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RECENT MARINE PODOCOPID OSTRACODA OF NARRAGANSETT BAY, RHODE ISLAND

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ABSTRACT

Forty-six Petterson dredge samples from Narragansett Bay, Rhode Island, have been examined for marine podocopid ostracode specimens. Estimated data on salinity, temperature, depth, and bottom sediment compiled from earlier published reports have no conclusive relationships with faunal distribution because of the possibility that they are not representative of the collecting period.

Twenty-one species of ostracodes are identified and illustrated, including a new species of *Loxoconcha* and *Cytheromorpha warneri* represented by a new subspecies. Three species —*Loxoconcha granulata, L. sperata,* and *Actinocythereis gomillionensis*—account for approximately 85 percent of the specimens collected. The remainder include five type species of well-known genera: *Sclerochilus contortus, Loxoconcha rhomboidea, Eucythere declivis, Cushmanidea seminuda,* and *Puriana rugipunctata.* Also identified are specimens of *Propontocypris edwardsi, Hemicythere emarginata, Aurila amygdala, Semicytherura similis, Cytheropteron pyramidale, Haplocytheridea setipunctata, Cushmanidea echolsae, Hulingsina americana, Cytheretta edwardsi, Triginglymus arenicola, Murrayina micula,* and *M. canadensis.*

The presence in Narragansett Bay of five species previously reported from North Caroline and three from Maine suggest a mixed marine fauna with representatives of both semitropical warm-water and arctic cold-water assemblages.

INTRODUCTION

The present study was conducted primarily to identify representatives of the ostracode fauna in Narragansett Bay (Fig. 1), and secondarily to determine their ecologic relationships, if possible. Through an arrangement with the Narragansett Marine Laboratory, University of Rhode Island, I conducted three collecting cruises aboard the charter vessel *Billie* (Fig. 2) on June 23, July 7, and July 21, 1960. Collecting localities were preselected to consist of stations located on a grid of 600-yard intervals. Sediment samples were obtained by means of a grab sampler (Petterson dredge) (Figs. 3, 4). After the grid sampling pattern had been followed for a portion of the first cruise, economic and other demands upon the vessel dictated that this method of station selection be changed to reduce the number of stations. For the remainder of the cruise and for remaining two cruises, a system of sampling was selected that provided a series of short transits across places where bottom sediments changed, using a general sediment distribution chart to locate the stations. The stations were accurately occupied through the use of triangulation acompanied by correlation of

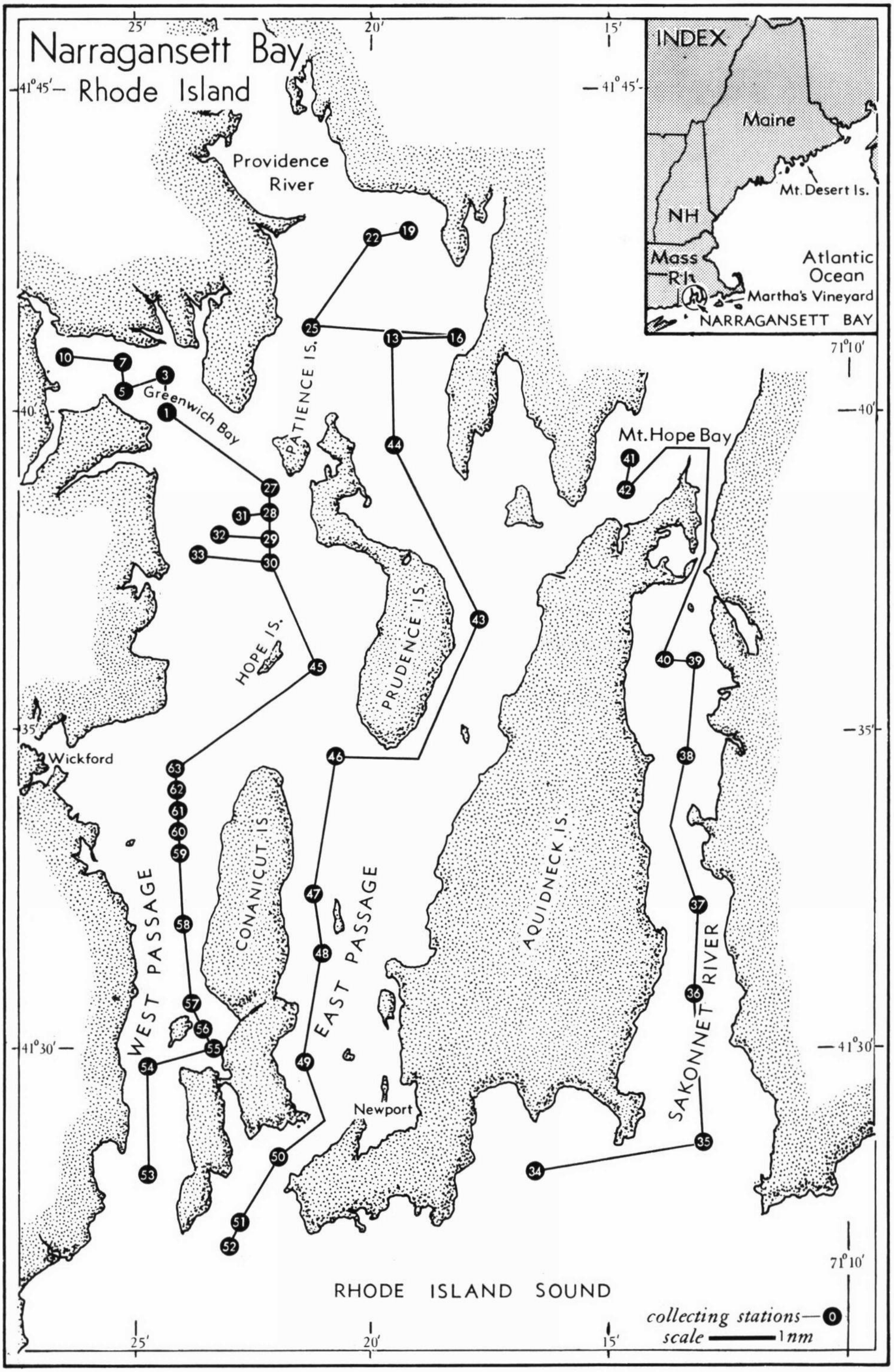

Fig. 1. Map of study area showing collecting stations.

fathometer readings with USC & GS Chart No. 353 of Narragansett Bay (revised January 25, 1960). A total of 63 stations were occupied, stations 1 to 26 on the first cruise, stations 27 to 45 on the second, and stations 46 to 63 on the third. Forty-seven of these samples were studied, using alternate samples from the earlier and denser grid sampling system for greater consistency with later sampling density (Fig. 1).

No provision was made to collect other information at the stations at time of sampling, and information as to salinity, temperature, depth, and substrate was derived from earlier published reports. Proper analyses of bottom sediment, as they relate to distribution of the living ostracode fauna, must necessarily include only the uppermost few millimeters of bottom sediment. I now believe the grab sampler to be unsuitable because it digs too deeply and because the apparatus leaks water and fine sediment as soon as lifted above the water surface and before it is opened on the deck.

A proper ecologic study includes only living organisms and data accumulated at the time of sampling. The remains of dead organisms and data interpreted for ecologic studies from reports compiled for other purposes can at best only give indications of ecologic relationships. The samples, while providing constant measured and similarly obtained material, also introduce a number of factors not desirable for an ecologic study, but remain entirely satisfactory for purposes of faunal identification and description. One such factor is the possibility of collecting nonindigenous dead ostracodes, especially in shallow marine areas where transportation and sorting of sediment commonly occurs. Sampling methods that include sediment other than the uppermost surface and that do not provide for identification of living organisms are suspected of not yielding accurate faunal distribution information.

For the reasons cited, studies of the ostracode fauna are limited in this report to the identification, description, and illustration of the fauna in Narragansett Bay. New data, obtained simultaneously, should be aimed at determining properly the existing ecologic controls over the present ostracode population in the Bay.

The lack of ecologic findings does not impair the usefulness of this report. The number of podocopid ostracode species present, at least four more than found by CUSHMAN in 1906 in the Martha's Vineyard vicinity, and twice as many as found by TRESSLER & SMITH (1948) in the Chesapeake Bay area, indicates that although the conditions in Narragansett Bay are not directly comparable, the area is conducive to the growth of a varied ostracode fauna. It is of interest to note the extended distribution of some ostracode species. The descriptions of species which follow serve to clear some of the tangles associated with poorly described and imperfectly known species of earlier workers, and the detailed illustrations of previously reported but poorly figured species will contribute to the understanding of the relationships of these to closely related species.

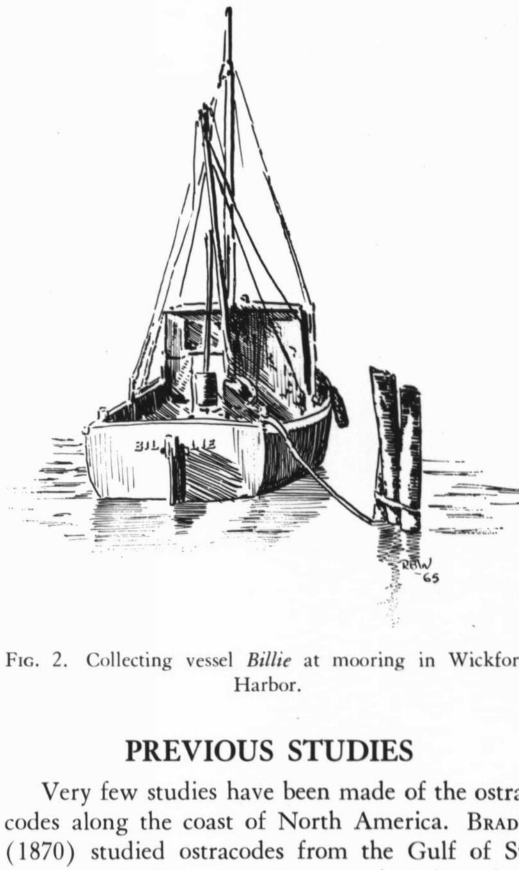

FIG. 2. Collecting vessel *Billie* at mooring in Wickford Harbor.

PREVIOUS STUDIES

Very few studies have been made of the ostracodes along the coast of North America. BRADY (1870) studied ostracodes from the Gulf of St. Lawrence, and BRADY & CROSSKEY (1871) studied ostracodes from the post-Tertiary deposits of Canada and New England. CUSHMAN (1906) reported on the ostracodes of Vineyard Sound, Massachusetts, and BLAKE (1929, 1933) made studies of ostracodes in the Mt. Desert Island region of Maine. WILLIAMS (1907) reported two ostracode species from Wickford, Rhode Island, TRESSLER & SMITH (1948) studied ostracode ecology in the Solomon's Island area of Chesapeake Bay, and GROSSMAN (1961) reported upon ostracode ecology in the Pamlico Sound area of North Carolina.

Information on the physical aspects of Narragansett Bay has been published by MCMASTER (1960) who reported upon the sediment distribution, and by HICKS (1959, 1963) who reported on the physical oceanography.

DESCRIPTION OF STUDY AREA

Narragansett Bay is located in the State of Rhode Island on the southern shore of New England, and opens to the south onto Rhode Island Sound at approximately Lat. 41°25′N, Long. 71°20′W (Fig. 1). The bay system is generally divided longitudinally into three "passages": the West Passage, East Passage, and Sakonnet River. The West Passage extends from Rhode Island Sound northward to East Greenwich Bay, and is divided from the East Passage by Conanicut, Prudence, and Patience Islands. The East Passage is the central axis of the bay system, and is the major shipping lane, connecting with the Providence River to the north. The Sakonnet River, easternmost member of the bay system, is divided from the East Passage by Acquidneck Island. It is open to the sea on the south, and connects with Mt. Hope Bay at the north through a narrows. Mt. Hope Bay discharges primarily into the East Passage. The bay is approximately 15 miles long and 10 miles wide at parallel 41° 35′N, and has an area of 94.5 sq. mi. at mean low water. The bay is relatively shallow, with a mean depth of 29 feet, the deepest portion being at the southern end of the East Passage, where depths to 188 feet are recorded (HICKS, 1959).

General data on temperature and salinity are obtained from HICKS (1959). The general bottom salinity range for the area is 31.0 to 32.0 ‰; and during the collecting period ranged from about 29.5 ‰ in the upper reaches to about 32.5 ‰ at the southernmost limits. Table 1 gives estimated salinity measurements for most stations as interpreted from HICKS (1959, p. 325, fig. 9, line 18). Areas of maximum salinity (more than 31 ‰) prevail on the bottom in the southern one-third of the West Passage, southern three-fifths of the East Passage-Providence River channel, and the southern one-half of the Sakonnet River.

In my opinion the salinity range encountered within the bay is not large enough to affect the faunal distribution, although brackish conditions at the mouths of some of the major streams would doubtless have some limited local effects. The sampling pattern did not permit the detection of such local effects, except possibly in the Greenwich Bay area (stations 1, 3, 5, 7, 10) where the numbers of specimens collected dropped to zero.

The general bottom temperature range for the area is 22.0 to 15.5° C, and for the collecting period probably ranged from about 52° F at the southern end of the bay to about 67° F at the northern limit of the East Passage and to about 68° F at Mt. Hope Bay (interpreted from HICKS, 1959).

Dissolved oxygen and total phosphorus information are presented by HICKS (1963) for longitudinal sections connecting stations occupied in 1957. Unfortunately, very few of these stations coincided with those occupied by me in this study, and as a result, oxygen and phosphorus data are not included in this report. The general dissolved oxygen range for the area is 3.0 to 4.5 ml./l., and the total phosphorus range is 4.4 to 1.4 ug. at./l.

The bottom sediment is predominantly clayey silt and sand-silt-clay, with sand dominant in some areas *(50)*[1].

HICKS (written communication, 1964) has informed me that in his opinion his data should generally typify the conditions prevailing during the collecting period here under consideration, but the remote possibility exists that extreme conditions in fact existed at the time that either his or my studies were in progress.

SAMPLING PROCEDURE AND LABORATORY METHODS

All samples used in this report were obtained by means of a Petterson dredge (Figs. 3, 4), which was opened on the deck for taking 200 ml. from the uppermost portion of its contents. The most recent sediment was commonly easily detected by its light color. In some samples, however, it was a fine black mud, commonly with a high content of amphipod tubes, algal growth, and mollusks, among which the gastropod *Crepidula fornicata* was most common *(85)*. A dilute formaldehyde

[1] Italicized numbers refer to corresponding numbers in the list of literature references.

TABLE 1. *Sampling Stations, with Location, Depth, Estimated Temperature and Salinity, and Substrate.*

Station#	N.Lat.	E.Long.	Depth (ft)	Temp.(°F)	Salinity(‰)	Bottom Sediment
1	41°39'58"	71°24'08"	4	62	30-	sand
3	41°40'32"	71°24'08"	10	62	30-	sand
5	41°40'13"	71°25'10"	6	62	30-	silty sand
7	41°40'42"	71°25'10"	12	62	30-	sand-silt-clay
10	41°40'53"	71°26'17"	10	62	30-	clayey silt
13	41°41'06"	71°19'13"	19	67	29.6	silty sand
16	41°41'17"	71°18'06"	18	67	30-	gravel-sand-silt
19	41°42'56"	71°18'57"	15	67	30-	sand
22	41°42'48"	71°19'40"	16	67	29.8	sand
25	41°41'23"	71°21'08"	18	67	30-	silty sand
27	41°38'52"	71°22'05"	17	60	29.8	sand
28	41°38'23"	71°22'05"	15	58	30.0	sand
29	41°37'52"	71°22'05"	20	58	30.3	silty sand
30	41°37'27"	71°22'05"	19	57	30.3	clayey silt
31	41°38'15"	71°22'41"	18	58	30.1	silty sand
32	41°37'53"	71°23'03"	23	58	30.3	sand-silt-clay
33	41°37'44"	71°23'23"	22	57	30.4	silty sand
34	41°27'53"	71°16'27"	59	52	32+	sand
35	41°28'16"	71°13'03"	55	58	31.6	sand
36	41°30'47"	71°13'11"	24	61	31.2	sand
37	41°32'10"	71°13'02"	26	64	31.0	clayey silt
38	41°34'33"	71°13'20"	40	66	30.5	clayey silt
39	41°36'13"	71°13'07"	17	68	30.0	clayey silt
40	41°36'14"	71°13'46"	7	68	30.0	sand-silt-clay
41	41°39'21"	71°14'32"	50	65	29.4	clayey silt
42	41°38'52"	71°14'35"	27	67	29.5	sand-silt-clay
43	41°36'38"	71°17'48"	76	55	31.5	sand-silt-clay
44	41°39'28"	71°19'27"	22	64	30.0	clayey silt
45	41°35'53"	71°21'03"	27	55	29.4	clayey silt
46	41°34'30"	71°20'42"	29	55	32.0	clayey silt
47	41°32'25"	71°21'14"	63	54	32.0	sandy silt
48	41°31'19"	71°21'03"	75	54	32.1	silty sand
49	41°29'37"	71°21'22"	102	54	32.4	silty sand
50	41°28'02"	71°21'58"	126	53	32.5	sand
51	41°27'08"	71°22'42"	115	53	32.6	sand
52	41°26'47"	71°22'58"	100	52	32.6	silty sand
53	41°27'46"	71°24'38"	47	52	32.2	silty sand
54	41°29'33"	71°24'47"	45	53	31.5	sand-silt-clay
55	41°29'57"	71°23'19"	15	55	31+	silty sand
56	41°30'12"	71°23'32"	24	54	31+	sand-silt-clay
57	41°30'36"	71°23'52"	22	55	31.0	gravelly sand
58	41°31'51"	71°23'48"	43	58	30.8	silty sand
59	41°32'52"	71°23'56"	30	59	30.3	silty sand
60	41°33'13"	71°23'54"	31	58	30.0	sandy silt
61	41°33'37"	71°23'57"	31	58	29.8	sand-silt-clay
62	41°33'50"	71°23'57"	29	58	29.6	clayey silt
63	41°34'09"	71°23'58"	24	58	29.4	clayey silt

solution was added to the sample upon reaching the laboratory.

