Revista Mexicana de Ciencias Geológicas, volumen 11, número 2,
1994, p. 193-213
Universidad Nacional Autónoma de México, Instituto de Geología,
México, D.F.

ECOLOGY, TAXONOMY AND DISTRIBUTION OF DOMINANT OSTRACODE TAXA IN MODERN CARBONATE SEDIMENTS, NORTHEASTERN YUCATÁN SHELF, MEXICO

Paul R. Krutak[1] *and*
Raúl Gío-Argáez[2]

ABSTRACT

Nearshore, oolitically-coated carbonate grains indicative of high energy characterize the marine strait between Isla Mujeres and Puerto Juárez, State of Quintana Roo, Mexico. Low-energy, high Mg-calcite-rich mud is forming to the south in Nichupte lagoon. Six ostracode species, two of which are new, are present in five widely spaced quantitative (total = live + dead) samples collected from each of these two discrete lithotopes. Ternary plots of the three most common species in marine strait grainstones reveal: (1) *Paranesidea gigacantha* dominates, (2) second-order dominants are almost equally divided between *P. gigacantha* and *Paranesidea cancunensis* n. sp., (3) third order dominants consist of *P. cancunensis* n. sp. and *Neonesidea longisetosa*.

Combined, these five species make up 59% of the ostracode fauna and are adapted to the following hydrochemical regime: salinity 20.4 to 37.6 ppt, temperature 28.0 to 31.0 degrees C, water depth 2.1 to 5.0 m, dissolved oxygen 5.0 to 6.8 ppm. Ternary diagrams of the first three dominants from low energy lagoonal muds indicate: (1) *Hemicyprideis nichuptensis* n. sp. dominates, (2) second-order dominants are usually *Xestoleberis* sp. aff. *X. margaritea*, (3) third-order dominants consist of *P.* cf. *P. bensoni* and *P. gigacantha*. Together, these four species make up 78% of the total ostracode fauna and inhabit sediments with the following characteristics: salinity 20.0 to 37.6 ppt, temperature 27.0 to 32.5°C, water depth 0.6 to 5.0 m, dissolved oxygen 1.8 to 5.0 ppm.

Key words: Ostracode, Yucatán shelf, Mexico.

RESUMEN

Granos de carbonato con recubrimiento oolítico indicativos de alta energía, formados en ambientes cercanos a la costa, caracterizan el estrecho marino entre Isla Mujeres y Puerto Juárez, en el Estado de Quintana Roo, México. Hacia el sur se está formando fango de baja energía rico en Mg-calcita en la laguna Nichupte. Seis especies características de ostrácodos, de las cuales dos son nuevas, se presenta en cinco muestras cuantitativas de reconocimiento (total = vivo + muerto) que fueron recolectadas en forma espaciada de cada uno de estos dos discretos litotopos. Las gráficas ternarias de las tres especies más comunes dentro de los granolitos *(grainstones)* del estrecho marino muestran que: (1) *Paranesidea gigacantha* predomina, (2) los dominantes del segundo orden están divididos casi en forma igual entre *P. gigacantha* y *Paranesidea cancunensis* n. sp., (3) los dominantes del tercer orden son *P. cancunensis* n. sp. y *Neonesidea longisectosa*.

Estas especies en conjunto constituyen el 59% de la fauna de ostrácodos y están adaptadas al siguiente régimen hidroquímico: salinidad 20.4 a 37.6 pp millón, temperatura 28.0 a 31.0 °C, profundidad 2.1 a 5.0 m, oxígeno disuelto 5.0 a 6.8 pp millón. Los diagramas ternarios de los tres primeros dominantes de los fangos lagunares de baja energía indican: (1) La predominancia de *Hemicyprideis nichuptensis* n. sp., (2) los dominantes del segundo orden son *Xestoleberis* sp. aff. *X. margaritea,* con algunas *Paranesidea* cf. *P. bensoni* y otras, (3) los dominantes del tercer orden consisten en *P.* cf. *P. bensoni* y *P. gigacantha.* Estas especies juntas constituyen el 78% del total de la fauna de ostrácodos y viven en sedimentos con las siguientes características: salinidad 20.0 a 37.6 pp mil, temperatura 27.0 a 32.5°C, profundidad 0.6 a 5.0 m y oxígeno disuelto, 1.8 a 5.0 pp millón.

