'	54	clayey silt
79	28°59.4'	91°41.4'	42	clayey silt
80	28°58.8'	91°43.0'	48	clayey silt
81	28°48.0'	91°47.4'	88	clayey silt
82	28°48.0'	91°47.4'	88	clayey silt
83	28°45.0'	91°52.2'	90	clayey silt
84	28°41.4'	91°53.4'	102	clayey silt
85	28°39.4'	91°55.7'	95	clayey silt
86	28°24.6'	92°01.2'	180	silty clay
87	28°26.4'	92°03.0'	174	silty clay
88	28°25.2'	92°05.4'	180	silty clay
89	28°23.4'	92°07.2'	186	silty clay
90	28°20.4'	92°13.2'	198	silty clay
91	28°20.4'	92°17.4'	198	silty clay
92	28°19.2'	92°23.4'	204	silty clay
93	28°21.6'	92°18.6'	192	silty clay
94	28°22.8'	92°18.6'	186	silty clay
95	28°25.8'	92°18.6'	180	silty clay
96	28°28.8'	92°13.2'	168	clayey silt
97	28°29.4'	92°08.4'	156	clayey silt
98	28°33.0'	92°08.4'	138	clayey silt
99	28°38.4'	92°07.2'	132	clayey silt
100	28°39.6'	92°01.2'	120	clayey silt
101	28°40.8'	92°05.4'	120	clayey silt
102	28°43.2'	92°07.2'	114	clayey silt
103	28°43.8'	92°05.4'	108	clayey silt
104	28°43.8'	91°59.4'	105	clayey silt
105	28°43.2'	91°56.8'	102	clayey silt
106	28°42.6'	91°56.4'	102	clayey silt
107	28°48.6'	91°53.4'	102	clayey silt
108	28°48.6'	91°57.0'	84	clayey silt
109	28°51.0'	91°58.2'	78	clayey silt
110	28°52.2'	92°02.4'	84	clayey silt
111	28°57.0'	92°19.8'	84	clayey silt
112	29°07.8'	92°15.0'	42	clayey silt
113	29°01.2'	92°11.4'	66	clayey silt
114	29°04.8'	92°07.2'	48	clayey silt
115	29°02.4'	92°05.4'	54	clayey silt
116	29°02.8'	92°03.6'	54	clayey silt
117	28°54.0'	91°53.4'	66	clayey silt
118	28°57.0'	91°51.0'	60	clayey silt

Station	Latitude North	Longitude West	Water Depth in Feet	Sediment Texture
119	29°00.0'	91°48.0'	60	clayey silt
120	29°06.0'	91°42.0'	14	sand
121	29°07.9'	91°27.6'	20	sand-silt-clay
122	29°17.8'	91°26.9'	15	silty clay
123	29°35.0'	91°14.1'	40	no data