The samples were washed through 20-, 40-, and 60-mesh screens, spread onto newspaper and permitted to dry slowly on racks. The ostracodes were then hand-picked from the three fractions. Accelerated drying was attempted and abandoned because the large quantity of algae and amphipod tubes caused the samples to harden into unworkable masses which required resoaking.

The drawings of the interiors and some exteriors of specimens were prepared by projecting the images with transmitted light through a monocular microscope onto albanene drawing paper as developed by BENSON. This method permitted the accurate outlining of the carapace and location of desired features, and was used for some of the half-tone exterior drawings, but the majority of these were done by use of camera lucida. Staining with silver nitrate made it possible to see many finer details. The line drawings were sketched in light blue pencil, then inked using Koh-i-noor Rapidograph points 00, 0, 1, and 2. The completed line drawings were then reduced to final size on a Standard (Master Making) Xerox with a No. 4 camera onto albanene. Gray areas and extraneous lines were removed from the albanene by wiping with trichloroethane. The tables were reduced

FIG. 3. Petterson dredge in closed position; note drainage.

FIG. 4. Sampling equipment, including 200 ml. sample bottles in box and Petterson dredge in open position.

similarly. The drawings of exteriors were executed in charcoal, using paper stomps and a kneaded eraser for desired textural effects, highlights, and corrections. These drawings were then photographed and reduced to a desirable size for plate composition, mounted together, and rephotographed. Minor retouching was done prior to final rephotographing. All labels, both on the plates and tables, were typewritten on an IBM Executive electric typewriter.

All illustrated specimens (hypotypes) and type specimens (holotypes) are catalogued and deposited in the University of Kansas Museum of Invertebrate Paleontology, herein abbreviated as UKMIP, and bear catalogue numbers 1000501 to 1000526, for convenience and brevity (M=1000) written as M501 to M526.

FAUNAL DISCUSSION

Twenty-one species of ostracodes are identified and figured in this paper, of which one is a new species and one is a new subspecies. Attempts to determine relationships between species distribution and available ecologic data are inconclusive because of three major factors: (1) inadequate collecting station location density; (2) lack of environmental data obtained at time of sampling; and (3), loss of portions of the sample attributable to leakage of the sampling apparatus. It may be that the third factor probably explains the lack or paucity of microfauna found at some localities,

TABLE 2. *Faunal Distribution in Percent for Sakonnet River-Mt. Hope Bay.*

LEGEND: Tables 2,3,4,&5

D......

R.......

A. Propontocypris edwardsi

B. Sclerochilus contortus

C. Loxoconcha rhomboidea

D. L. granulata

E. L. sperata

F. Cytheromorpha warneri newportensis

G. Hemicythere emarginata

H. Aurila amygdala

I. Semicytherura similis

J. Cytheropteron pyramidale

K. Haplocytheridea setipunctata

L. Eucythere declivis

M. Cushmanidea seminuda

N. C. echolsae

O. Hulingsina americana

P. Cytheretta edwardsi

Q. Triginglymus arenicola

R. Actinocythereis gomillionensis

S. Murrayina micula

T. M. canadensis

U. Puriana rugipunctata

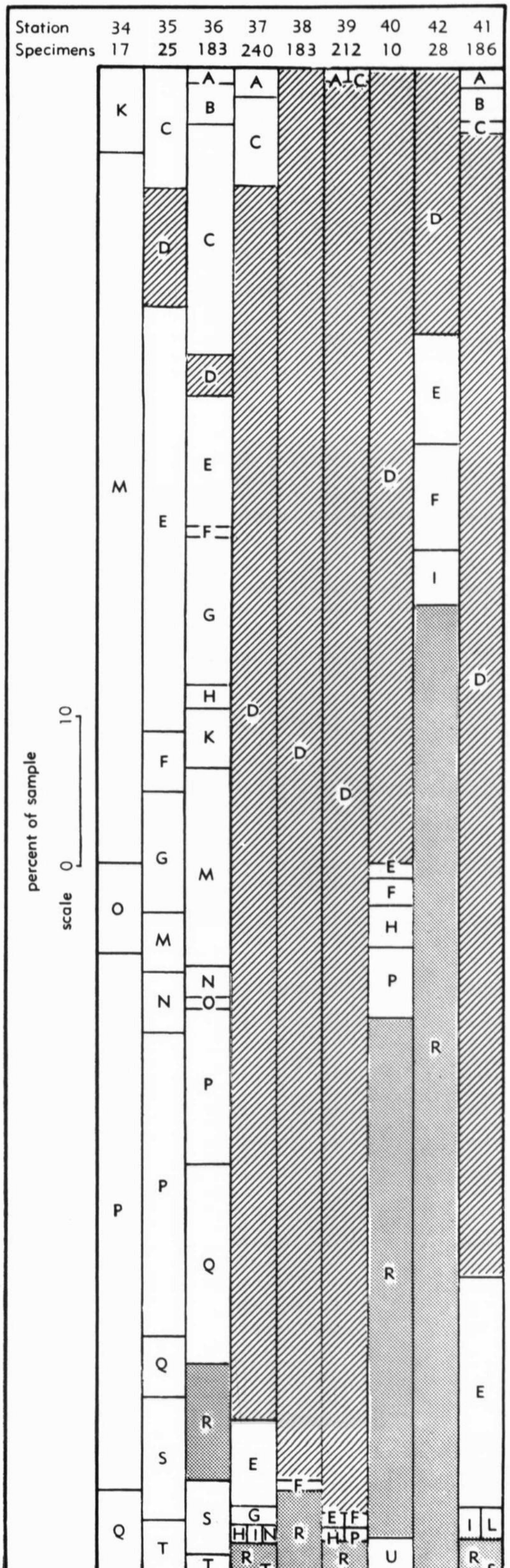

TABLE 3. *Faunal Distribution in Percent for East Passage.*

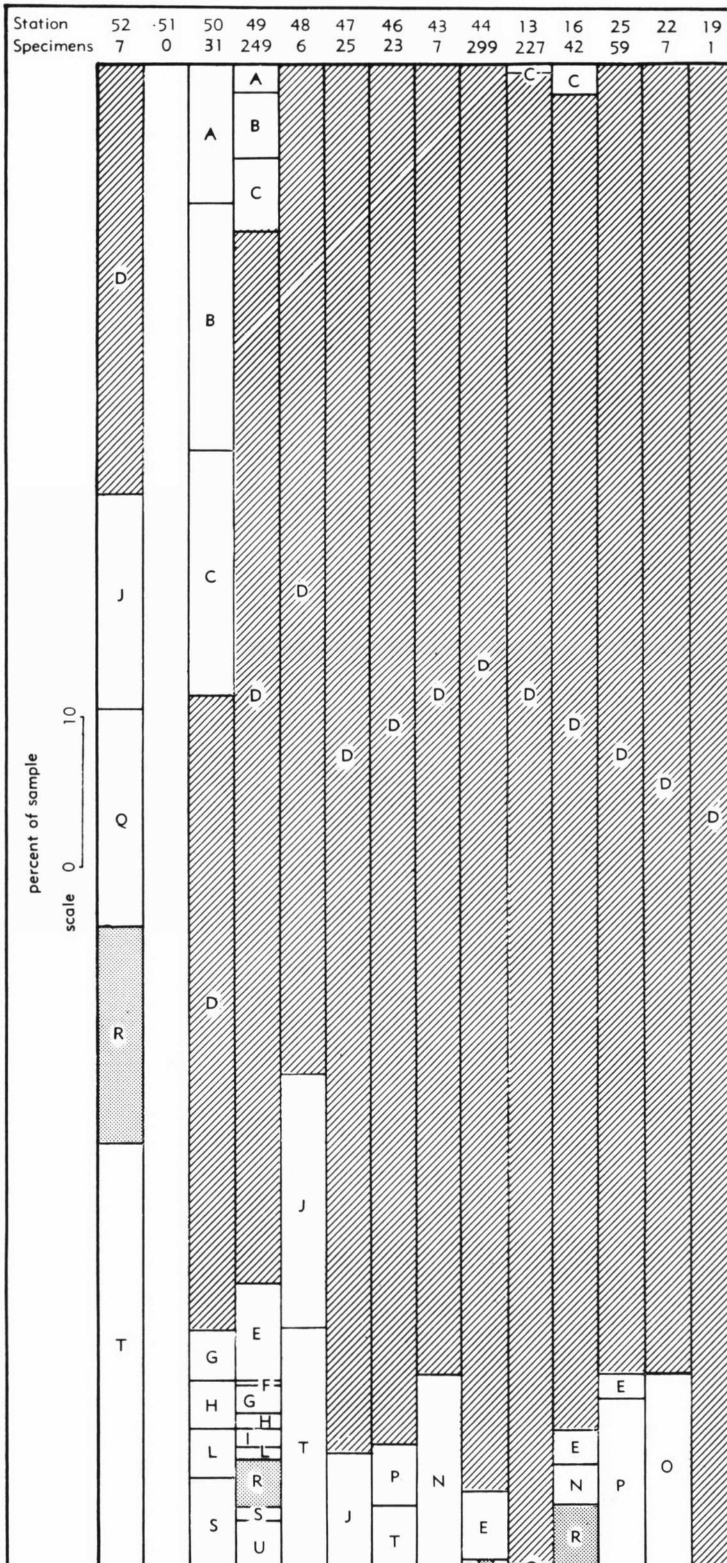

TABLE 4. *Faunal Distribution in Percent for West Passage-East Greenwich Bay.*

notably at stations 51 and 53 were one would expect at least an average number of specimens.

Some general observations can be made concerning the fauna. Inspection of the percent of population tables (Tables 2, 3, 4) and the general distribution table (Table 5) reveals that the greatest variety of species is toward the southern reaches of the bay where more open marine conditions prevail, whereas in the northern reaches less variation in the fauna is encountered. At some of the northernmost stations contents of the samples were rather large in terms of specimen count but very low in number of species, some containing *Loxoconcha granulata* exclusively or nearly exclusively. *Actinocythereis gomillionensis*, another abundant species and collected at 21 of 47 stations, appears to inhabit the Sakonnet River and West Passage primarily, and is slightly displaced from open marine conditions. *Cushmanidea seminuda, Hemicythere emarginata, Trigingiymus arenicola*, and possibly *Cytheropteron pyramidale and Murrayina micula* were among species found only in open or nearly open marine waters. *C. seminuda* is the only species apparently restricted to a single sediment size (sand).

The geographic ranges of some of the previously reported species are herein extended. Species previously reported from Pamlico Sound which are now reported from Narragansett Bay are *Aurila amygdala, Cushmanidea echolsae, Haplocytheridea setipunctata,* and *Puriana rugipunctata.* Species with geographic ranges extended southward are *Cytheropteron pyramidale, Eucythere declivis,* and *Sclerochilus contortus*, all previously reported from the Mt. Desert Island region of Maine. Most of the remaining previously reported species are common to the eastern coast of North America. Thus it appears that Narragansett Bay specifically, and waters south of Cape Cod in general, are characterized by a mixed ostracode fauna containing representatives of both arctic cold-water and semitropical warm-water faunas.

Six species present in the samples from Narragansett Bay but insufficient in quantity to be treated properly in this study are: *Sahnia fasciata* (Brady & Robertson)?, *Cushmanidea elongata* (Brady)?; *Cytherura?* sp.; *Eucythere?* sp.; *Limnocythere?* sp.; and a progonocythereid of uncertain affinities. Also present, but not treated in this study because mature specimens are lacking, is a series of instars of the "archicythereid" or immature cytheracean category that belong to *Pterygocythereis inexpectatus* (Blake) (identification by J. E. Hazel, personal communication, April 7, 1965). The instars are characteristically smooth, with a prominent smooth subcentral tubercle, a ventrolateral ridge rounded at its posterior end, and a broadly and evenly rounded anterior margin. The appearance of this form only as instars suggests to me that mature specimens have fortuitously escaped sampling, have surprisingly great migratory ability, or are newly introduced to this area. It is possible, but improbable, that this form is too delicate in the mature stage to be preserved.

Table 5. *General Faunal Distribution.*

	SPECIES																				
Station#	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1			X					X			X										
3			X																		
5																					
7																					
10																					
13			X	X														X			
16			X	X	X									X				X			
19				X																	
22				X											X						
25				X	X											X					
27		X		X	X				X						X			X			
28				X					X					X				X			
29				X	X			X	X		X				X	X					
30				X	X													X			
31	X	X		X	X				X												
32				X	X																
33				X																	
34											X		X		X	X	X				
35			X	X	X	X	X						X	X		X	X		X	X	
36	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X	
37	X		X	X	X		X	X	X					X				X		X	
38				X		X												X			
39	X		X	X	X	X		X								X		X			
40				X	X	X		X						X				X			X
41	X	X	X	X	X				X			X						X	X		
42				X	X	X			X									X			
43				X										X							
44				X	X											X		X		X	
45				X																	
46				X												X				X	
47				X						X											
48				X						X										X	
49	X	X	X	X	X	X	X	X	X			X						X	X		X
50	X	X	X	X			X	X				X							X		
51																					
52				X						X							X	X		X	
53			X																		
54	X	X	X	X	X	X	X	X	X								X	X	X		
55			X	X		X															
56	X	X		X	X	X	X		X			X		X		X		X	X	X	
57		X	X	X	X	X			X									X		X	
58				X	X				X									X		X	
59				X	X	X												X			
60	X			X		X															
61				X	X															X	
62				X		X										X		X		X	
63				X																	

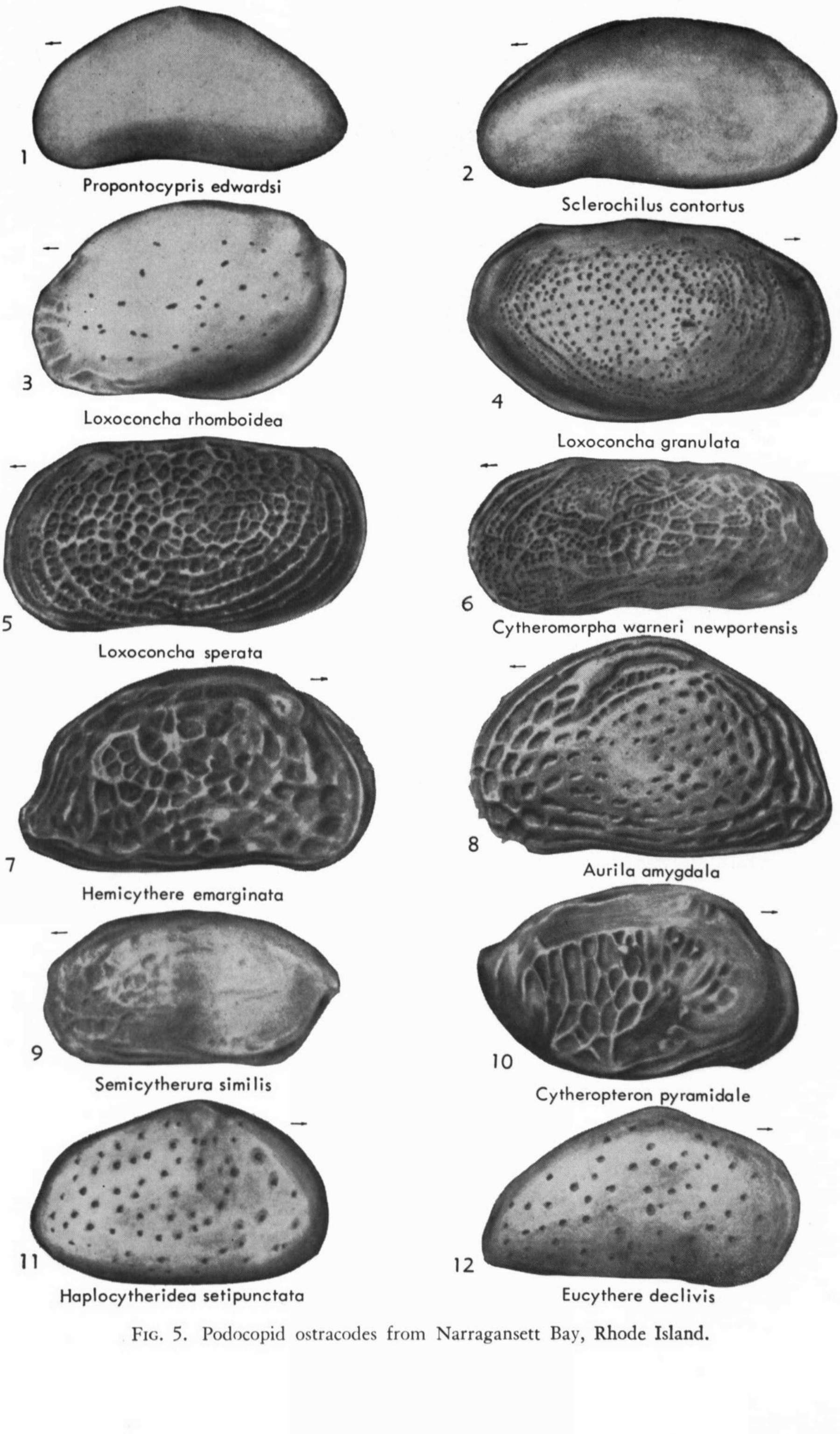

FIG. 5. Podocopid ostracodes from Narragansett Bay, Rhode Island.

ACKNOWLEDGMENTS

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SYSTEMATIC DESCRIPTIONS

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIDA Müller, 1894

Suborder PODOCOPINA Sars, 1866

Superfamily CYPRIDACEA Baird, 1845

Family PONTOCYPRIDIDAE Müller, 1894

Genus PROPONTOCYPRIS Sylvester-Bradley

Propontocypris SYLVESTER-BRADLEY, 1947, p. 193.——Type species: *Pontocypris trigonella* SARS, 1866, p. 16.