Palabras clave: Ostrácodos, plataforma de Yucatán, México

INTRODUCTION

Carbonate shelf margins like Yucatán constitute models for predictable trends and facies patterns in fossil oil and gas reservoirs. For this reason, they have long attracted the interest of petroleum geologists. A huge literature exists concerning their sediment composition, texture, and structures (Frost *et al.*, 1977; Enos and Perkins, 1977; Scholle *et al.*, 1983). Their ostracode microfaunas have been documented by many authors (Baker and Hulings, 1966; Bold, 1966, 1974, 1977, 1988; Brady, 1866, 1867-1871, 1879; Izuka and Kaesler, 1986; Keij, 1973, 1976; Kornicker, 1957, 1958, 1961, 1963; Krutak, 1974, 1975, 1982; Maddocks, 1969, 1974; Malz, 1988; Malz and Lord, 1988; Palacios-Fest *et al.*, 1983; Pokorny, 1968, 1978; Teeter, 1975; Tressler, 1949; Triebel, 1948). The tendency of these benthic microscopic crustaceans to live in discrete lithotopes makes them extremely valuable as facies indicators and as indices of depositional environments. Furthermore, since they are microscopic, they can easily be recovered from well cuttings and cores. Like the foraminifers, they are extremely valuable in subsurface correlation and paleoecology (Pokorny, 1978; Bate and Robinson, 1978).

[1]*Department of Geosciences, 600 Park Street, Fort Hays State University, Hays, Kansas 67601-4099, U.S.A.*
[2]*Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Delegación Coyoacán, 04510 D.F., México.*

This paper documents six distinctive species of modern ostracodes that characterize nearshore carbonate sediments on the northeastern Yucatán Shelf, Mexico. The species represent the dominant—the three most common species in each sample—species identified from ten samples out of a total of 46 collected by the authors. Ten reconnaissance samples were selected to represent two discrete sedimentary-ecologic environments: (1) high Mg-calcite-rich organic muds of shallow-water brackish lagoons, and (2) oolitically-coated grainstones of an open-marine strait. The junior author is currently documenting the entire ostracode fauna extracted from all 46 samples and these will be the subject of a future report.

This preliminary report describes the bottom water conditions prevailing at the time of sampling and relates these to species distribution in the 10 samples.

STUDY AREA

The northeastern Yucatán Peninsula contains a nearly continuous belt of coastal lagoons filled with carbonate muds, muddy sands, and organic detritus (Figure 1). From west to east, they include: (1) Lagartos, (2) Yalahau (called Yalchan by some authors), (3) Boca Iglesia, (4) Blanca, and (5) Nichupte lagoons.

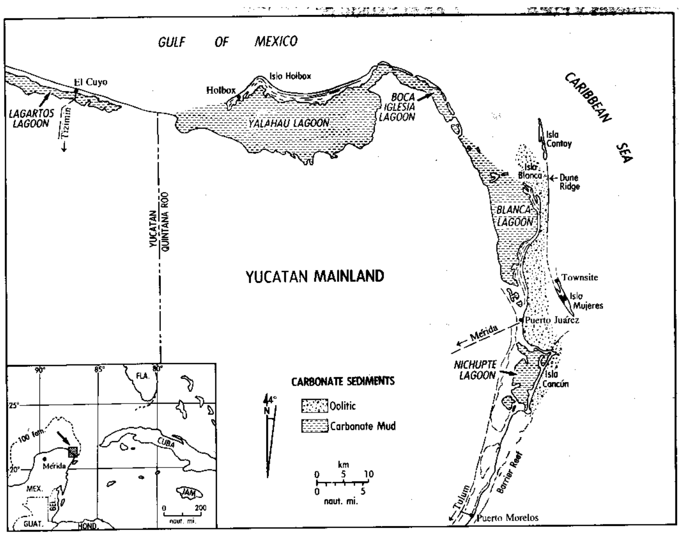


Figure 1.- Carbonate lagoons of northeastern Yucatán, Mexico. Adapted from Brady (1974, p. 150, fig. 1).

Despite their proximity and apparent similarities (*cf.* Brady, 1974) each lagoon has a different geological history. Brady (*op. cit.*) showed that differences in local geography, bedrock topography, and the nature of seaward barriers influence the texture and composition of their sediments. Cores through Holocene sediments of Blanca and Nichupte lagoons (Figure 1) reveal complex changes in barrier island development and Holocene sea level rise during the last 6,000 years (Brady, 1974, figs. 2-11). Seaward of these muddy, shallow lagoons and bays, carbonate sediments increase in size to sand and even gravel (Ward and Brady, 1973; Ward, 1974; Ward and Wilson, 1974). This part of the Caribbean continental shelf is only a few miles wide, and has narrowed sharply from the broad Gulf of Mexico platform (Campeche Shelf).