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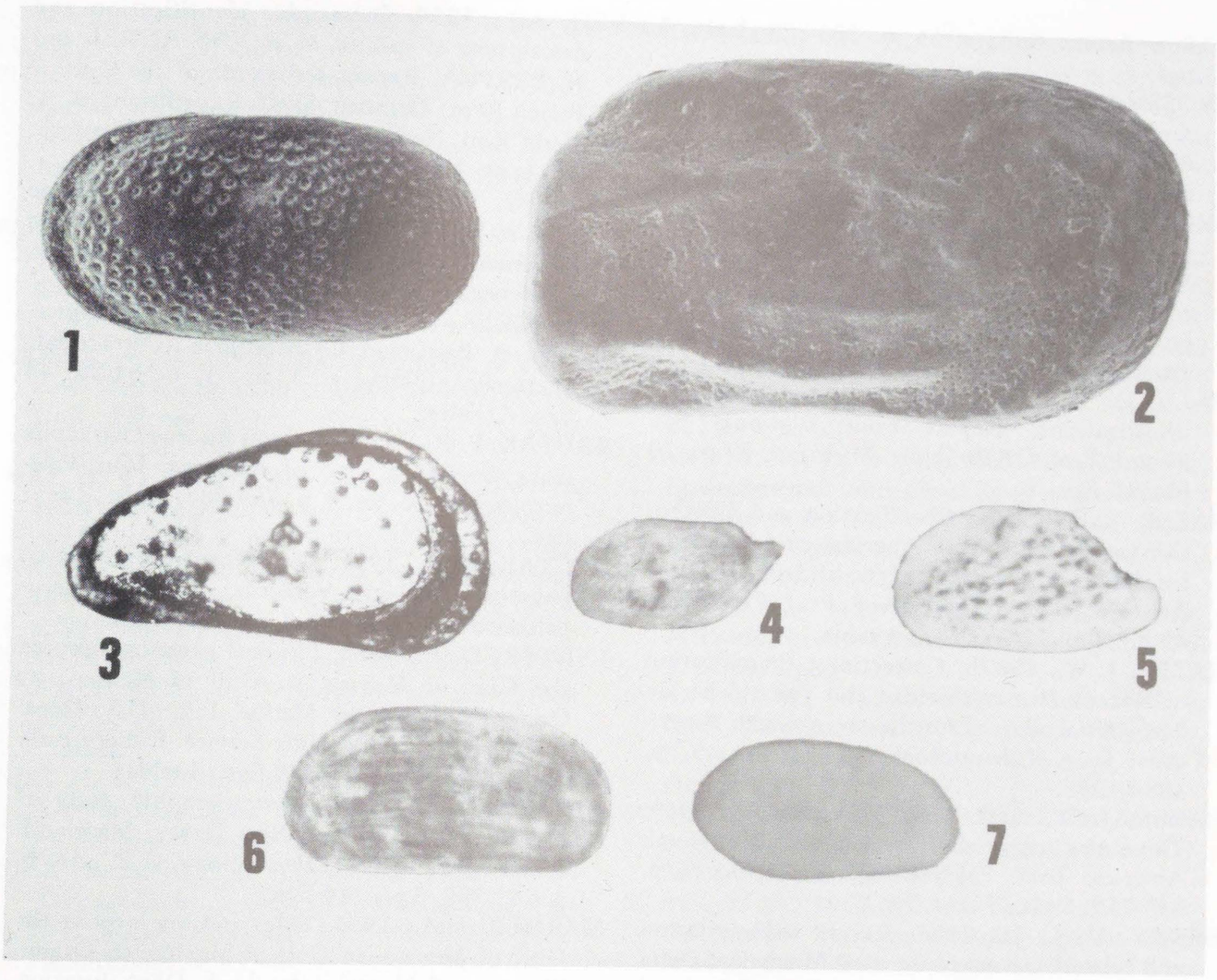

PLATE 8

Figure

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REVIEWS

STATISTICAL METHODS FOR THE EARTH SCIENTIST, An Introduction, by Roger Till. Published by John Wiley & Sons, New York and Toronto, 1974, xii + 154 pp., $11.75

This is a textbook on the application of statistics to the earth sciences. It is intended as a short and simplified approach to this subject. It is applicable not only to the study of rocks and fossils, but to the processes of weathering and sedimentation, the description of landforms, and the measurement of engineering properties of rocks and soils. It can be used with a simple algebra background and all calculations can be made with a small calculator; this is most desirable and makes the book more generally useful.

A TEXTBOOK ON GEONOMY, by J. A. Jacobs. Published by John Wiley & Sons, New York, 1975, ix + 328 pp., $19.75

Curiously, the author has obscured the nature of his book by choosing an unfamiliar term to characterize his subject matter. Surely, the content of the volume is more significant and its utilization more important than the desire of the author to revive another forgotten (and best left at rest) synonym for a subdivision of the earth sciences. Many potential readers will never open the cover of this volume and learn that it is concerned with the Physics of the Earth.

Recent developments in geophysics and the planetary sciences make it most necessary to revise our views of the physics and chemistry of the earth and its place in the solar system. This book is an attempt to present an updated review of these subjects and to present a modern approach to the broader questions of the origin of the earth, its moon, and the solar system itself. Regrettably, any book on a rapidly developing and dynamic discipline will be out-of-date before publication; this one was in press more than two years. However, it does present a fresh and useful approach to this subject. It will prove useful to those who find their way past the title.

THE MECHANICS OF FROZEN GROUND, by N. A. Tsytovich. Published by McGraw-Hill Book Company, New York, 1975, xix + 426 pp., $34.50

This is a translation of the Russian edition (Moscow, 1973) of a work based on many years of work by many investigators on permafrost in Siberia and the construction problems related to frozen ground. Written by a leading pioneer in this field, the book was translated by George K. Swinzow, one of the leading students of frozen ground mechanics in the United States. The subjects of constructing foundations and dams, as well as highway construction on permafrost are treated, and solutions to these engineering problems are suggested.

—H.C.S.