Diagnosis.—Shell medium size, smooth, elongate acuminate. Highly arched dorsum, highest anterior to mid-dorsum; posterior end rounded. Margins smooth. Hinge adont. Marginal area broad with anterior and posterior vestibules; radial pore canals short or absent. Has large eye, commonly visible in fresh specimens. Circular cluster of muscle scars. (Genus established on soft parts.) *Pleist.-Rec.*

PROPONTOCYPRIS EDWARDSI (Cushman)

Pontocypris edwardsi CUSHMAN, 1906, p. 368; pl. 30, fig. 26-34.

Diagnosis.—Recognized by its smooth triangular carapace, highest at mid dorsum. Height equals or exceeds half length. Inflated. Identification based upon soft parts. Dimorphism pronounced, with males lower and longer than females.

Remarks.—The carapace features of specimens collected in Narragansett Bay are identical with the figures of specimens collected by CUSHMAN (1906) in Vineyard Sound. The species is determined from characteristics of the soft parts, and inasmuch as no examined specimens from Narragansett Bay contained soft parts, this identification cannot be regarded as absolutely certain. Illustrations of soft parts of *P. edwardsi* from CUSHMAN (1906) and of *P. trigonella* (SARS), 1866 (from *20,* 79) reveal a close similarity between these two species.

CUSHMAN (1906) named this species from specimens collected in a brackish pond on a muddy bottom, and therefore dissimilar to the Narragansett Bay forms which are found in conditions of normal salinity on a coarse substrate. However, *Propontocypris* is one of the few free-swimming marine podocopids, and as such is less restricted to any particular type of substratum, and therefore few conclusions should be drawn relating this genus to the substratum from which the specimens were taken.

Dimensions.—Length 0.7 mm.; height 0.38 mm.; width 0.29 mm.

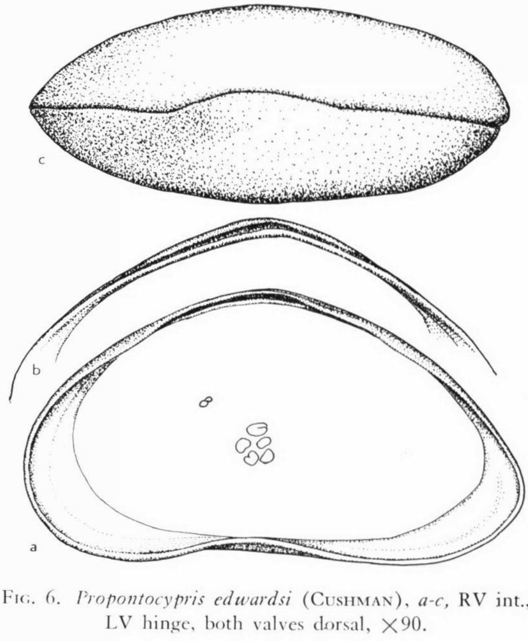

FIG. 6. *Propontocypris edwardsi* (CUSHMAN), *a-c,* RV int., LV hinge, both valves dorsal, ×90.

Material.—Specimens 34, of which 29 were articulated.

Distribution.—Narragansett Bay, Rhode Island; Vineyard Sound, Massachusetts.

Occurrence.—Taken at stations 31, 36, 37, 39, 41, 49, 50, 54, 56, 60. Depths 17 to 126 feet in clayey silt to sand.

Hypotype.—UKMIP M501.

Illustrations.—Fig. 5,*1*, LV lat. ext., ×65.——Fig. 6*a,b*, RV lat. int. and hinge, ×90; 6*c*, both valves dorsal, ×90.

Superfamily CYTHERACEA Baird, 1850

Family PARADOXOSTOMATIDAE Brady & Norman, 1889

Subfamily PARADOXOSTOMATINAE Brady & Norman, 1889

Genus SCLEROCHILUS Sars

Sclerochilus Sars, 1866, p. 89; Brady, 1868*(20)*, p. 455; Wagner, 1957, p. 100.——Type species: *Cythere contorta* Norman, 1862, p. 48.

Diagnosis.—Recognized by its smooth, subspatulate carapace with adont hinge; muscle scar pattern 4 or more subequal elliptical adductor scars in nearly vertical row with other scars possible anteriorly; marginal area broad with deep vestibules; radial pore canals simple, straight, commonly grouped in pairs. *Mio.-Rec.*

SCLEROCHILUS CONTORTUS (Norman)

Cythere contorta Norman, 1862, p. 48, pl. 2, fig. 15.

Sclerochilus contortus (Norman), Sars, 1866, p. 90; Brady, 1868*(20)*, p. 455; Brady, Crosskey, & Robertson, 1874, p. 212; Sars, 1928, p. 247; Blake, 1933, p. 241; Wagner, 1957, p. 101.

Diagnosis.—Recognized by its smooth, nearly glassy carapace with subspatulate lateral and siliquose dorsal outlines, anterior margin narrowly rounded and ventral margin sinuous. Hinge adont. Muscle scar pattern consisting of nearly vertical row of 5 elliptical scars. Marginal area broad, with continuous vestibule; radial pore canals moderately numerous and commonly bifurcating or in clusters of 2 to 4 canals.

Remarks.—This species is identical with that described by Wagner (1957) with the exception that the radial pore canals in his figure 1 appear somewhat stylized. Blake (1933) has reported that the form present in Bar Harbor, Maine, is shorter than those reported by Müller (1912) from Scandinavia. Blake's specimens measure 0.71 mm., and those of Müller, 0.8 mm.

Dimensions.—Length 0.63 mm., width 0.28 mm., height 0.20 mm.

Material.—Specimens studied 46, of which 24 had articulated valves.

Distribution.—Narragansett Bay, Rhode Island; Scandinavian countries and British Isles; Greenland; Mt. Desert Island, Maine; doubtfully in the Mediterranean.

Occurrence.—In Narragansett Bay mainly in silty sand (22 specimens) from depths of 17 to 126 feet. It is reported to subsist mainly on marine vegetation and to be very eurythermal and euryhaline.

Hypotype.—UKMIP M502.

Illustrations.—Fig. 5, 2, LV lat. ext., ×80.——Fig. 7*a*, RV lat. int., ×100; 7*b*, LV hinge, ×100; 7*c*, both valves dorsal, ×100.

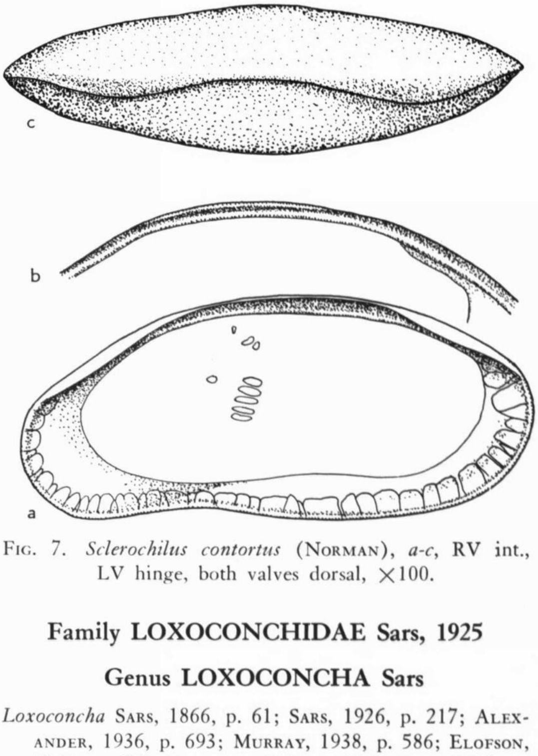

Fig. 7. *Sclerochilus contortus* (Norman), *a-c*, RV int., LV hinge, both valves dorsal, ×100.

Family LOXOCONCHIDAE Sars, 1925

Genus LOXOCONCHA Sars

Loxoconcha Sars, 1866, p. 61; Sars, 1926, p. 217; Alexander, 1936, p. 693; Murray, 1938, p. 586; Elofson, 1941, p. 322; Edwards, 1944, p. 526; Keij, 1957, p. 139; Benson, 1959, p. 51; Howe, 1961, p. Q313; Benson & Coleman, 1963, p. 36; Benson & Kaesler, 1963, p. 26; Benson & Maddocks, 1964, p. 23; Pooser, 1965, p. 50.——Type species: *Cythere impressa* Baird, 1850 (*non* M'Coy), 1844) (=*C. rhomboidea* Fischer, 1855).

Diagnosis.—Recognized by its rhomboidal carapace with nearly smooth to reticulate surface. Hinge gongylodont with crenulate median element. Marginal area with anterior and posterior vestibules; radial pore canals few, straight. Males longer and narrower than females. *Cret.-Rec.*

LOXOCONCHA RHOMBOIDEA (Fischer)

Cythere rhomboidea Fischer, 1855, p. 656.

Cythere impressa BAIRD, 1850, p. 175, pl. 21, fig. 9 (*non* M'COY, 1844).
Loxoconcha impressa (Baird), BRADY, 1868*(20)*, p. 433.
Loxoconcha rhomboidea (Fischer), WAGNER, 1957, p. 64.

Diagnosis.—Distinguished from other species by commonly dark, circular to elliptical, moderately widely but evenly spaced papillae. Surface nearly smooth, but with dense white calcareous incrustation on mature specimens. *Plio.-Rec.*

Remarks.—This species is identified on the basis of its strong affinities to *Loxoconcha impressa* (BAIRD) in shell shape, dimorphism, and ornamentation. BRADY (1868, *20*) drew attention to the calcareous incrustation which in more mature forms both conceals, or in some specimens, accentuates rows of minute punctations. This ornamentation is easily overlooked in contrast to the bold papillae which are external expressions of normal pore canals. SYLVESTER-BRADLEY (1946) pointed out that the name *Cythere impressa* was already in use by M'COY (1844), therefore making it unavailable to BAIRD in 1850. BRADY & NORMAN (1889) indicated that *C. rhomboidea* was synonymous with *C. impressa* (BAIRD) and it therefore stands as the currently valid name for the species.

Dimensions,—Male, length 0.63 mm., height 0.38 mm., width 0.29 mm. Female, length 0.59 mm., height 0.41 mm., width 0.30 mm.

Material.—Specimens 85, of which 20 were articulated.

Distribution.—First reported by BAIRD (1850) from Recent sands at Torquay, southeastern Devonshire, England, *Loxoconcha rhomboidea* subsequently has been found to be abundant throughout the British Isles, the Baltic, along the coasts of Sweden, Norway, and Finland, and along the coasts of the Netherlands and France to the Mediterranean and Black Seas. Reported from the Miocene of Cuba by VAN DEN BOLD (1946). TRESSLER & SMITH (1948) have recorded the species from the Solomon's Island area of Chesapeake Bay, but they figured a form which appears to bear great similarity to *L. granulata*. Reported from Vineyard Sound, Massachusetts, by CUSHMAN (1906); from Wickford, Rhode Island, by WILLIAMS (1907), Narragansett Bay; and from the Mt. Desert Island area of Maine by BLAKE (1933), and from Recent sediments of Trinidad *(18)*.

Occurrence.—WILLIAMS (1907) reported collection of the species from eel grass and from dredgings in Narragansett Bay, and TRESSLER & SMITH (1948) obtained it from weeds in the littoral zone. *Loxoconcha rhomboidea* has been reported to be restricted to warm water *(31, 91)* and common in brackish water, 5 to 7 ‰ and upwards *(91)*. Taken in Narragansett Bay through a full range of depths from 4 to 126 feet, in sediment ranging from clayey silt to gravelly sand.

Hypotype.—UKMIP M503.

Illustrations.—Fig. 5,*3*, LV lat. ext., ×80.——Fig. 8*a*, RV lat. int., ×110; 8*b*, LV hinge, ×110; 8*c*, both valves dorsal, ×110.

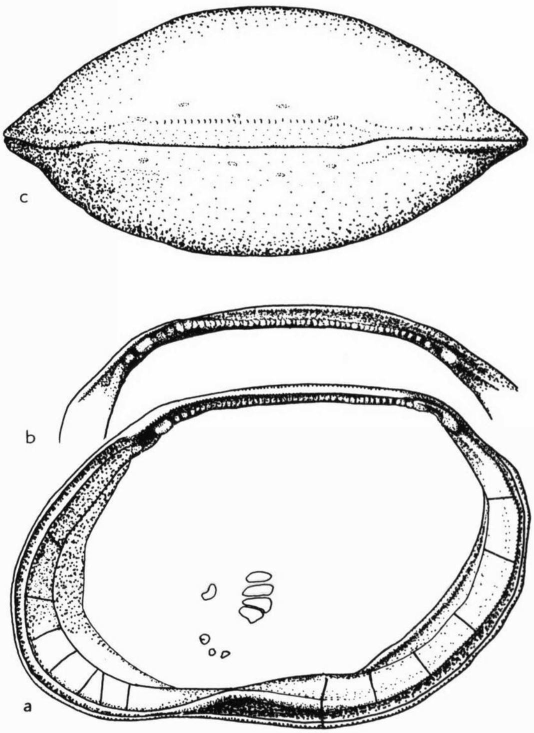

FIG. 8. *Loxoconcha rhomboidea* (FISCHER), *a-c*, RV int., LV hinge, both valves dorsal, ×110.

LOXOCONCHA GRANULATA Sars

Loxoconcha granulata SARS, 1866, p. 64; —, 1928, p. 219.
Loxoconcha guttata (Norman), CUSHMAN, 1906, p. 370.

Diagnosis.—Recognized by nearly parallel dorsal and ventral margins; carapace covered by orderly rows of minute punctate arranged more or less parallel to margins; dimorphic posterior flangelike prominence on left valve of female, with corresponding re-entrant interruption of posterior margin of right valve.

Description.—Carapace medium-sized, inflated, rounded subrhomboid; ovate in dorsal view. Dorsal margin gently arched in female, nearly straight in male. Anterior margin broadly rounded, flattened or slightly concave at dorsal end. Posterior margin of female with bluntly rounded subrectangular projection or flange at mid-height, right valve corresponding with notched posterior margin; upper juncture of notch with margin rounded, lower juncture pointed; posterior margin of male narrowly rounded.

Surface finely punctate with moderately few normal pore canals; punctae arranged in concentric rows, giving appearance of delicate concentric ridges parallel to anterior, ventral, and posterior margins.

Hinge gongylodont. Muscle-scar pattern an oblique row of 4 scars, curving toward anteroventer below, with single arcuate scar anterior to row. Moderately broad marginal area, with moderately deep anterior and posterior vestibules. Radial pore canals few, simple, straight, with tendency to cluster.

Remarks.—Confusion has existed in the past in distinguishing *Loxoconcha granulata* (SARS) from *L. guttata* (NORMAN). Both BRADY *(20)* and SARS *(79)* drew attention to an obtuse posterior prominence in the female of both species and showed *L. granulata* as being rather finely punctate. On the other hand, BRADY *(20)* and NORMAN *(61)* both characterized *L. guttata* as having large, concentrically arranged pits, whereas BRADY *(20)* and SARS *(79)* described *L. granulata* as having small, closely set pittings. Inspection of NORMAN's figures and of SARS' figure of these two forms reveals that the surface sculpture of the two species is clearly different. SARS *(79)* stated that *L. guttata* is not identical with *L. granulata* as the shell sculpture differs. CUSHMAN *(29)* noted that all of his specimens were "of the type" called *L. granulata* by SARS, but he identified them as *L. guttata,* following BRADY & NORMAN *(26)* who considered *L. granulata* as younger instars of *L. guttata.* None of the more than 2,500 specimens in the Narragansett Bay collections bear the deep, large pittings diagnostic of *L. guttata*, and therefore in my opinion the specimens here present, as well as those of CUSHMAN identified as *L. guttata*, actually are *L. granulata.* BLAKE (1933) identified specimens from Bar Harbor, Maine, with CUSHMAN's *L. guttata,* and therefore these should also be *L. granulata.* BRADY (1870) listed only one species of *Loxoconcha* from the Gulf of St. Lawrence, namely *L. granulata* SARS.

The dimorphic obtuse posterior projection, cited by BRADY, SARS & NORMAN (not recognized as dimorphic by NORMAN, 1865) is not a caudal process, as many workers may presume. CUSHMAN (1906) diagnosed *Loxoconcha* as "usually with a decided projection on the dorso-posterior angle with a corresponding reentrant behind it." I do not think that this projection is diagnostic of the genus, for it is commonly absent in both sexes of many species and in the males of a few. The projection occurs in both *L. granulata* and *L. guttata.* A true caudal process, as is common in the Cytheruridae and many species of *Loxoconcha,* is developed in both valves providing a tubular projection for circulation of water when the valves are fully articulated. In contrast, the obtuse projection of *L. granulata* is a modification of the posterior flange wherein a protrusion on the left valve fits into a notch in the right valve (see Fig. 9) in such manner as to produce a complete or nearly full seal when the valves are closed. I assume that this distinction has been overlooked by earlier authors. This feature is diagnostic of specimens in Narragansett Bay and deserves further study, especially in comparison with specimens of earlier authors.

Dimensons.—Male, length 0.66 mm., height 0.38 mm., width 0.30 mm. Female, length 0.65 mm., height 0.39 mm., width 0.33 mm.

Material.—Specimens 2,500, of which 1,250 were articulated.

Distribution.—Atlantic coast of North America including Narragansett Bay, Rhode Island; Britain; Norway.

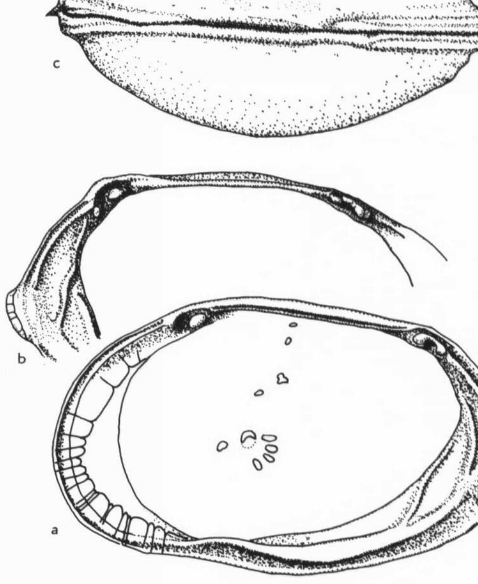

FIG. 9. *Loxoconcha granulata* SARS, *a-c,* RV int., LV, hinge and post. margin, both valves dorsal, ×100.