Ward and Wilson (1974, fig. 2) showed that the main portions of the islands of Contoy, Mujeres, and Cancún (Figures 1 and 2) are remnants of eolian ridges (Figure 1) deposited on the outer edge of the 5-fathom (~ 9m) terrace during a low sea-level stand.

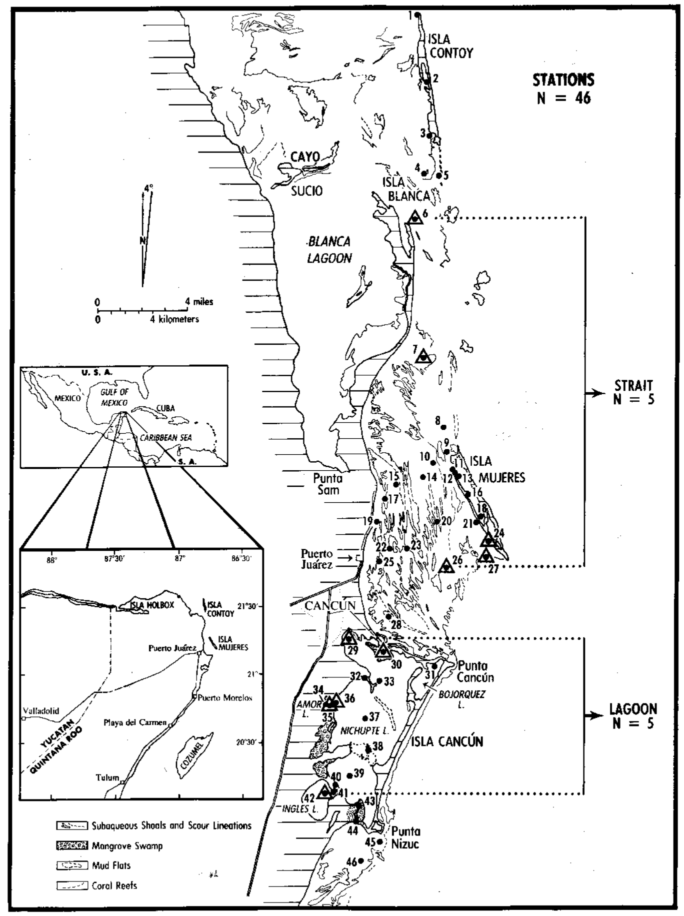


Figure 2.- Study area, northeastern Yucatán Shelf, Mexico. Black dots indicate all sampling stations (N = 46). Triangles locate strait (stations 6, 7, 24, 26, 27) and lagoon samples (stations 29, 30, 35, 36, 42). See Table 1 for summary of ecological data at all 46 stations, and Figures 3-6 for map distributions of salinity, temperature, depth, and dissolved oxygen.

The structure of the continental shelf south of Isla Cancún is controlled by a series of normal fault blocks (Vedder *et al.*, 1971); the sea floor descends to depths over 1,000 feet (305 m) in less than 10 miles (16 km) from the Caribbean shoreline. Near Cancún, where the narrow shelf begins to widen again, an abrupt change in sedimentation occurs. Coastal sediments accumulate in a barrier-reef-lagoon setting south of Cancún (beginning at Punta Nizuc; Figure 2). Northward, sediments are being deposited in eolian ridge-strait and barrier island-coastal lagoon settings.

Purdy (1974) published cross sections of Holocene sediment and reef thickness of the Belize reef complex. His sections indicate that both the barrier reef platform and associated lagoon reefs are located on Pleistocene limestone prominences. Ward (1974) described a similar situation along the northeastern coast of Quintana Roo in the Isla Mujeres-Cancún area.

This area has been proposed as a modern analogue of the Smackover (Jurassic, Oxfordian) grainstone and associated facies belt on the northern rim of the Gulf of Mexico (Wilson and Jordan, 1983).

HYDROGRAPHY

A portion of the Yucatán Current, the major surface current in the Gulf of Mexico, flows northwestward along the Yucatán coast. It funnels through the strait between Isla Mujeres and Puerto Juárez (Figure 2) with average velocities of about 50 cm/sec—1 knot—(Harms *et al.*, 1974). Apparently, these currents are rarely altered in direction except during winter northerly gales. As Ward (1974) pointed out, the Yucatán Current, coupled with wave refraction, causes a net northward-moving longshore current in this area. Littoral drift and wave deposition contributed to accretion of numerous Holocene beach ridges in the peninsular Isla Blanca area north of Punta Sam (Figure 2).

Southeast of Puerto Juárez, longshore currents have deposited sandy spits and tombolos connecting the bedrock points of Isla Cancún to the mainland beach. Carbonate dunes also occur along this portion of the coast from the northern tip of Isla Blanca to the southern end of Isla Cancún.

This portion of Yucatán is on a principal hurricane track. Almost every hurricane that affects the northern Gulf of Mexico moves through the Yucatán Channel or over the northeastern corner of the Yucatán Peninsula (Dunn and Miller, 1964). For example, Hurricane Gilbert (September 15, 1988), one of the most destructive of this century, passed over Cancún. There is little synoptic data on the number and intensity of tropical storms that have passed through the area; however, in the first half of this century, at least 12 hurricanes crossed northeastern Yucatán (Tannehill, 1950). These hurricanes result in large finger-like spillover lobes and shoals developed by catastrophic waves refracting around Isla Contoy and Isla Cancún and in washover fans extending into the lagoons behind Isla Blanca and Isla Cancún. Ward (1974) thought that the prominent, deep current lineations (dashed lines, Figure 2) between Isla Mujeres and Puerto Juárez may have been excavated during hurricanes and are maintained by the prevailing current.

SAMPLING PROGRAM AND COLLECTING TECHNIQUES

Sediment samples were collected in July, 1981, from 46 stations (Table 1, Figure 2). Bottom samples were obtained by snorkeling and free diving. In some cases, a heavy pipe dredge was used to obtain material. Samples are surface scrapes and consist of large volumes of material (usually more than a liter of sample).

The following data were recorded at each sample site: date and hour of sampling, salinity, temperature, depth, and dissolved oxygen (Table 1, Figures 3-6). Sample stations were located on aerial photographs by resection from known shore points at Puerto Juárez, Cancún, and Isla Mujeres (Figure 2).

A Yellow Springs Instrument Corporation Model 512A polarographic oxygen meter was used to measure bottom water dissolved oxygen and temperature. Bottom water salinity readings were obtained with a Martek TDC (temperature, depth, conductivity) probe. Depth measurements were taken with a centimeter-calibrated sounding line on the oxygen thermistor and checked against the TDC readings.

After recovery, the samples were immediately stored in large plastic jars, fixed with methyl alcohol, and stained with Rose Bengal. The stain marks soft parts of living ostracodes and makes possible the later distinction between living and dead individuals.

LABORATORY TECHNIQUES

Large volumes (~ 1 liter) of fixed bottom sediment were washed using a 200-mesh sieve (openings 74-88 micrometers) and oven-dried at low temperature. Ostracodes from each of the 46 dry samples were picked (U.S. standard sieve sizes 105-840 micrometers) and mounted using conventional techniques.

Five samples from each of the two major sedimentary facies were selected for analysis. Stations 6, 7, 24, 26, and 27 (Figure 2) represent marine strait carbonate grainstones. Stations 29, 30, 35, 36, and 42 (Figure 2) include lagoonal micrites and organics.

Where possible, approximately 300 specimens from each sample were picked and counted (Dryden, 1931; Kafescioglu, 1975). Live-dead counts were not made, although it is possible to do so at a later date. Counts shown on Tables 2 and 3 and Figures 9 and 10 represent total populations (live + dead, counted as valves or carapaces) at each sampling site. These thanatocoenoses approximate what paleontologists may recover from ancient sedimentary rocks.

ECOLOGIC PARAMETERS

Salinities on the open inner shelf are 35-36 ppt (Leipper, 1954). Salinities determined in this study ranged from 19.4 ppt to 40 ppt (Figure 3, Table 1).

Surface water temperatures on the shelf are about 82°F (28°C) during the summer and about 7° F (25°C) in the winter (Leipper, 1954). Bottom water temperatures measured during this summer study ranged from 79°F (26°C) to 100°F (38.0°C) (Figure 4, Table 1).