Occurrence.—Taken at all stations except 1, 3, 5, 7, 10, 34, and 51, at depths from 7 to 126 feet in sediment ranging from clayey silt to gravelly sand.

Hypotypes.—UKMIP M504 (female); UKMIP M505 (male).

Illustrations.—Fig. 5, *4*, RV lat. ext., ×85.——Fig. 9*a-c*, RV lat. int., LV hinge and post. margin, both valves dorsal, ×100.

LOXOCONCHA SPERATA Williams, n. sp.

Diagnosis.—Distinguished by its punctate, reticulate carapace, its subrectangular lateral outline with nearly perfectly flat dorsum, and subtriangular dorsal outline; hinge gongylodont; cardinal angles distinct.

Description.—Carapace medium-sized, inflated, widest in posteroventral quadrant, subrectangular in lateral view, subtriangular in dorsal view, with acuminate anterior and truncate posterior extremities. Dorsal margin elongate and nearly straight, merging with broadly rounded anterior margin at cardinal angle of approximately 135°; ventral margin sinuous, with prominent posteroventral keel, merging gradually with very broadly rounded ventroposterior margin which rises nearly vertically to posterior cardinal angle of about 100°.

Surface evenly pitted to reticulate; reticulations in orderly concentric rows, divided by ridges more pronounced toward margins. Reticulate fossae characteristically subdivided into 4 or 5 punctations. Inframarginal zone devoid of ornament.

Hinge gongylodont. Anterior hinge element in right valve consists of socket containing a tooth, followed posteriorly by a nearly smooth shallow groove which terminates at an arcuate bilobate posterior tooth. Hinge of left valve corresponds with a bilobed arcuate anterior tooth which is received into the anterior socket of the right valve and surrounds the tooth lying within it. Posterior hinge element of left valve a socket containing a tooth encompassed by the arcuate posterior tooth of the right valve when articulated.

Muscle-scar pattern oblique row of 4 with single scar anterior to uppermost scar of row. Marginal area wide, with moderately deep anterior and shallow posterior vestibules. Radial pore canals in anterior few, evenly spaced, do not reach margins; not observed in posterior. Sexual dimorphism not pronounced, but detectable, females possessing a more truncate posterior.

Remarks.—This species is easily distinguished from *Loxoconcha rhomboidea*, the type species, by its subrectangular outline, longer in comparison to its height, and by its reticulate surface. *L. rhomboidea* is more ovate, shorter in comparison to height, and bears dark papillae on its surface. *L. sperata* is distinguishable from most other forms by its blunt, nearly vertical posterior margin which joins the dorsal margin with a distinct cardinal angle and without any posterodorsal truncation whatever.

Etymology.—Name derived from Latin *sperare*, to hope, for the island Hope in Narragansett Bay, and numerous other geographical and cultural features in Rhode Island, as well as the State motto.

Dimensions.—Length 0.65 mm., height 0.35 mm., width 0.32 mm.

Material.—Specimens 201, of which 89 were articulated.

Distribution.—Narragansett Bay, Rhode Island.

Occurrence.—Taken mainly in shallow depths, from 7 to 31 feet, but appears at depths to 102 feet.

Holotype.—UKMIP M506; paratypes UKMIG M507.

Illustrations.—Fig. 1,*5*, LV lat. ext., ×85.——Fig. 10*a-c*, RV lat. int., LV hinge, both valves dorsal, ×100.

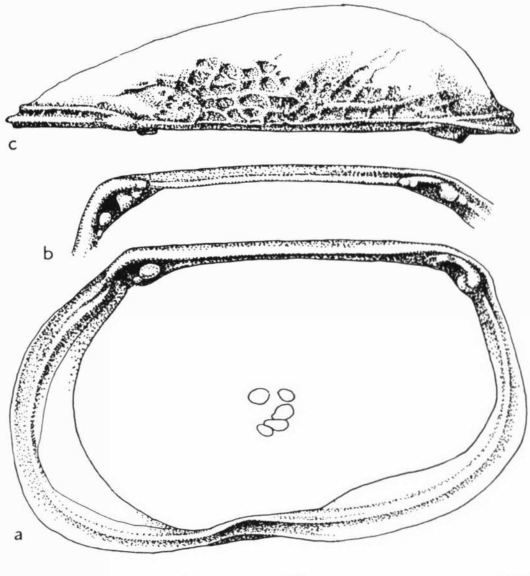

FIG. 10. *Loxoconcha sperata* WILLIAMS, n. sp., *a-c*, RV int., LV hinge, RV dorsal, ×100.

Genus CYTHEROMORPHA Hirschmann

Cytheromorpha HIRSCHMANN, 1909, p. 292; SARS, 1925, p. 177; KLIE, 1938, p. 170; OERTLI, 1956, p. 72; SWAIN, 1955, p. 630; WAGNER, 1957, p. 49; HOWE, 1961, p. Q313; VAN MORKHOVEN, 1963, v. 2, p. 396; POOSER, 1965, p. 51.——Type species: *Cythere fuscata* BRADY, 1869, p. 47, pl. 7, figs. 5-8. (=*Cytheromorpha albula* HIRSCHMANN, 1909, p. 290); SD SARS, 1925.

Diagnosis.—Recognized by its small, elongate ovate carapace; valves delicate, thinly calcified. Surface smooth, pitted, or reticulate. Hinge gongylodont. Marginal areas wide with anterior and posterior vestibules; radial pore canals widely spaced, simple, straight. *Paleoc., Rec.*

CYTHEROMORPHA WARNERI NEWPORTENSIS
Williams, n. subsp.

Diagnosis.—Distinguished from *Cytheromorpha warneri* in having anterior portion of carapace covered by minute, closely spaced punctae; posterior surface separated from anterior by shallow sulcus and characterized by delicate reticulate network except in ventral portion where subtriangular area is completely smooth.

Description.—Carapace moderately small, elongate ovate, highest at anterior cardinal angle. In lateral view dorsal and ventral margins nearly parallel in male, convergent posteriorly in female. Anterior margin broadly and evenly rounded, extending below venter; ventral margin flexuous merging smoothly with posterior extremity which is evenly rounded below, truncate above. Males longer than females. Outline in dorsal view lanceolate.

Surface covered with closely spaced, minute punctae, becoming delicately reticulate behind shallow and commonly vague median sulcus. Adjacent to ventral margin extending through middle third of carapace length is low keel which trends posterodorsally at its posterior end and marks anterior margin of small subtriangular entirely smooth area.

Hinge characteristic of genus. Marginal area broad anteriorly, narrow posteriorly. Deep irregular anterior vestibule with simple straight, moderately few, radial pore canals. Muscle-scar pattern slightly oblique row of 4 or 5 scars with 2 scars below and anterior to lowermost of row. Mandibular fulcral point marked by prominent raised projection, arcuate above and excavate below, located anterior to uppermost adductor scar.

Remarks.—This subspecies closely resembles *C. warneri okaloosaensis* as described by Howe & Chambers (1935), and by Puri (as *C. warneri okaloosensis, 69*, p. 277), the only difference being the smooth posteroventral area on *C. warneri newportensis.* The coarseness of the reticulations varies within the assemblage here considered, but the smooth area is consistent throughout.

Dimensions.—Male, length 0.55 mm., height 0.24 mm., width 0.22 mm. Female, length 0.57 mm., height 0.29 mm., width 0.25 mm.

Material.—Specimens 36, of which 16 were articulated females and 14 were articulated males.

Distribution.—*Cytheromorpha warneri okaloosaensis* has been reported only from the Miocene of Florida *(42, 67, 82). C. warneri* has been reported from the Miocene of Florida *(42, 70, 82)*; South Carolina *(64)*; North Carolina *(87)*; Virginia and Maryland *(49, 51)*; Venezuela and Cuba *(17)*; and Recent seas from Panama City, Keys, and Cape Romano, Florida *(6, 72, 73)*; and Pamlico Sound, North Carolina *(33).*

Occurrence.—Taken at 13 stations in depths from 7 to 102 feet (mainly less than 63 feet) in sediment ranging from clayey silt to gravelly sand.

Holotype.—UKMIP M508.

Illustrations.—Fig. 1,6, LV lat. ext., ×100.——Fig. 11*a-c*, RV lat. int., LV hinge, LV ventral, ×120.

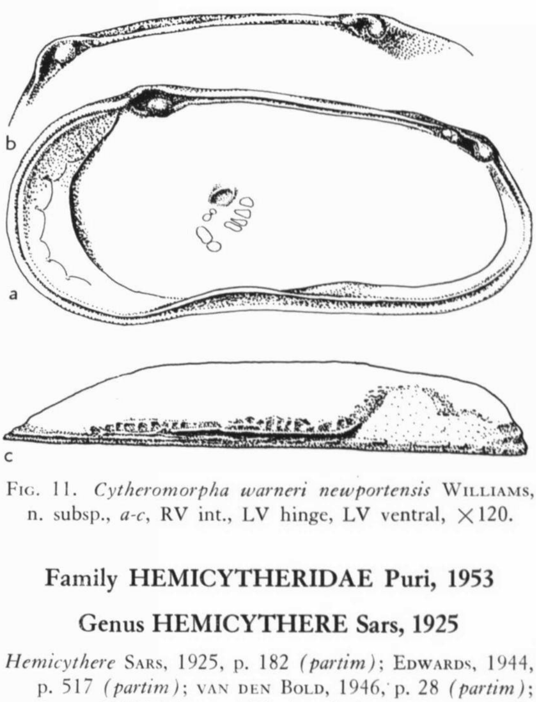

Fig. 11. *Cytheromorpha warneri newportensis* Williams, n. subsp., *a-c*, RV int., LV hinge, LV ventral, ×120.

Family HEMICYTHERIDAE Puri, 1953

Genus HEMICYTHERE Sars, 1925

Hemicythere Sars, 1925, p. 182 *(partim)*; Edwards, 1944, p. 517 *(partim)*; van den Bold, 1946, p. 28 *(partim)*; Puri, 1953*(68)*, p. 172 *(partim)*; Pokorný, 1955, p. 6; Oertli, 1956, p. 95; Benson, 1959, p. 65; Howe, 1961, p. Q302; van Morkhoven, 1963, p. 134; Benson & Maddocks, 1964, p. 27.——Type species: *Cythere villosa* Sars, 1866, p. 42; SD Edwards, 1944.
Cythereis gruppo *auris* Neviani, 1928, p. 72 *(partim).*
Cythereis (Eucythereis) Klie, 1940, p. 415 *(partim).*
?*Procythereis* Skogsberg, 1928, p. 17 *(partim).*

Diagnosis.—Recognized by its heavy almond-shaped pitted carapace; anterior margin broadly and obliquely rounded, posterior margin commonly caudate, concave above. Hinge holamphidont.

Muscle-scar pattern with vertical row of 4 adductor scars, next to top element divided, and 2 antennal scars in front. Marginal area with numerous radial pore canals. *Eoc.-Rec.*

HEMICYTHERE EMARGINATA (Sars)

Cythereis emarginata SARS, 1866, p. 38.
Cythere emarginata (Sars) BRADY, 1868*(20)*, p. 475; BRADY, CROSSKEY, & ROBERTSON, 1874, p. 166; BRADY & NORMAN, 1889, p. 163.
Hemicythere emarginata (Sars) SARS, 1922, p. 183; PURI, 1953*(68)*, p. 169.

Diagnosis.—Recognized by its medium size and subreniform outline; right valve of female higher and more highly arched than left; moderately high-arched dorsum, emarginate posterior margin, extended and truncate toward venter. Coarse rounded reticulated surface with prominent vertical ridge toward posterior margin and ventrolateral ridge trending to posterior extremity from small node located one-third of length of valve from posterior margin. In most specimens, 2 vertical rows of pits occur just behind mid-length in middle third of carapace between dorsum and venter.

Remarks.—*Hemicythere emarginata* is a distinctive form resembling no other domestic species except in most general manner. PURI *(68)* did not recognize its presence in America. SARS (*79*, p. 184) and BRADY (*20*, p. 475) mentioned that the right valve is highly bowed and BRADY stated that the right valve is higher than the left. VAN MORKHOVEN (1963, p. 135) described the left valve as higher than the right, which is clearly opposed to the findings of BRADY. The specimens from Narragansett Bay confirm the observations of BRADY (Fig. 12a).

The illustrated specimen (Fig. 12a) is either a penultimate instar or a final instar not fully calcified, and as such the hinge is not fully developed. Undoubtedly, the median element of the right valve does not serve as an accommodation groove and therefore the hingement is normal for the Hemicytherinae.

Dimensions.—Male, right valve length 0.77 mm., height 0.44 mm. Female, right valve length 0.79 mm., height 0.49 mm.

Material.—Specimens 32, of which 3 were articulated.

Distribution.—Reported by CUSHMAN (1906) from Martha's Vineyard and by BRADY (1870) from the Gulf of St. Lawrence, as well as from the Arctic seas and from Davis Strait, Baffin Bay, Norway, Sweden, Shetland Is., Iceland, Spitzbergen, and Franz Joseph Land. BRADY (1869) noted that it is an Arctic species, and appears to have been abundant in the Pleistocene; BRADY & CROSSKEY (1871) reported the species from the post-Tertiary of Maine.

Occurrence.—Taken at stations 34, 35, 36, 49, 50, 54, 56, at depths of from 24 to 126 feet, but mainly less than 55 feet, in sediment ranging from clayey silt to sand.

Hypotype.—UKMIP M509.

Illustrations.—Fig. 5,7, RV lat. ext., ×70.——Fig. 12*a,b*, RV lat. int., both valves post., ×80.

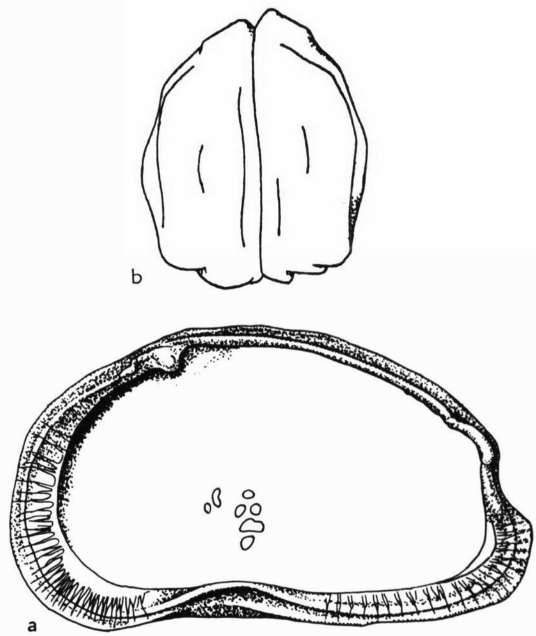

FIG. 12. *Hemicythere emarginata* (SARS), *a,b,* RV int., both valves post., ×80.

Genus AURILA Pokorný

Cythereis JONES, 1849, p. 14, 15 *(partim)*; auctt.
Hemicythere SARS, 1925, p. 182 *(partim)*; auctt.
Cythereis gruppo *Auris* NEVIANI, 1928, p. 72 *(partim)*.
Cythereis (Eucythereis) ELOFSON, 1941, p. 283 *(partim)*.
Aurila POKORNÝ, 1955, p. 17; WAGNER, 1957, p. 59; HOWE, 1961, p. Q302; BENSON & COLEMAN, 1963, p. 34; BENSON & KAESLER, 1963, p. 23; BENSON & MADDOCKS, 1964, p. 31; POOSER, 1965, p. 48; *non* POKORNÝ, 1958, p. 268.——Type species: *Cythere convexa* BAIRD, 1850, p. 174, pl. 21, fig. 3.

Diagnosis.—Distinguished from other almond-shaped hemicythereids by its heavy carapace and holamphidont hinge which, in right valve, consists of high-stepped anterior tooth and ventrally incised reniform posterior tooth. Muscle-scar pattern with 3 antennal scars and 2nd from uppermost adductor scar divided. *Mio.-Rec.*

AURILA AMYGDALA (Stephenson)

Hemicythere amygdala STEPHENSON, 1944, p. 158; pl. 28, figs. 8, 9; PURI, 1953*(69)*, p. 266; PURI, 1953*(68)*, p. 176.
Cythereis albomaculata (Baird), CUSHMAN, 1906, p. 378 (*non* BAIRD, 1850).
Aurila amygdala (Stephenson), BENSON & COLEMAN, 1963, p. 36.

Diagnosis.—Distinguished by its moderately small almond-shaped carapace ornamented by somewhat concentrically arranged circular pits in center increasing in size and becoming more rectangular toward margins. Broadly rounded anterior margin. Right valves somewhat caudate and smaller than left valve.

Remarks.—The Narragansett specimens appear to be identical with those of BENSON & COLEMAN (1963), to the degree that most display the posteroventral denticle noted in their remarks (not shown on fig. 5,*8*, nor on fig. 13).

Dimensions.—Female, length 0.64 mm., height 0.39 mm.

Material.—Specimens 28, of which 9 were articulated.

Distribution.—First reported by STEPHENSON *(83)* from the mid-Tertiary of Texas; also recorded by PURI *(68, 69)* from the Alum Bluff Stage of the Florida Miocene, by GROSSMAN *(33)* from Recent sediments in Pamlico Sound, North Carolina, by PURI & HULINGS *(73)*, and by BENSON & COLEMAN *(8)* from Recent sediments in the eastern Gulf of Mexico.

Occurrence.—Taken at stations 1, 29, 36, 37, 40, 49, 50, 54, in depths of 4 to 126 feet, in sediment ranging from clayey silt to sand. Taken by BENSON & COLEMAN at depths of 19 to 76 feet at a salinity of 36.91 to 39.92 ‰; by GROSSMAN from 8 feet deep in sand, at a salinity of 30.00 ‰.

Hypotype.—UKMIP M510.

Illustrations.—Fig. 5,*8*, LV lat. ext., ×85.——Fig. 13, RV lat. int., ×100.

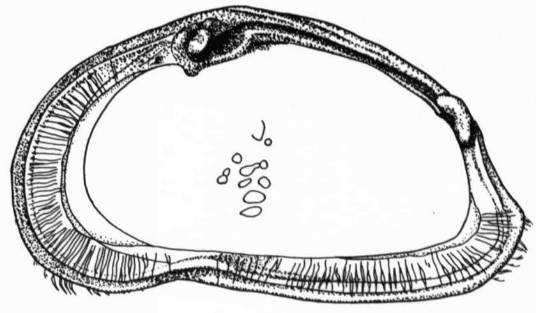

FIG. 13. *Aurila amygdala* (STEPHENSON), RV, int., ×100.

Family CYTHERURIDAE Müller, 1894

Genus SEMICYTHERURA Wagner

Semicytherura WAGNER, 1957, p. 80; REYMENT, 1961, p. Q299; VAN MORKHOVEN, 1963, p. 346.——Type species: *Cythere nigriscens* BAIRD, 1838, p. 143, pl. 5, fig. 27.

Diagnosis.—Carapace small to medium-sized, generally fragile, with caudal process more or less well developed. Hinge cytherurine, with crenulate median element in some species. Line of concrescence coincident with inner margin, in posterior region curving strongly forward; radial pore canals few, long, sinuous, commonly in groups, some false, commonly with 2 or 3 terminating in caudal process. *Pleist.-Rec.*

SEMICYTHERURA SIMILIS (Sars)

Cytherura similis SARS, 1866, p. 72; BRADY & NORMAN, 1889, p. 203, pl. 18, figs. 7-9; SARS, 1925, p. 203, pl. 94, fig. 2.

Diagnosis.—Recognized by its moderately small size, ovate to subrectangular outline, smooth to delicately reticulate ornamentation, and subdued posterior caudal extension.

Description.—Carapace subovate to subrectangular. Valve of female moderately robust, widest in posteroventral quadrant, nearly equal in height throughout; dorsal margin smoothly and evenly convex, merging with smoothly rounded anterior margin without discernible break in slope; ventral margin slightly concave, produced into small keel toward posterior extremity; ventral part of posterior margin nearly straight, sloping to smoothly rounded, subdued caudal extension slightly above mid-point; dorsoposterior margin merging with dorsal margin without discernible break in slope. Dorsal outline inflated; anterior bluntly pointed, carapace swelling to just in front of mid-point where it is gently constricted; posterior half thickest, narrowing abruptly to posterior edge produced to narrow point.

Surface generally smooth with shallow median sulcus. Some specimens display delicate reticulation but only near extremities, whereas others are delicately ribbed or reticulate over entire carapace. Male valves are lower and more elongate and appear to be more ornamented and less tumid than those of females.

Hinge of right valve comprising anterior element, which is modification of backward extension of selvage slightly crenulate on its posterior end, and posterior element, which similarly is the forward extension of selvage bearing small node or tooth at its anterior end. Above these elements groove extends full length of dorsum, bordered dorsally by flange slightly crenulate anteriorly; groove deepens between anterior and posterior elements, with well-marked floor delimiting extent into which median elements of left valve protrude. Median element of left valve crenulate or toothed at each extremity.

Marginal area very wide, with zone of concrescence extending well toward center of valve in posterior and anterior regions, posterior area being deltaic in outline. Line of concrescence equal to inner margin except posterior to ventral sinuation in both sexes, where shallow vestibule occurs. Radial pore canals few and irregular, tending to be clustered; some bifurcate at extremities, others coalesce in front of mid-length, majority not reaching outer margin. Muscle-scar pattern vertical row of 4 with numerous accessory scars.

Remarks.—In some females the caudal extension is mid-posterior, but in others and in males it is dorsal to mid-posterior. This form is not heavily or distinctively ornamented, and is therefore easily distinguished from the majority of *Semicytherura* species, but is not extremely small, sharply caudate, or devoid of ornament as is the type species.

Dimensions.—Male, length 0.54 mm., height 0.26 mm., width 0.20 mm. Female, length 0.56 mm., height 0.31 mm., width 0.25 mm.

Material.—Specimens studied 46, 38 with valves articulated.

Distribution.—Reported by SARS (1925) from recent sediments of British Isles and Arctic Seas, and fossil in Norway and Scotland. VAN DEN BOLD (1946) reported a new variety *Cytherura similis meridionalis* from the Miocene of Guatemala.

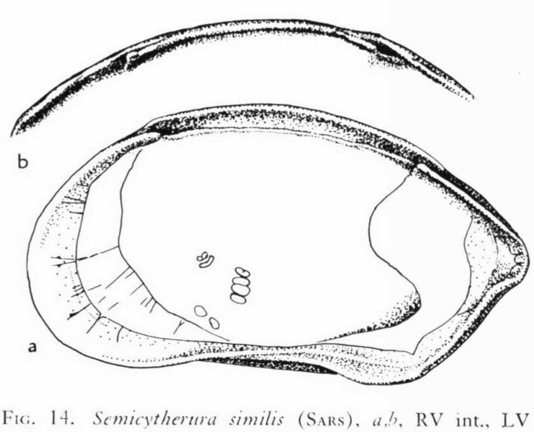

FIG. 14. *Semicytherura similis* (SARS), *a,b*, RV int., LV hinge, ×115.

Occurrence.—Taken at 12 stations mainly in depths of 15 to 20 feet in clayey silt to gravelly sand, but 3 specimens were taken at 102 feet.

Hypotype.—UKMIP M511.

Illustrations.—Fig. 5,9, LV lat. ext., ×80.——Fig. 14*a,b*, RV lat. int., LV hinge, ×115.

Genus CYTHEROPTERON Sars

Cytheropteron SARS, 1866, p. 779; SARS, 1926, p. 223; ALEXANDER, 1933, p. 181; MARTIN, 1939, p. 176; STEPHENSON, 1946, p. 318; HANAI, 1957, p. 26; WAGNER, 1957, p. 89; BENSON, 1959, p. 54; REYMENT, 1961, p. Q292; VAN MORKHOVEN, 1963, p. 384; POOSER, 1965, p. 47.——Type species: *Cythere latissima* NORMAN, 1865, p. 19, pl. 6, figs. 5-8 (=*Cytheropteron convexum* SARS, 1866).

Diagnosis.—Recognized by its smooth, pitted, or reticulate carapace with caudal extension, arched dorsum, and ventral alar process. Hinge antimerodont; right valve with crenulate terminal teeth divided by crenulate groove. Marginal area with small anterior vestibule; radial pore canals simple, bifurcating. *U. Jur.-Rec.*

CYTHEROPTERON PYRAMIDALE Brady

Cytheropteron pyramidale BRADY, 1868*(21)*, p. 34, pl. 5, fig. 11-14; HIRSCHMANN, 1916; p. 576; BLAKE, 1933, p. 240.

Diagnosis.—Distinguished by its inflated appearance in dorsal view, with gently sloping profile from aliform projection to posterior extremity, posterior included angle approximately 85°; subreticulate ornamentation, increasing in prominence toward posterodorsal quadrant in lateral view, with single ridge trending from below mid-dorsum to mid-posterior edge. Venter ornamented with delicate longitudinal ridges between aliform projection and ventral margin; small nodular prominence just above alate ridge and below median point, followed by shallow transverse sulcus.

Description.—Carapace moderately small, thick, inflated, subovate in lateral view; single valves subscalene in dorsal view. Highest in front of mid-length; widest at one-third length from posterior end. Dorsal margin gently convex, with slight posterior sinuosity; anterior margin broadly rounded below concavity at cardinal angle; ventral lateral profile convex; posterior edge drawn out, broadly convex below and concave above posterior extremity.

Surface characteristically weakly reticulate to punctate in anterior half, with increasingly bold reticulations in posterior half oriented with reticulations elongated away from area of maximum alation toward well-defined though shallow ridge which trends parallel to dorsal margin and about one-fourth height of carapace from it. Second low alate ridge underlain by 5 poorly defined longitudinal ridges visible only in ventral view. Just in front of mid-line and above alate ridge is single small node, behind which is shallow sulcus inclined anterodorsally.

Hinge of right valve consists of single crenulate anterior tooth, followed posteriorly by sinuous crenulate groove, indentations of which deepen and widen in posterior third, followed by crenulate posterior tooth. Hinge in left valve corresponds. Right valve with marginal concavity at each end of hinge and bar above hinge; left valve with anterior and posterior hinge flanges which overlap concavities in right valve; median portion of left hinge overlapped by dorsal bar of right valve. Muscle-scar pattern vertical row of 4 adductor scars, anterior to uppermost of which is cluster of 3, and 2 accessory scars (only one visible in Fig. 15a) anterior and ventral to main group. Exterior sulcus expressed within by bold vertical ridge posterior to muscle-scar pattern. Marginal area broad and without selvage. Moderately deep anterior and shallow posterior vestibules. Radial pore canals few, simple, straight, and irregularly spaced.

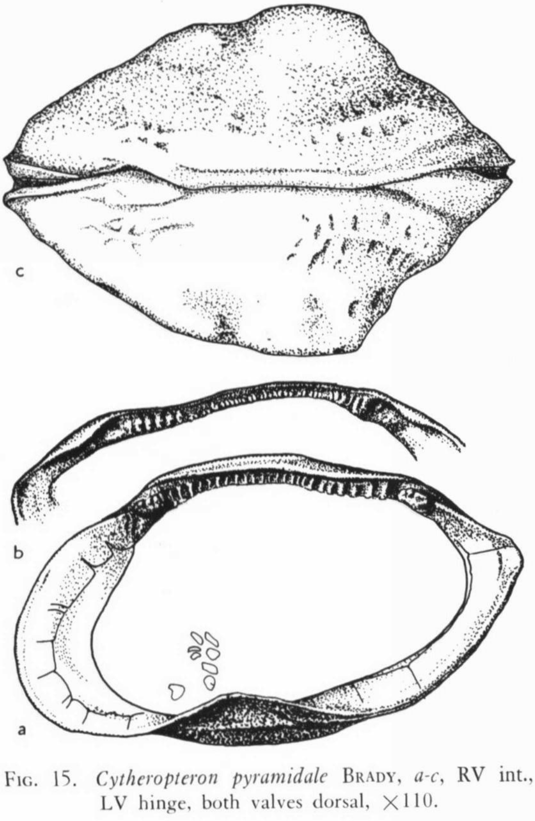

FIG. 15. *Cytheropteron pyramidale* BRADY, *a-c*, RV int., LV hinge, both valves dorsal, ×110.

Dimensions.—Length 0.59 mm., height 0.32 mm., width 0.36 mm.

Material.—Specimens 4, 3 of which were articulated valves.

Distribution.—Reported by BRADY (1868) from the coast of Norway; by HIRSCHMANN (1916) from the Baltic; by ELOFSON (1941) from coasts of Greenland, Spitzbergen, Franz Joseph Land and Sweden; by BLAKE (1933) from the Mt. Desert Island area.

Occurrence.—Taken at stations 47, 48, 52, at depths of 63, 75, and 100 feet and in a substrate of sandy silt, silty sand, and silty sand respectively. BLAKE collected this species to a depth of 72 feet.

Hypotype.—UKMIP M512.

Illustrations.—Fig. 5,*10*, RV lat. ext., ×85.——Fig. 15*a-c*, RV lat. int., LV hinge, both valves dorsal, ×110.

Family CYTHERIDEIDAE Sars, 1925

Subfamily CYTHERIDEINAE Sars, 1925

Genus HAPLOCYTHERIDEA Stephenson

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

Cytheridea (Haplocytheridea) STEPHENSON, 1936, p. 700; EDWARDS, 1944, p. 507.

Haplocytheridea STEPHENSON, 1944, p. 159; STEPHENSON, 1946, p. 321; SWAIN, 1955, p. 617; KEIJ, 1957, p. 59; BENSON, 1959, p. 48; HOWE, 1961, p. Q276; BENSON & COLEMAN, 1963, p. 27; BENSON & TATRO, 1964, p. 15, SANDBERG, 1964, p. 357; POOSER, 1965, p. 41.——Type species: *Cytheridea montgomeryensis* HOWE & CHAMBERS, 1935*(41)*, p. 17; pl. 1, fig. 1; pl. 2, figs. 1-3, 7, 9; pl. 6, figs. 17-18.

Diagnosis.—Recognized by its subovate to subpyriform carapace. Surface smooth, pitted, or with median subvertical weak furrows. Hinge holomerodont; reversal not unknown. *U. Cret.-Rec.*

HAPLOCYTHERIDEA SETIPUNCTATA (Brady)

Cytheridea setipunctata BRADY, 1869, v. 1, p. 124, pl. 14, figs. 15, 16.

Cytheridea (Haplocytheridea) ponderosa STEPHENSON, 1938, p. 133.

Haplocytheridea setipunctata (Brady), SANDBERG, 1964, p. 361.

Diagnosis.—Recognized by is moderately large size, highly arched dorsum, truncate posterior, reverse hingement, and notched selvage, and distinctive ornamentation.

Description.—Carapace of moderate size (reported as large by most authors), heavily calcified. Lateral outline subtriangular in left valve consisting of gently sloping, nearly straight anterodorsum, narrowly rounded anterior; nearly straight venter except for gentle sinuosity anterior to midpoint; perpendicular, nearly straight posterior margin joints posterodorsal margin slightly above mid-height, which in turn forms obtuse angle with anterodorsal margin at point of maximum height. Right valve overlaps left valve, outline more ovate and margins more convex than left valve.

Ornamentation of numerous, moderate large pits which are outer expressions of sieve-type normal pore canals. Hinge of left valve consisting of broad, inward sloping anterior dental area with 10 or 11 denticles, narrowing backward into narrow, straight crenulate bar which widens at posterior end into terminal dental area with 6 denticles, anterior 2 of which tend to be V-shaped. Hinge of right valve corresponds. Muscle scar consisting of vertical row of 4 scars with heart-shaped scar anterior to uppermost of row and single elongate accessory scar anterior to and slightly below lowermost member of row. Marginal area of left valve narrow posteriorly, wide at anterior end, without vestibule. Numerous simple straight radial pore canals.

Remarks.—SANDBERG (1964), in his paper on *Haplocytheridea*, had at his disposal many of the collections of authors who had previously worked on this genus, including specimens from BRADY's collections, STEPHENSON's holotype and paratype, and numerous specimens of *H. setipunctata*. SANDBERG's figures of the species from Laguna Madre, Mexico, are nearly identical to specimens in the Narragansett Bay fauna, except that the latter are slightly smaller. Comparison of figures of *H. gigantea* BENSON & COLEMAN (1963) with those of *H. setipunctata* given by SANDBERG (1964) indicates their close similarity, and SANDBERG states that the BRADY specimens had a notched or depressed selvage in the posteroventral area. There are differences, however, between the Narragansett Bay specimens and those of BENSON & COLEMAN from the eastern Gulf of Mexico. The adult specimens from Rhode Island are not denticulate on the anteroventral margin, and they possess reverse hingement. Therefore I am not quite as certain as SANDBERG that *H. gigantea* is conspecific with *H. setipunctata*.

ALEXANDER & ALEXANDER (1933) noted that where a species of *Cytheridea* occurred abundantly, hinge reversal was present in 75 percent of the specimens. Therefore, some question exists as to the propriety of characterizing a species partly on the presence of hinge reversal. All of the specimens from Narragansett Bay exhibit hinge reversal, as did those of GROSSMAN's (1961) unnamed species from Pamlico Sound. *Haplocytheridea setipunctata* possess a definite notched selvage which, as noted by GROSSMAN, occurs with reversed dentition in *H. proboscidiala* (EDWARDS), but it is much more highly arched and has a stronger hinge. It should be noted that the muscle-star pattern is apparently reversed in the figure of *H. proboscidiala* (EDWARDS) in BENSON & COLEMAN, 1963, p. 29, fig. 15. *H. setipunctata* also has reverse dentition in common with *H. bradyi* (STEPHENSON), but differs from it in shape and in not having a granulate surface.

Dimensions.—Length 0.77 mm., height 0.45 mm.

Material.—Specimens 17, of which 3 were articulated. Two adults.

Distribution.—Narragansett Bay, Rhode Island; Pamlico Sound, North Carolina; Laguna Madre, Mexico.

Occurrence.—Taken at stations 1, 29, 34, and 36 at depths of 4 to 59 feet, in sediment ranging from silty sand

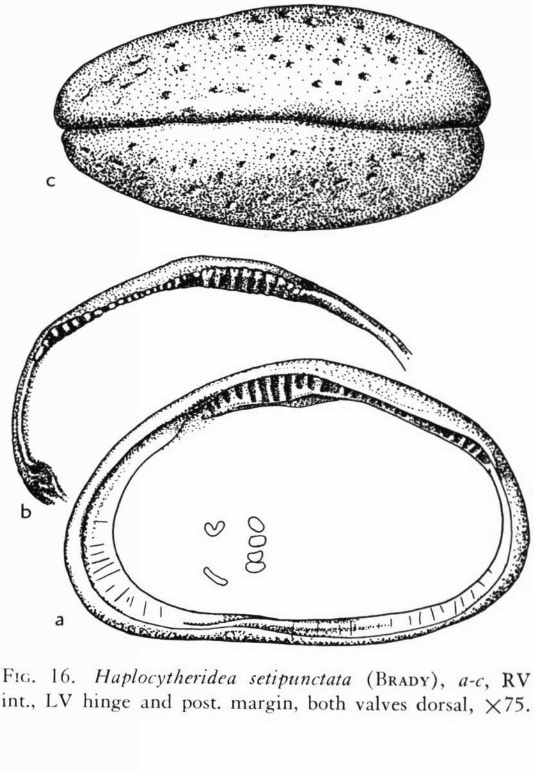

FIG. 16. *Haplocytheridea setipunctata* (BRADY), *a-c*, RV int., LV hinge and post. margin, both valves dorsal, ×75.

to sand. Reported by GROSSMAN to have been taken at 10 feet in silty sand at a salinity of 30.00 ‰.