Table 1.- Ecologic data collected at 46 sampling stations, northeastern Yucatán Shelf, Quintana Roo, Mexico, 7-6-81 to 7-17-81. Salinity is in parts per thousand (ppt), temperature in degrees Celsius (°C), depths in meters (m), and dissolved oxygen in parts per million (ppm). Salinity, temperature and dissolved oxygen values are bottom measurements made near or at the sediment-water interface. Positions where no data were obtained indicated by "n. da". See Figure 2 for locations of sampling stations and Figures 3-6 for map distributions of ecologic data. Average number (mean) for each ecological variable is plotted graphically on Figures 3-6.

Station	Date	Time	Salinity [ppt]	Temp. [°C]	Depth [m]	Diss. Oxygen [ppm]
1	7-17-81	13:13	n. da	29.00	3.40	10.00
2	7-17-81	12:43	n. da	31.00	1.80	2.50
3	7-17-81	12:13	n. da	28.00	1.50	4.80
4	7-17-81	11:45	n. da	31.00	5.00	6.20
5	7-17-81	14:00	n. da	29.00	2.40	n.da
6	7-17-81	11:15	n. da	31.00	2.10	6.20
7	7-17-81	10:32	n. da	28.00	5.00	5.00
8	7-17-81	10:06	n. da	28.00	6.00	5.40
9	7-06-81	10:53	37.50	28.50	2.00	7.20
10	7-06-81	11:15	37.50	28.50	4.00	6.40
11	7-06-81	10:21	37.50	28.00	2.00	6.80
12	7-10-81	09:00	n. da	27.50	1.10	5.20
13	7-06-81	09:48	36.80	28.00	1.00	5.50
14	7-10-81	10:26	n. da	27.50	4.10	5.20
15	7-10-81	11:00	n. da	29.50	2.40	7.60
16	7-06-81	09:30	37.80	30.00	1.50	5.80
17	7-10-81	11:40	n. da	29.00	2.90	6.00
18	7-06-81	08:20	40.00	31.00	6.00	4.20
19	7-10-81	14:18	n. da	29.50	3.50	7.60
20	7-08-81	12:43	36.20	29.00	3.00	6.90
21	7-08-81	09:25	37.60	38.00	3.50	6.80
22	7-10-81	14:27	n. da	29.00	3.50	5.80
23	7-15-81	10:05	n. da	28.00	5.00	5.80
24	7-08-81	10:37	37.60	28.00	3.00	6.80
25	7-13-81	11:00	36.20	29.00	3.50	5.80
26	7-08-81	12:00	36.20	29.00	4.00	6.50
27	7-08-81	11:10	37.60	28.00	4.00	6.30
28	7-13-81	11:49	36.20	28.50	2.80	6.40
29	7-14-81	10:40	34.80	31.50	2.20	6.60
30	7-13-81	14:17	36.40	30.50	2.00	5.89
31	7-13-81	12:57	36.00	31.00	1.60	4.80
32	7-14-81	11:30	29.40	31.50	1.00	4.60
33	7-13-81	12:37	34.00	31.00	1.90	6.00
34	7-14-81	13:50	19.40	26.00	2.40	0.40
35	7-14-81	14:05	20.00	27.00	1.90	3.40
36	7-14-81	12:35	20.40	27.00	2.50	1.80
37	7-14-81	11:50	33.00	30.50	2.40	5.40
38	7-13-81	13:32	35.00	31.00	2.00	6.40
39	7-14-81	12:22	35.00	31.00	2.20	5.50
40	7-15-81	11:35	n. da	31.50	2.10	6.00
41	7-15-81	12:16	n. da	32.00	1.80	5.20
42	7-15-81	11:55	n. da	32.50	0.60	4.60
43	7-13-81	13:32	33.40	32.00	2.00	7.00
44	7-15-81	13:30	n. da	31.00	1.70	5.80
45	7-13-81	14:30	37.40	29.00	1.70	6.40
46	7-15-81	13:00	n. da	32.00	3.30	7.20
Sum			888.90	1366.50	125.30	247.69
Average			34.20	29.71	2.72	5.50
Count			26.00	46.00	46.00	45.00
Minimum	7-06-81	09:00	19.40	26.00	0.60	0.40
Maximum	7-17-81	14:30	40.00	38.00	6.00	10.00
Standard Deviation			13.85	2.02	1.27	1.65
Variance			191.82	4.09	1.61	2.72