Hypotype.—UKMIP M513.

Illustrations.—Fig. 5,*11*, RV lat. ext., ×55.——Fig. 16*a-c*, RV lat. int., LV hinge and post. margin, both valves dorsal, ×75.

Subfamily EUCYTHERINAE Puri, 1954

Genus EUCYTHERE Brady

Eucythere BRADY, 1868, p. 430; VAN MORKHOVEN, 1963, p. 337.——Type species: *Cythere declivis* NORMAN, 1865, p. 16; SD BRADY & NORMAN, 1889.

Diagnosis.—Carapace ovate triangular in lateral view. Hinge lophodont. Muscle-scar pattern oblique row of 4 with large heart-shaped scar located anteriorly. Marginal area broad anteriorly with development of deep vestibule: radial pore canals few, normal pore canals large sieve type. Sexual dimorphism present, males more elongate and narrower than females. *U. Cret.-Rec.*

EUCYTHERE DECLIVIS (Norman)

Cythere declivis NORMAN, 1865, p. 16, pl. 5, figs. 9-12.
Eucythere declivis (Norman), BRADY, 1868*(20)*, p. 429; SARS, 1922, p. 163; BLAKE, 1933, p. 233; WAGNER, 1957, p. 43.

Diagnosis.—Recognized by its small size and subtriangular outline, very broadly rounded anteriorly and abbreviated posteriorly. Maximum height equal to three-fifths of length, highest at anterior cardinal angle. Hinge typical of genus, with anterior element in right valve indistinctly crenulate extension of selvage, followed by groove and posterior crenulate element which merges with selvage posteriorly. Above groove is dorsal flange and below it delicate ridge. Left valve overlaps right valve above anterior and posterior elements. Hinge margin nearly straight; ventral margin nearly straight with very slight sinuation. Circular mandibular scar present in some specimens with 2nd small circular scar below. Surface with numerous large, sieve-type normal pore canals forming large punctae.

Remarks.—Recent specimens of *Eucythere declivis* have been reported by BLAKE from the Mt. Desert Island region of Maine, and BRADY (1870) reported it from the Gulf of St. Lawrence. After studying numerous specimens of *E. argus* (SARS) and *E. declivis,* BRADY & NORMAN (1889) decided that they were conspecific with *E. anglica* (BRADY, CROSSKEY, & ROBERTSON), and that *E. argus* and *E. anglica* were local impoverished forms of *E. declivis*. On the other hand, SARS (1928), rejected this, stating that *E. argus* was easily distinguished from *E. declivis. E. argus* is lower, with height not quite one-half of its length; its surface is more heavily punctate, and legs are heavier and lengthen backward more quickly.

Eucythere declivis is distinguished from *E. undulata* KLIE by the absence of a crenulate or denticulate anterior margin, in having a more slanting posterior margin, and in its smaller size.

EDWARDS (1944) named a new species, *Eucythere gibba*, from the Duplin Marl (upper Miocene) of North Carolina. It differs from *E. declivis* in being considerably larger (0.70 to 0.77 mm. long and 0.38 to 0.40 mm. high) and is more evenly rounded. EDWARDS cited the presence of 2 circular scars between the anterior U-shaped scar and the posterior row of 4 scars in the muscle-scar pattern. In my opinion the larger of the 2 scars is the mandibular fulcral scar common to the genus and the lower smaller scar, present in some but not all specimens of *E. declivis* from Narragansett Bay, is possibly also common to the genus. Accordingly, the 2 are not diagnostic of any one species. In addition to these scars, I have observed that the anterior U-shaped scar tends to subdivide into 2 subequal parts. Also, the lowermost and largest scar of the vertical row of 4 tends to subdivide, leaving a small scar just in front of the next to lowermost scar.

Dimensions.—Length 0.48 mm., height 0.26 mm., width 0.26 mm.

Material.—Specimens 19, of which 11 were articulated.

Distribution.—World-wide. *Eucythere declivis* has been reported by BRADY (1868) from Scotland (single specimen); BRADY & NORMAN (1889) from Norway, Bay of Biscay, Isle of Capri, and Naples; RUGGIERI (1952) from the Quaternary of Italy; by WAGNER (1957) from the Holocene of the Netherlands, and in fossil form from Scotland, South Wales, Ireland, Norway, and Canada.

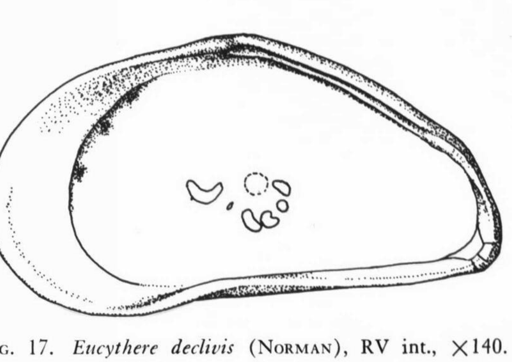

FIG. 17. *Eucythere declivis* (NORMAN), RV int., ×140.

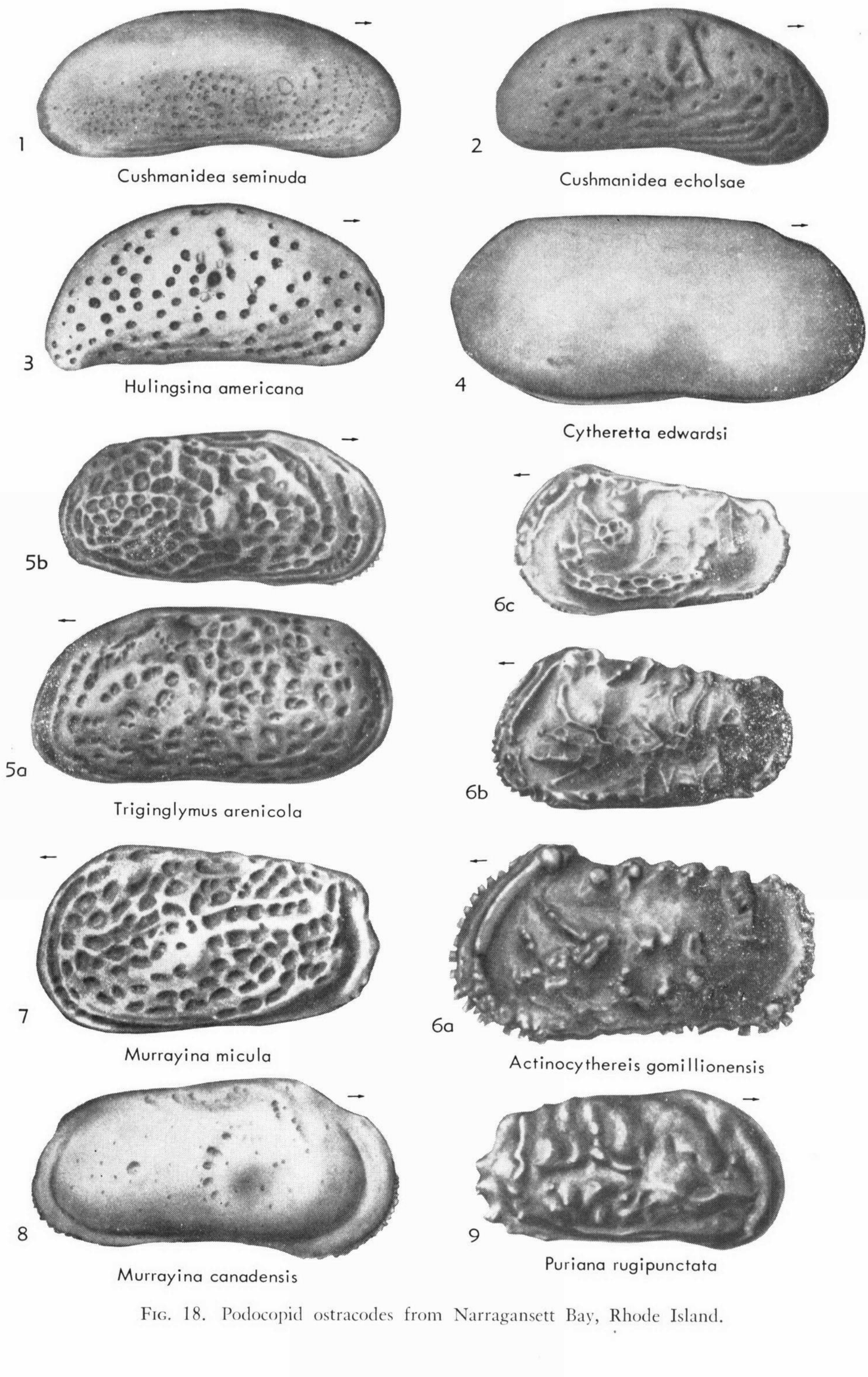

FIG. 18. Podocopid ostracodes from Narragansett Bay, Rhode Island.

Occurrence.—Taken at stations 41, 56, 57, 49, 50, at depths of 22 to 126 feet in clayey silt to silty sand.

Hypotype.—UKMIP M514.

Illustrations.—Fig. 5,*12*, RV lat. ext., ×100.——Fig. 17, RV lat. int., ×140.

Subfamily NEOCYTHERIDEIDINAE Puri, 1957

Genus CUSHMANIDEA Blake

Cytherideis JONES, 1847, p. 46 *(partim)*.
Cytheridea JONES, auctt.
?*Sacculus* NEVIANI, 1928, p. 72.
Pontocythere DUBOVSKY, 1939, p. 29; OERTLI, 1956, p. 56.
Hemicytherideis RUGGIERI, 1952, p. 60; KEIJ, 1957, p. 80.
Cushmanidea BLAKE, 1933, p. 233; PURI, 1958*(70)*, p. 171; HOWE, 1961, p. Q290; BENSON & KAESLER, 1963, p. 21.——Type species: *Cytheridea seminuda* CUSHMAN, 1906, p. 374, pl. 33, figs. 62-64; pl. 34, figs. 76-77.

Diagnosis.—Recognized by its elongate, rounded anterior margin and broadly rounded posterior extremity; smooth, pitted, or reticulate surface with ornamentation in linear patterns tending to parallel margins. Hinge lophodont, in right valve with selvage greatly elongated to form anterior tooth, elongate median groove, and more or less rounded posterior tooth which is joined posteriorly to selvage. *Jur.?, Rec.*

REMARKS.—VAN MORKHOVEN (1963) retains the genus *Pontocythere* DUBOVSKY (1937), distinguishing it from *Cushmanidea* on details of soft parts and hingement. PURI *(70)* and HOWE *(40)* have regarded *Pontocythere* as congeneric with *Cushmanidea*. Certainly the hinge structure is very similar and on this basis I favor placing *Pontocythere* in synonymy with *Cushmanidea*.

VAN MORKHOVEN (1963) has figured *Cythereis elongata* BRADY as a species of *Pontocythere*, and WAGNER (1957) has placed *C. elongata* in *Hemicytherideis*. PURI (1958, *70*) included *C. elongata* as a species of *Cushmanidea*, with which I concur. The generic features of WAGNER's figure of the interior of this species, republished by VAN MORKHOVEN (1963) under *Pontocythere*, compare quite favorably with specimens of *Cushmanidea seminuda*. However, WAGNER's drawing probably should include a groove above the crenulate median element.

CUSHMANIDEA SEMINUDA (Cushman)

Cytheridea seminuda CUSHMAN, 1906, p. 374, pl. 33, figs. 62-64, pl. 34, figs. 76, 77.

Diagnosis.—Recognized by its relatively large size; evenly rounded extremities, anterior more narrowly rounded than posterior; nearly smooth except in ventral and anterior portions where punctae are arranged in even rows parallel to anterior and ventral margins; hinge distinctive, consisting in right valve of elongate anterior element which merges without break with anterior selvage. Dorsal to this element and continuing to posterior end is groove, above which prominent dorsal flange occurs. Dorsal flange and median groove continue slightly over posterior hinge element which merges with prominent posterior selvage. Hinge of left valve corresponds; it has elongate anterior groove, above which is prominent flange and below which is antislip bar that terminates abruptly anteriorly. Median element is slightly crenulate bar below groove bordered dorsally by delicate flange. Posterior element is crenulate socket, more or less open to interior and over which is flange. Anterodorsal flange of left valve is commonly broken in inarticulated specimens.

Remarks.—This well-known species is easily distinguished by its ornamentation and outline. The species is characterized by sexual dimorphism, males being lower and more elongate than females, approaching a subrectangular outline. In this respect, the male *Cushmanidea seminuda* appears to be very like specimens of *C. elongata*, except for lacking a hulingsinid-type of posteroventral angulated selvage. PURI (1958, *70*) figured more variation within *C. seminuda* than I believe to exist, and there is possibly some confusion between *C. seminuda* and *C. elongata*.

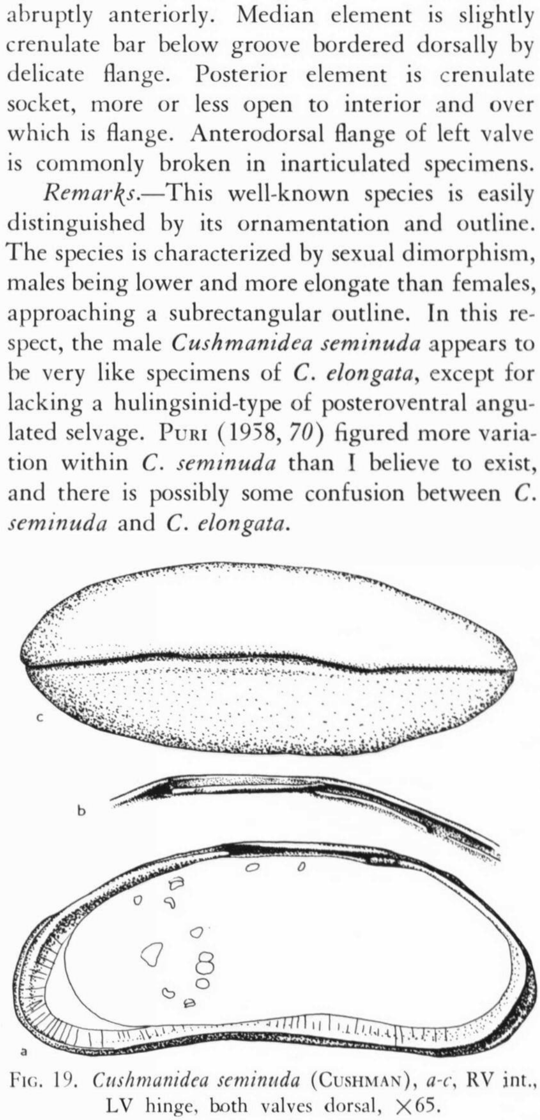

FIG. 19. *Cushmanidea seminuda* (CUSHMAN), *a-c*, RV int., LV hinge, both valves dorsal, ×65.

Dimensions.—Length 1.06 mm., height 0.47 mm., width 0.45 mm.

Material.—Specimens 37, of which 12 were articulated valves.

Distribution.—Reported by BLAKE (1933) from waters off Mt. Desert Island, Maine; by CUSHMAN (1906) from parts of Vineyard Sound, Massachusetts; by GROSSMAN (1961) from the Pamlico Sound, North Carolina, area.

Occurrence.—Taken at stations 34, 35, 36, in depths of 59, 55, and 24 feet, respectively, on a substrate of sand. Collected by BLAKE in 8 feet of water, and by GROSSMAN in from 8 to over 30 feet of water in sand, with a salinity of from 25 to 35 ‰.

Illustrations.—Fig. 18,*1*, RV lat. ext., ×50.——Fig. 19*a-c*, RV lat. int., LV hinge, both valves dorsal, ×65.

CUSHMANIDEA ECHOLSAE (Malkin)

Cytherideis echolsae MALKIN, 1953, p. 778, pl. 78, fig. 14-17.

Cushmanidea echolsae (Malkin), MCLEAN, 1957, p. 78.

Diagnosis.—Recognized by its thin-walled, elongate carapace: numerous irregularly spaced moderately large pits, somewhat sparse in dorsal and posterior regions; gently curved to straight premedian sulcus; up to 5 ventral ribs parallel to margin and trending toward mid-anterior edge.

Remarks.—This is one of the most distinctive species of *Cushmanidea*, and the Narragansett Bay forms are nearly identical to those figured by MCLEAN and GROSSMAN.

Dimensions.—Length 0.78 mm., height 0.35 mm.

Material.—Specimens 16, of which 4 were articulated valves.

Distribution.—Reported from the Yorktown (Miocene) formation of Virginia *(49, 51)*; from the inshore facies of the eastern Mississippi Delta region *(28)*; throughout the Pamlico Sound, North Carolina, area as one of the most widespread species *(33)*.

Occurrence.—Taken in Narragansett Bay at 8 stations at depths of 7 to 76 feet in sediment ranging from clayey silt to gravel-sand-silt. Occurred in Pamlico Sound *(33)* at depths of less than 1 foot to more than 30 feet at a salinity of 20 to more than 30 ‰, and in the eastern Mississippi Delta region at depths of 0 to 15 fathoms, at an average temperature of 24°, in sands, silts, and clays *(28)*.

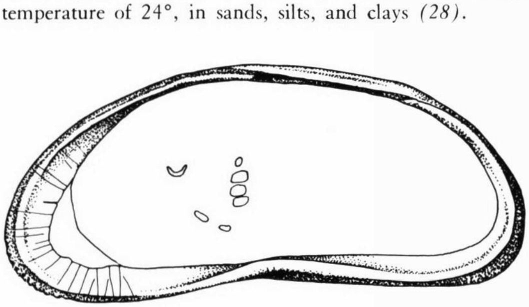

FIG. 20. *Cushmanidea echolsae* (MALKIN), RV int., ×85.

Hypotype.—UKMIP M516.

Illustrations.—Fig. 18,*2*, RV lat. ext., ×65.——Fig. 20, RV lat. int., ×85.

Genus HULINGSINA Puri

Hulingsina PURI, 1958*(70)*, p. 173; HOWE, 1961, p. Q290; BENSON & COLEMAN, 1963, p. 30; POOSER, 1965, p. 45. ——Type species: *Hulingsina tuberculata* PURI, 1958 *(70)*, p. 173, pl. 2, figs. 5-9.

Diagnosis.—Similar to *Cushmanidea*, but posterior margin flattened obliquely in dorsal half. Selvage characteristically well developed, and angles obliquely in posteroventral corner, especially in right valve where it produces pronounced subtriangular flange-groove. *Mio.-Rec.*

HULINGSINA AMERICANA (Cushman)

Cytheridea americana CUSHMAN, 1906, p. 375, pl. 33, fig. 67; pl. 34, figs. 68-75.

Hulingsina americana (Cushman), PURI, 1958*(70)*, p. 173.

Diagnosis.—Recognized by its deeply pitted carapace and highly arched dorsum; distinctive selvage in right valve, which is continuous from anterior hinge element to anterior, ventral, and posterior margins to posterior hinge element. Selvage set well within anterior margin and notably within posteroventral margin where pronounced flange groove occurs; selvage approaches margin in anterodorsum and again slightly anterior to ventral sinuation.

Remarks.—CUSHMAN (1906) figured the left valve of an adult specimen which compares most favorably with left valves in the collections from Narragansett Bay, and it is most logical to assume that CUSHMAN's species would probably be present in an area so near that of his types. CUSHMAN's description did not include hingement, and it is interesting to note that this species has a variation in typical hulingsinid hinge structure (Fig. 21). The posterior flange element of the hinge in the right valve noticeably thickens toward its anterior end so as to form a crenulate tooth. This was found on only one specimen, the single articulated specimen, others being possibly abraded. PURI (1958, *70*) did not mention the feature in his restudy of "*Cushmanidea* and its allies" (although it is suuggested in his figure); also he did not figure clearly the posteroventral flange groove, which is commonly characteristic of the genus. His drawings are all rather more elongated (10%) than one would expect from a comparison of outlines with CUSHMAN's figure and those presented here.

It has been common practice of authors to extend the stratigraphic range of *Hulingsina ashermani* (ULRICH & BASSLER, 1904), with which *H. americana* is very similar, from the Miocene to the Recent, although it has not been found in Pliocene or Pleistocene sediments. *H. ashermani* has been reported from Recent sediments of the eastern Gulf of Mexico *(8)*; eastern Mississippi Delta region *(28)*; open Gulf area of Cape Romano, Florida *(6)*; and Pamlico Sound, North Carolina *(33)*. These forms, with possible exception of the Cape Romano specimens, which are figured without systematic description, are all rather coarsely pitted to reticulate, the carapace being not at all smooth, whereas the Narragansett Bay and Vineyard Sound hulingsinids are essentially smooth, with numerous large punctae (compare with BENSON & COLEMAN, 1963, pl. 4, figs. 1,2). My specimens are similar to those identified as *Cytherideis ashermani* by SWAIN (1946), on deposit at the U.S. National Museum (no. 559899). I am not aware of any publication by SWAIN in 1946 which deals with this specimen, and its age and locality are unknown.

Dimensions.—Length 0.79 mm., height 0.37 mm., width 0.36 mm.

Material.—Six specimens, of which one was articulated.

Distribution.—Vineyard Sound, Massachusetts.

Occurrence.—Taken at stations 22, 27, 29, 34, 36, at depths of 16 to 59 feet in sediment ranging from silty sand to sand (mainly sand).

Hypotype.—UKMIP M517.

Illustrations.—Fig. 18,*3*, RV lat. ext., ×65.——Fig. 21, RV lat. int., ×85.

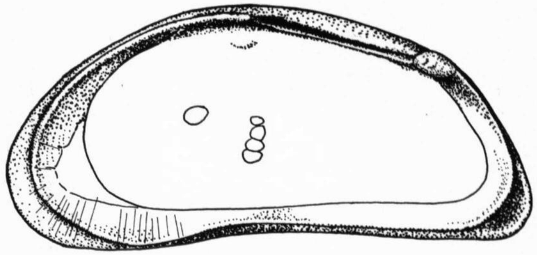

FIG. 21. *Hulingsina americana* (CUSHMAN), RV int., ×85.

Family CYTHERETTIDAE Triebel, 1952

[*nom. transl. et correct.* HOWE, 1961 (*ex* Chyterettinae TRIEBEL, 1952)]

Genus CYTHERETTA Müller

Cytheretta MÜLLER, 1894, p. 382; MÜLLER, 1912, p. 366; EDWARDS, 1944, p. 524; VAN DEN BOLD, 1946, p. 27; PURI, 1952, p. 202; TRIEBEL, 1952, p. 16; PURI, 1953, p. 281; KEIJ, 1957, p. 131; PURI, 1958*(71)*, p. 186; HOWE, 1961, p. Q290; BENSON & MADDOCKS, 1964, p. 21; POOSER, 1965, p. 37.——Type species: *Cytheretta rubra* MÜLLER, 1894, p. 382, pl. 8, fig. 9, 10, 13, 16; pl. 39, figs. 8-22, 24 (=*Cytherina subradiosa* ROEMER, 1838); SD RUGGIERI, 1950, p. 9.

Pseudocytheretta CUSHMAN, 1906, p. 382.

Cylindrus NEVIANI, 1928, p. 106.

Prionocytheretta MÉHES, 1941, p. 60.

Diagnosis.—Recognized by its elongate ovoid carapace; surface smooth, punctate, or reticulate, some species with prominent longitudinal ribs. Left valve larger than right. Hinge holamphidont, in right valve consisting of prominent triangular anterior tooth, postjacent open socket, smooth median groove, and large smooth (usually triangular) posterior tooth. Muscle-scar pattern vertical row of 4 scars with heart-shaped antennal scar anterior and mandibular scars near ventral inner margin. Marginal area broad and irregular, with line of concrescence coincident with inner margin throughout, forming characteristic S-shaped curve anteriorly. Radial pore canals numerous, curved, commonly branching and thickened at mid-length. *Eoc.-Rec.*

Remarks.—VAN MORKHOVEN (1963) considered species with longitudinal ridges or folds to belong to separate subgenera from the taxon—*Cytheretta (Cytheretta)*—which includes *C. jurinei* (MÜNSTER, 1830), *C. burnsi* (ULRICH & BASSLER, 1904), *C. minor* (LIENENKLAUS, 1905), *C. edwardsi* (CUSHMAN, 1906), *C. rhenana* TRIEBEL, 1952, and *C. eocaenica* KEIJ, 1957, as species conforming to his understanding of the genus.

CYTHERETTA EDWARDSI (Cushman)

Pseudocytheretta edwardsi CUSHMAN, 1906, p. 382, 383; pl. 38, figs. 119-132.

Cytheretta edwardsi (Cushman), MÜLLER, 1912, p. 366; PURI, 1958*(71)*, p. 187.

Diagnosis.—Distinguished from most other species by total absence of external ornament.

Remarks.—This species of *Cytheretta* is identical to CUSHMAN's forms, as revealed by PURI *(71)*, who reoccupied CUSHMAN's stations. MÜLLER (1912) reported that CUSHMAN's *Pseudocytheretta* is indistinguishable from *Cytheretta* on the basis of carapace characteristics. PURI considered this to be paleontologically sound. However, CUSHMAN indicated anatomical differences in his original description. *C. edwardsi* differs from *C. rhenana rhenana* TRIEBEL (1952), another smooth species, in that *C. edwardsi* has a much straighter dorsal margin in both sexes, more evenly rounded anterior and less truncate dorsoposterior margins, is much larger (*C. rhenana rhenana* being 0.81 to 0.88 mm. long), and has about one-third more anterior radial pore canals.

Specimens collected in Narragansett Bay commonly display gastropod borings.

Dimensions.—Length 1.28 mm., height 0.63 mm., width 0.59 mm.

Material.—Specimens 37, of which 7 were articulated.

Distribution.—Taken by CUSHMAN in Vineyard Sound, Massachusetts, confined to deep water and sandy sediment.

Occurrence.—Taken at stations 25, 29, 34, 35, 36, 39, 44, 46, 56, 62 from depths of 29 to 59 feet in clayey silt to sand (6 articulated specimens from sand).

Hypotype.—UKMIP M518.

Illustrations.—Fig. 18,*4*, RV lat. ext., ×45.——Fig. 22, RV lat. int., ×50.

FIG. 22. *Cytheretta edwardsi* (CUSHMAN), RV int., ×50.

Family LEGUMINOCYTHERIDIDAE Howe, 1961

Genus TRIGINGLYMUS Blake

Triginglymus BLAKE, 1950, p. 181; KEIJ, 1957, p. 127; HOWE, 1961, p. Q307; POOSER, 1965, p. 35.——Type species: *Triginglymus hyperochus* BLAKE, 1950, p. 181, pl. 30, figs. 4-9.

Diagnosis.—Recognized by its moderately large subquadrate carapace. Hinge holamphidont; ventrally directed triangular projections (dorsal supporting scar platforms) below and posterior to anterior elements. Muscle-scar pattern consisting of a vertical row of 4 adductor scars, with 2 small antennal scars in front of upper elements of row and 2 mandibular scars just above ventral inner margin. Radial pore canals numerous, simple, straight. *Eoc.-Rec.*

TRIGINGLYMUS ARENICOLA (Cushman)

Cythereis arenicola CUSHMAN, 1906, p. 379, pl. 36, figs. 97-107.

Diagnosis.—Recognized by its triangular dorsal supporting scar platform; robust and moderately large size in mature specimens, contrasting with younger instars; pitted carapace; slightly concave anterodorsal margin in right valve, and dorsal pit below margin.

Description.—Carapace elongate to oblong in lateral view, dorsal and ventral margins parallel. Anterior margin obliquely rounded with slight concavity in anterodorsal margin of right valve; posterior margin evenly rounded in left valve, flattened in upper half of right valve. Inflated in dorsal view; broadly rounded posteriorly and evenly rounded to narrowly rounded anteriorly. Width one half of length, widest in posterior third of carapace.

Surface of mature specimens pitted somewhat randomly except in anterior part where 3 concentric rows of coalescing pits occur, with outermost row trending parallel to margin, from midanterior region around ventral margin to upper posterior margin, diminishing in prominence at ventral sinuation. Second row, consisting of large pits not so commonly coalescing as in outer row, trends parallel to outer row from slightly higher anteriorly, and extends to just behind ventral sinuation where pits become scattered and no longer aligned. Intervening ridge between 2 outer rows smooth and prominent. Inner row of pits trending anteroventrally from just behind and below anterior cardinal angle, where it continues parallel to next outer row, becoming less well defined ventrally. Surface further characterized by single large, much deeper, pit below dorsal margin, one-quarter of its length from anterior cardinal angle. Subcentral tubercle, prominent in younger instars, is all but lost in ultimate stage; this pit has form of elongate depression in young instars. Pits occupy less than one-half of total surface area in adults, whereas pits account for well over one-half surface of immature specimens.

Interior with holamphidont hinge, modified in both valves by presence of ventrally directed triangular projections (commonly called "antislip teeth"). In right valve, trending obliquely downward and rearward from just below anterior end of hinge groove is lobelike projection that terminates abruptly at point about one-third of length of hinge groove. In right valve this projection lies just inward of hinge, whereas in left valve it is displaced inward from hinge approximately one-half depth of valve. Muscle-scar pattern lies upon sides of smooth depression and consists of vertical row of 4 elongate scars with 2 or 3 additional scars anterior on the opposite slope of depression. Tendency is seen for some elongated scars in vertical row to divide. Marginal area broad, with shallow anterior vestibule. Radial pore canals numerous, simple, straight anteriorly, less numerous posteriorly.

Remarks.—Forms which appear closely related to *Triginglymus arenicola* are *T. gnythophoreus* KRUTAK (1961) and *Leguminocythereis whitei* SWAIN (1951). *T. gnythophoreus*, from the Eocene of Alabama, differs in having more pits, randomly oriented, flattening of anterior margin, and in general hinge geometry. SWAIN's form, which should properly be classified as a species of *Triginglymus*, is very similar except in ornamentation and shape, being more reticulate and elongate, closely resembling young forms of *T. arenicola*. POOSER (1965, p. 37) reported that *T. whitei* is commonly found in Recent sediments of Narragansett Bay, and while I found no specimens of *T. whitei*, it is my opinion that *T. arenicola* is the form to which POOSER referred.

This genus requires further study. Considerable change in size and shape, strength, and ornament of the carapace appears to distinguish latest from earlier instars. The valves become less angular and more heavily calcified. A subcentral tubercle, prominent in the young, is all but lost in mature forms. These changes confuse ontogeny of this species, and mature specimens appear superficially to bear no direct relationship with younger instars.

I believe the term "antislip tooth" (BLAKE. 1950), to be a misnomer, in that this feature would not serve any function in hingement, and that very probably it is a greatly enlarged body scar. The location of the feature is not the same in each valve, being displaced well below the hinge in the left valve, and the ventral surface of the feature appears to have the character and substance of other muscle or ligamentary scars. The term "antislip tooth" should be abandoned and be replaced by designation as dorsal supporting scar platform. Moos (1957) is correct in disclaiming the antislip properties of this feature, but because it is a prominent and distinguishing characteristic, I can find no reason for placing this genus in synonymy with *Leguminocythereis*. KEIJ (1957) was possibly in error in his depiction of the "antislip tooth" as an integral part of the hinge.

PURI *(66)* listed *Hemicythere arenicola* (CUSHMAN) as a good *Hemicythere*. I regard *Triginglymus*, as well as the remainder of the Leguminocytheridae, as intermediate between the Hemicytheridae and Trachyleberididae, and while rather close affinities with the Hemicytheridae cannot be doubted (as indicated by subdivision of muscle scars), a sufficient combination of characteristics serves to distinguish them from the Hemicytheridae.

Dimensions.—Male, length 0.89 mm., height 0.36 mm., width 0.46 mm. Female, length 0.91 mm., height 0.45 mm.

Material.—Specimens 27, of which 3 were articulated.

Occurrence.—Taken at stations 34, 35, 36, 52, 54, at depths from 24 to 100 feet, in sediment ranging from sand-silt-clay to sand. At station 36 at 24 feet 23 specimens were taken in sand. CUSHMAN (1906) found this species common on sandy bottoms.

Hypotypes.—UKMIP M519 (adult); UKMIP M520 (instar).

Illustrations.—Fig. 18,*5a*, LV lat. ext., ×55; *5b*, RV lat. ext., immature instar, ×65.——Fig. 23*a-c*, RV lat. int., LV hinge, RV dorsal, ×70.

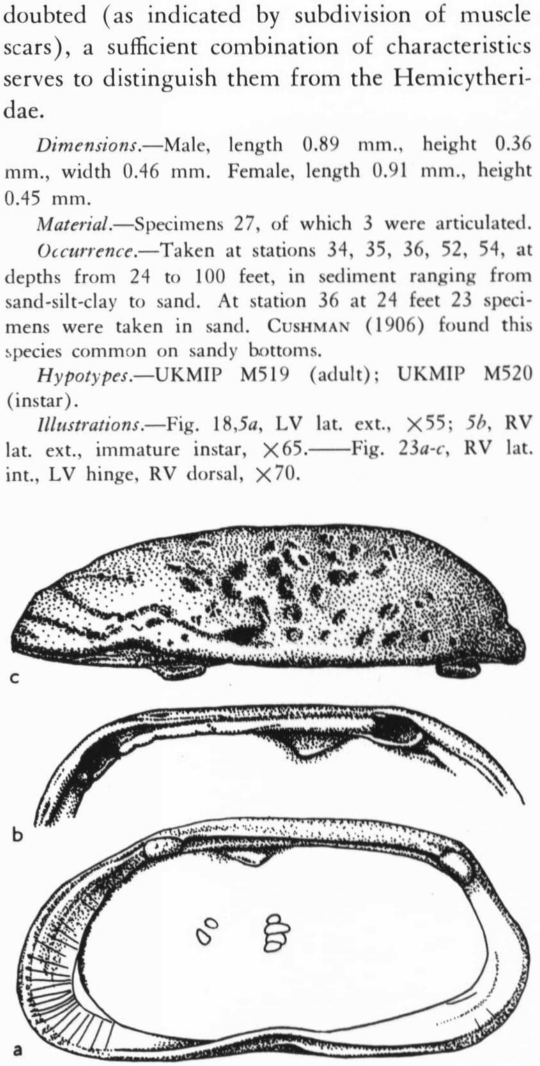

FIG. 23. *Triginglymus arenicola* (CUSHMAN), *a-c*, RV int., LV hinge, both valves dorsal, ×70.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Genus ACTINOCYTHEREIS Puri

Actinocythereis PURI, 1953*(66)*, p. 178; PURI, 1954, p. 252; SWAIN, 1955, p. 634; SYLVESTER-BRADLEY, 1961, p. Q334; BENSON & COLEMAN, 1963, p. 47; POOSER, 1965, p. 55.——Type species: *Cythere exanthemata* ULRICH & BASSLER, 1904, p. 117, pl. 36, figs. 1-5.

Diagnosis.—Carapace with 3 longitudinal rows of spines; hinge holamphidont. *Eoc.-Rec.*

ACTINOCYTHEREIS GOMILLIONENSIS (Howe & Ellis)

Cythereis exanthemata, var. *gomillionensis* HOWE & ELLIS, 1935*(42)*, p. 19; pl. 1, figs. 6-12; pl. 4, fig. 3; EDWARDS, 1944, p. 521; VAN DEN BOLD, 1946, p. 88.

Trachyleberis exanthemata gomillionensis (Howe & Ellis), MALKIN, 1953, p. 792.

Actinocythereis exanthemata, var. *gomillionensis* (Howe & Ellis), PURI, 1953*(66)*, p. 181; PURI, 1953*(69)*, p. 253; McLEAN, 1957, p. 83.