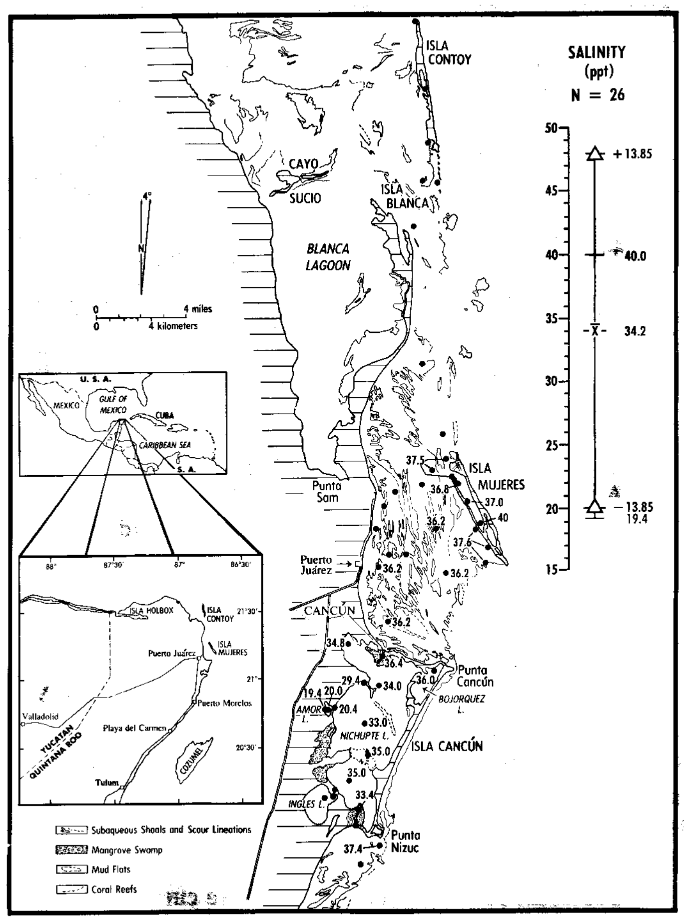


Figure 3.- Bottom water salinity distribution (ppt), northeastern Yucatán Shelf, Mexico. Barred x = mean value of 26 measurements. Horizontal bars give ranges. Deltas are 1 standard deviation on either side of the mean. See Table 1 for tabulation of raw data.

Shallow water prevails in the strait between Isla Mujeres and the mainland and in adjacent lagoons. Depths measured in this study ranged from 2 ft (0.6 m) to 20 ft (6 m) (Figure 5, Table 1).

Dissolved oxygen values at the sediment/water interface range from 0.40 ppm to 10.00 ppm (Figure 6, Table 1).

SYSTEMATICS

This section includes taxonomic descriptions, illustrations, and discussions of the six dominant ostracode species occurring in the study area. The descriptions and illustrations were prepared by Krutak. The species include: *Hemicyprideis-nichuptensis* Krutak n. sp., *Neonesidea longisetosa* (Brady, 1902), *Paranesidea bensoni* (Teeter, 1975), *Paranesidea cancunensis* Krutak n. sp., *Paranesidea gigacantha* (Kornicker, 1961), and *Xestoleberis* sp. aff. *X. margaritea* (Brady, 1869).

The systematics section follows the taxonomic system of Hartmann and Puri (1974); however, the taxonomic units Tribe and Subgenus are not used here. Identifications are based on comparison of our specimens with the Belize primary types of Teeter (1975) on deposit in the Henry V. Howe collection