Diagnosis.—Carapace typical of genus. Species recognized by its 3 distinct rows of rounded to sharp buttressed elongate spines; elongation of spines perpendicular to trend of rows, dorsal row parallel to dorsal margin to just in front of posterior cardinal angle, where it turns toward mid-line of venter; median row trends rearward from subcentral tubercle, then bends toward postero-venter, anterior to point where dorsal row intersects mid-line; ventral row trends parallel to median row, but is less well defined and commonly broken into isolated spines. Three rows of spines radiate from subcentral tubercle, perpendicular to anterior margin. Posterior angle nearly 90°. Smooth ridge extends from eye tubercule, within and parallel to anterior margin, to mid-anterior margin where it abruptly changes into row of spines continuing parallel to ventroanterior margin and venter. Species is easily recognized by its row of fine pustules (Fig. 24c) above dorsal row of spines and adjacent to hinge of right valve.

Remarks.—This species is common to the east coast of the United States. In my collection are numerous instars, affording opportunity to determine through establishment of recognizable criteria, immature forms previously categorized simply as "archycythereid" forms. These instars were found to possess at least 3 distinguishing morphologic features from the earliest instar (Fig. 18, fig. 24c). Trending parallel to the anterior margin from the eye tubercule on all instars is a delicate ridge which increases in boldness with successive instars, forming an anterior marginal rim in the adult stage. The second feature is found on the subcentral tubercle, which is always divided in the anterior portion into 3 punctations which gradually deepen with maturity to the degree that intervening ridges become spines in the adult. The third feature is in development of the lowermost ridge, which is not spinose in the early instars, but rather is a prominent reticulate ridge, the reticulations of which become more pronounced with maturity, then break into spines. The posterior end of the ridge is commonly pointed, and not rounded, presenting a nearly alate configuration in dorsal view.

A previously unreported feature of the mature forms of *Actinocythereis gomillionensis* was noted in this collection, although probably present on the earlier reported specimens. The male forms, which are lower and more elongate in lateral view, possess a dimorphic flaring in the posteroventral extremity which is accounted for in a parting of the valves when fully articulated. This is possibly to accommodate the genitalia, and is quite pronounced and consistent throughout the collection.

The foregoing features are sufficiently diagnostic of forms previously referred to *Actinocythereis exanthemata gomillionensis* that this subspecies is here elevated to full species rank, standing as distinct from *A. exanthemata. Cythereis vineyardensis* CUSHMAN (1906) possibly is conspecific with *A. gomillionensis.* Anatomical studies will have to be made comparing the two, because CUSHMAN's figures of the carapace are insufficiently diagnostic. If they prove identical, *C. vineyardensis* will become senior synonym for the species, and the correct name will be *Actinocythereis vineyardensis* (CUSHMAN).

Dimensions.—Male, length 0.81 mm., height 0.40 mm., width 0.36 mm. Female, length 0.82 mm., height 0.40 mm., width 0.36 mm.

Material.—Specimens 181, of which 55 were articulated, and 108 adult or penultimate.

Distribution.—Reported from the Miocene of Cuba and Guatemala by VAN DEN BOLD (1946) and from the upper Miocene of North Carolina (EDWARDS, 1944), Virginia (MALKIN, 1953; McLEAN, 1957), Florida (HOWE & graduate students, 1935,*42*; PURI, 1953,*69*).

Occurrence.—Found at depths of 7 to 102 feet in clayey silt to gravelly sand. [See table 5 for localities.]

Hypotypes.—UKMIP M521 (adult); UKMIP M522 (intermediate instar); UKMIP M523 (early instar).

Illustrations.—Fig. 18,*6a*, LV lat. ext., adult, ×80; *6b*, LV lat. ext., intermediate instar, ×60; *6c*, LV lat. ext., early instar, ×65.——Fig. 24*a-c*, RV lat. int. (adult), RV lat. int. (late instar), both valves dorsal (adult), ×75.

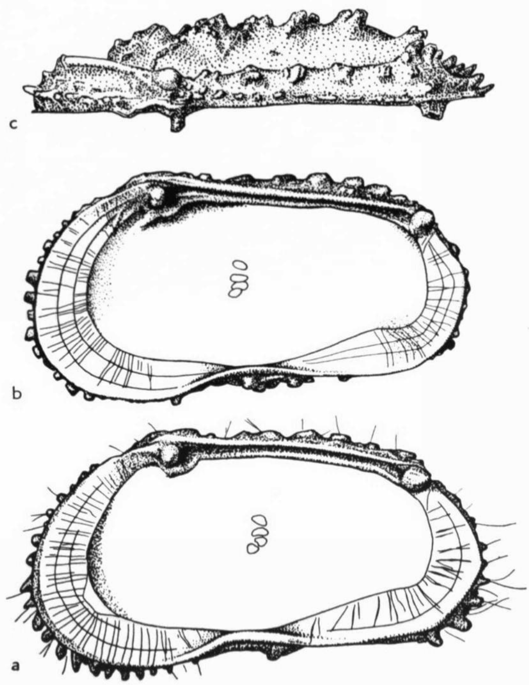

FIG. 24. *Actinocythereis gomillionensis* HOWE & ELLIS, *a-c,* RV int. (adult), RV int. (late instar), RV dorsal (adult), ×75.

Genus MURRAYINA Puri

Murrayina PURI, 1953*(69)*, p. 255; MCLEAN, 1957, p. 85; SYLVESTER-BRADLEY, 1961, p. Q339; POOSER, 1965, p. 59.——Type species: *Murrayina howei* PURI, 1953 *(69)*, p. 255, pl. 12, figs. 9, 10; text figs. 8g, h.

Diagnosis.—Recognized by its elongate, subrectangular carapace with smooth, pitted, or reticulate surface. Well-defined anterior and posterior rims and subcentral tubercle. Hinge holamphidont; right valve with smooth, crenulate, or stepped anterior tooth, postjacent socket, crenulate groove, and smooth posterior tooth. Adductor muscle scars subdivided.

Remarks.—The categorization of genera followed herein is that of the *Treatise on Invertebrate Paleontology* (MOORE, 1961). With respect to *Murrayina*, however, it is probable that this genus should be placed in the Hemicytheridae, since the modified holamphidont hinge, divided adductor and frontal scars, and weakly developed eye tubercules *(95)* are not generally attributed to the Trachyleberididae. It is further probable that *Murrayina* is closely related to *Urocythereis*, but there are differences in hingement *(69)* that distinguish the genera. Analyses of soft parts of the constituent species of the respective genera will probably resolve this problem. *Paleoc.-Rec.*

MURRAYINA MICULA (Ulrich & Bassler)

Cythere micula ULRICH & BASSLER, 1904, p. 116, pl. 36, figs. 18-20.

Trachyleberis? martini (Ulrich & Bassler), SWAIN, 1951, p. 29.

Murrayina martini (Ulrich & Bassler), MCLEAN, 1957, p. 86; POOSER, 1965, p. 60.

Diagnosis.—Identified by its moderately small (0.5 mm.), subrectangular carapace, with reticulations radiating from low but well-defined subcentral tubercle, narrow but prominent rim and groove about anterior, ventral, and posterior margins; crenulate anterior and smooth posterior hinge teeth on right valve.

Remarks.—Specimens in the Narragansett Bay collections fulfill most of the descriptive requirements for the species as set forth by ULRICH & BASSLER (1904). There are discrepancies, however. The adult specimens are slightly larger than those of ULRICH & BASSLER (yet not so large as *Murrayina martini*), nor do they bear spines. Spines are present on both valves of immature specimens, but diminish to low pustules in the ultimate stage. J. E. HAZEL (personal communication, 1965) has suggested that the *M. martini* of recent authors is mainly *M. micula* (only SWAIN, 1948, having reported *M. martini* accurately), and that by comparisons made with specimens in the U. S. National Museum, those from Rhode Island are most similar to *M. micula*, and not *M. martini*; how-

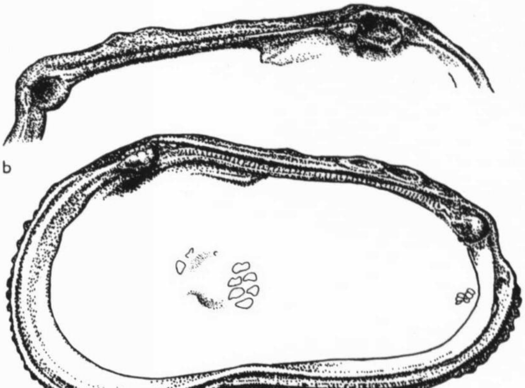

FIG. 25. *Murrayina micula* (ULRICH & BASSLER), *a,b,* RV int., LV hinge, ×95.

ever, the poor illustration and crushed holotype of *Cythere linenklausi* ULRICH & BASSLER may also represent this species and, therefore, would have page priority.

Dimensions.—Length 0.67 mm., width 0.38 mm.

Material.—Specimens 20, of which 3 were articulated.

Distribution.—Reported throughout Miocene sediments from Maryland to Florida.

Occurrence.—Taken at stations 35, 36, 41, 49, 50, 54, 56, at depths of 24 to 126 feet (mainly less than 55 feet) in sediment ranging from clayey silt to sand.

Hypotype.—UKMIP M524.

Illustrations.—Fig. 18,7, LV lat. ext., ×75.——Fig. 25*a,b*, RV lat. int., LV hinge, ×95.

MURRAYINA CANADENSIS (Brady)

Cythere canadensis BRADY, 1870, p. 452, pl. 19, fig. 4-6; BRADY & NORMAN, 1889, p. 166.

Cythereis canadensis (Brady), CUSHMAN, 1906, p. 377.

Diagnosis.—Distinguished by its moderate size and weakly pitted to finely reticulate carapace, with 5 pits arranged in sulcate arc about posterior edge of subcentral tubercle.

Description.—Carapace of medium size, with nearly parallel dorsal and ventral margins, obliquely rounded anterior margin denticulate in lower half, posterior margin flat or slightly concave in upper half, evenly rounded and denticulate in lower half, denticulation present on both valves. Moderate rim and inner groove extending from upper portion of anterior margin, around venter to upper portion of posterior margin. Outline in dorsal view ovate, more pointed anteriorly, without irregular projections.

Surface ornamentation variable, some specimens more reticulate than others, characteristically with prominent smooth subcentral tubercle bordered posteriorly by at least 5 prominent pits arranged in arcuate row; pits commonly most anterior members of rows radiating backward from subcentral tubercle. Lower anterior quadrant of valve commonly devoid of ornament.

Hinge typical of genus. Muscle-scar pattern variable, most commonly with posterior row of 4 scars, next to uppermost divided and commonly next lower scar divided or greatly elongated. Anterior to this group is cluster of 2 or 3 scars. Prominent elongate body scar, analogous to that found on *Triginglymus* but not so elevated, is commonly located on underside of hinge, just behind anterior socket in right valve and in corresponding position in left valve. Marginal area broad, with prominent selvage and shallow vestibule. Numerous straight, simple radial pore canals.

Remarks.—Some specimens of *Murrayina canadensis* resemble those of *M. micula*, but *M. canadensis* is larger, less quadrate, longer in relation to height, and more obliquely rounded anteriorly. The reticulations of both forms follow the same general pattern when present on *M. canadensis*. BRADY (1870) noted the ornamentation displayed by this species, some forms having a rather well-developed reticulate network especially in the posterior region, but others only a trace of this ornamentation. All specimens in the Narragansett Bay collections have at least the rudiments of this ornamentation, manifested in the row of pits just posterior to the subcentral tubercle. BRADY & NORMAN (1889, pl. 15, figs. 4 and 5) figured a specimen which is more angular than the rounded form which BRADY (1870) originally described and figured. The Narragansett Bay specimens compare best with the 1870 figures and description.

Dimensions.—Length 0.74 mm., height 0.38 mm., width 0.31 mm.

Material.—Specimens 43, of which 13 were articulated.

Distribution.—Vineyard Sound, Massachusetts; Gulf of St. Lawrence; Davis Strait.

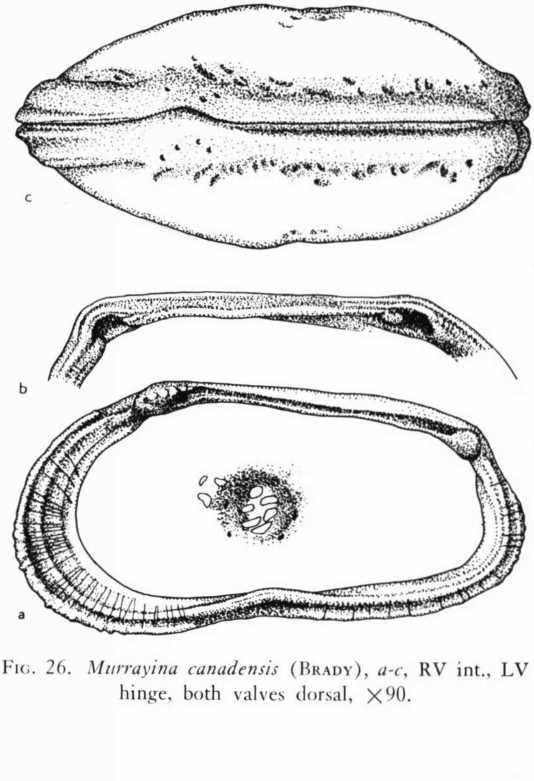

FIG. 26. *Murrayina canadensis* (BRADY), *a-c*, RV int., LV hinge, both valves dorsal, ×90.

Occurrence.—Taken at 12 stations at depths of 22 to 100 feet (mainly less than 55 feet) in sediment ranging from clayey silt to gravelly sand.

Hypotype.—UKMIP M525.

Illustrations.—Fig. 18,*8*, RV lat. ext., ×75.——Fig. 26*a-c*, RV lat. int., LV hinge, both valves dorsal, ×90.

Genus PURIANA Coryell in Puri

Favella CORYELL & FIELDS, 1937, p. 8; EDWARDS, 1944, p. 523 (*non Favella* JORGENSEN, 1925).

Puriana CORYELL in PURI, 1953, p. 751; SWAIN, 1955, p. 634; BENSON, 1959, p. 60; SYLVESTER-BRADLEY, 1961, p. Q341; BENSON & COLEMAN, 1963, p. 42; BENSON & KAESLER, 1963, p. 30; VAN MORKHOVEN, 1963, p. 200; POOSER, 1965, p. 61.——Type species: *Favella puella* CORYELL & FIELDS, 1937, p. 8, figs. 8a-c, juvenile (=*Cythere rugipunctata* ULRICH & BASSLER, 1904, p. 118, pl. 38, figs. 16-17).

Diagnosis.—Distinguished from other trachyleberids by its small, subquadrate carapace, ornamented with subvertical rounded ridges on posterodorsum, 3 to 5 spines on posteroventral margin, subcentral tubercle, and prominent anterior marginal rim. Hinge holamphidont. Marginal area moderately broad, commonly with vestibules; radial pore canals few, simple, sometimes branching. *Mio.-Rec.*

PURIANA RUGIPUNCTATA (Ulrich & Bassler)

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

Cythereis rugipunctata (Ulrich & Bassler), HOWE & Graduate Students, 1935*(42)*, p. 23.

Favella rugipunctata (Ulrich & Bassler), EDWARDS, 1944, p. 524; MALKIN, 1953, p. 797; VAN DEN BOLD, 1946, p. 100; VAN DEN BOLD, 1950, p. 86.

Puriana rugipunctata (Ulrich & Bassler), CORYELL & FIELDS in PURI, 1953, p. 751; PURI, 1953, p. 257; McLEAN, 1957, p. 89; BENSON & COLEMAN, 1963, p. 43.

Diagnosis.—Easily recognized by its small size and ornamentation, which consists of prominent subcentral tubercle, backward from which single longitudinal flexuous ridge trends above smooth continuous depression. Extending to dorsal margin from this ridge are 4 or 5 rounded ridges, and below depression numerous nodes or spines. Posteroventral margin characteristically bears 4 or 5 spines or denticles.

Remarks.—The specimens collected from Narragansett Bay conform in most respects to those previously described. In ornamentation, however, the forms are subdued, being less spinose and more smoothly rounded than those reported by BENSON & COLEMAN (1963), nor were any spines observed on the anterior margin as reported by McLEAN (1957).

Dimensions.—Length 0.68 mm., height 0.34 mm., width 0.36 mm.

Material.—Specimens 12, of which 2 were articulated.

Distribution.—Reported from Miocene sediments of Maryland *(93)*; New Jersey, Maryland, and Virginia *(51)*; Virginia *(49)*; North Carolina *(30, 87)*; Florida *(42, 69)*; Panama *(27)*; Cuba Guatemala, British Honduras, Venezuela, and Trinidad *(16-18)*. Reported also from Recent sediments of eastern Gulf of Mexico *(8, 72, 73)*; from Pamlico Sound, North Carolina *(33)*; and Trinidad *(18)*.

Occurrence.—Taken at stations 40 and 49 at depths of 7 and 102 feet in sand-silt-clay and silty sand respectively. Taken by BENSON & COLEMAN at depths of 19 to 239 feet (most abundant at depths less than 50 feet) at a salinity of from 35.01 to 39.92 ‰. Taken by GROSSMAN from depths of 10 to more than 30 feet on sand to silty sand at a salinity of from 25 to 35 ‰

Hypotype.—UKMIP M526.

Illustrations.—Fig. 18,9, RV lat. ext., ×65.——Fig. 27*a,b*, RV lat. int., LV hinge, ×95.

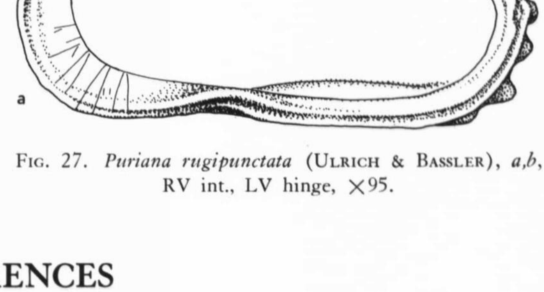

FIG. 27. *Puriana rugipunctata* (ULRICH & BASSLER), *a,b*, RV int., LV hinge, ×95.

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