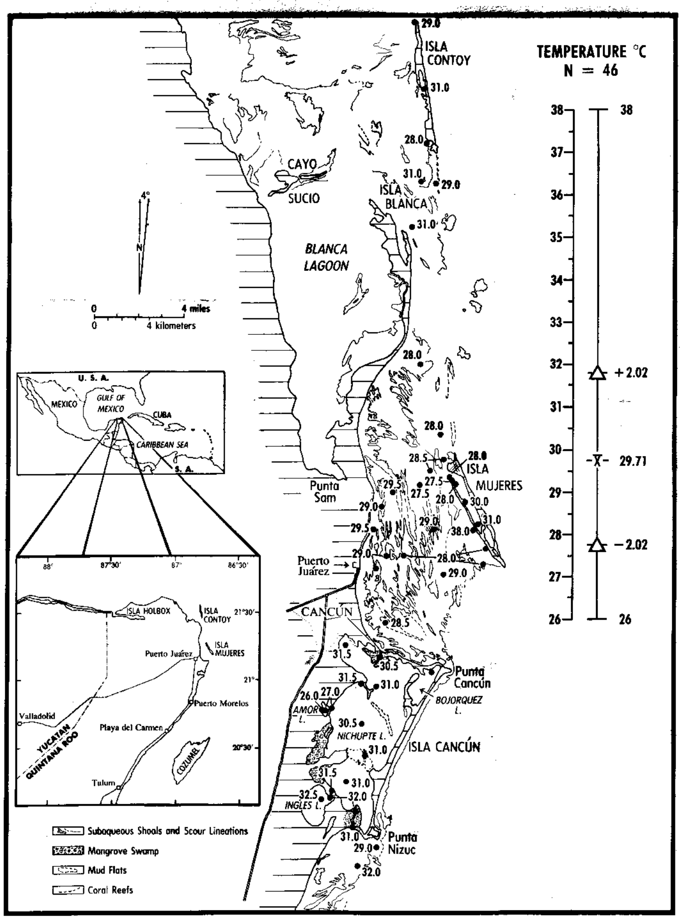


Figure 4.- Bottom water temperature distribution (°C), northeastern Yucatán Shelf, Mexico. Barred x = mean value of 46 measurements. Horizontal bars give ranges. Deltas are 1 standard deviation on either side of the mean. See Table 1 for tabulation of raw data.

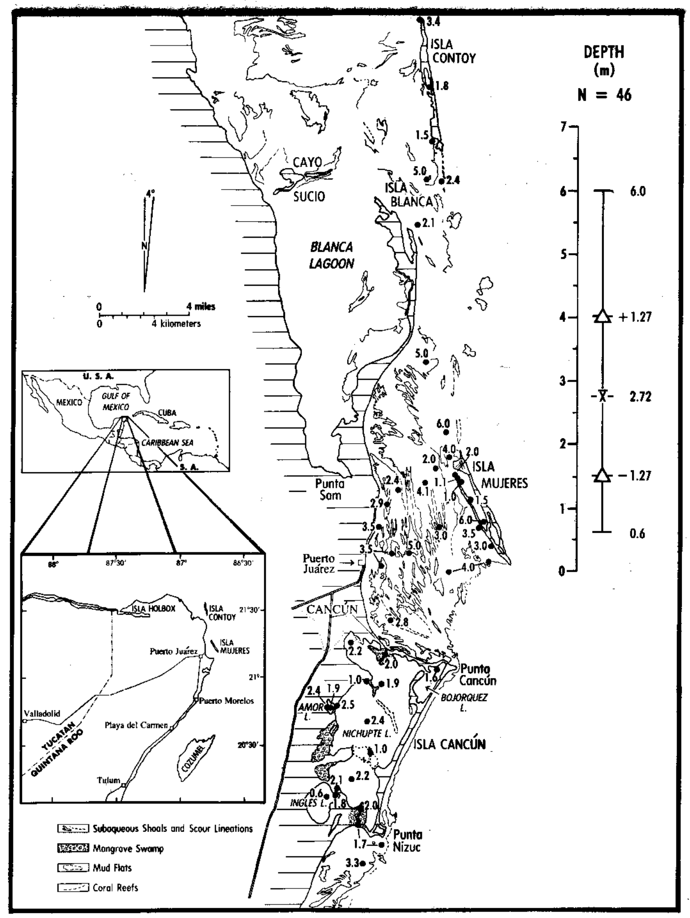


Figure 5.- Depth distribution (meters), northeastern Yucatán Shelf, Mexico. Barred x = mean value of 46 measurements. Horizontal bars give ranges. Deltas are 1 standard deviation on either side of the mean. See Table 1 for tabulation of raw data.

(HVH), Museum of Geoscience, Louisiana State University, Baton Rouge, Louisiana. Materials from Veracruz, Mexico (Krutak, 1982) and from various Caribbean modern and Tertiary localities of van den Bold (1966, 1974, 1977, 1988) were also used.

Figured specimens—see numbers on plate descriptions and comments under Comparisons and Remarks—are on deposit in the HVH collection, Louisiana State University, Baton Rouge, Louisiana.

Measurements of type specimens are indicated on the plate captions. Where appropriate, presence or absence of information on appendage morphology is noted. Plates are arranged alphabetically.

Subclass Ostracoda Latreille, 1806
Order Podocopida G.W. Mueller, 1894
Suborder Podocopa Sars, 1866
Superfamily Cythereacea Baird, 1850
Family Cytherideidae Sars, 1925
Subfamily Cytherideinae Sars, 1925
Genus *Hemicyprideis* Malz and Treibel, 1970

Hemicyprideis nichuptensis Krutak n. sp.
(Plate 1, figures 1-8; Figure 7)

Diagnosis—*Hemicyprideis* with uppermost adductor scar shaped like an upper case Greek letter gamma; medially nodose anterior, ventral, and posterior radial pore canals; denticulate anterior and posteroventral margins (especially right valves); flange tabs of right valves with five to six denticulations.

Description:

Appendages.- Not known. Although this is a modern species, available specimens do not have well preserved chitinous soft parts.

Carapace.- Adult female valves subelliptical in lateral view; left valve larger than right. Right valve with dorsal margin arched at middle and with faint dorso-ventral sulcus. Anterior margin broadly rounded with 14 to 15 minute denticles along edge; posterior margin sloping with poorly defined posterodorsal angulation; ventral margin slightly concave be-

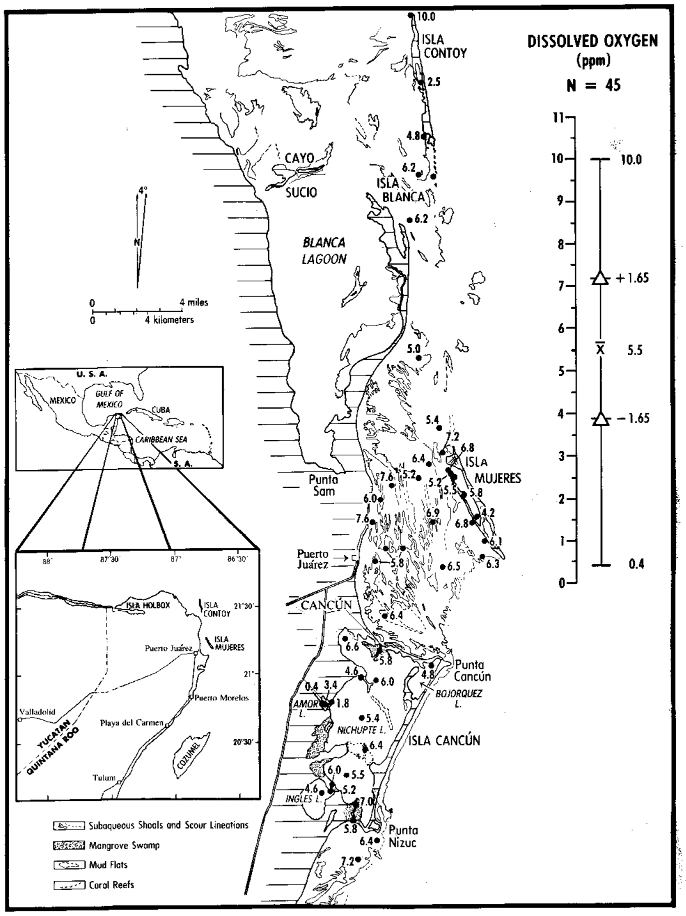


Figure 6.- Bottom water dissolved oxygen (ppm), northeastern Yucatán Shelf, Mexico. Barred x = mean value of 45 measurements. Horizontal bars give ranges. Deltas are 1 standard deviation on either side of the mean. See Table 1 for tabulation of raw data.

low muscle scar field. Left valve with dorsal margin less arched; dorso-ventral sulcus weakly developed; anterior margin broadly rounded with less pronounced, variable denticles; posterior margin as in right valve. Female carapace a flattened ellipse in dorsal view; moderately inflated at posterior; anterior end pointed; posterior end gently rounded.

Adult male valves are similar in lateral and dorsal views except that they are less swollen posteriorly, and tend to be longer.

Valve surfaces are smooth and indented by widely spaced normal-pore canal openings that have circular to oval openings. A weak dorso-ventral sulcus is better developed on right valves just in the front of the middle.

Internally, the anterior duplicature is moderately broad; it narrows markedly ventrally, but continues to the posterior where it fuses with the outer shell at the posteroventral angulation. Approximately 20 to 22 closely spaced anterior radial pore canals; ventrally and posteriorly, 15 to 18 are present, but are widely spaced. All radial pore canals are swollen in their medial portions. About 14 to 15 anterior marginal denticules occur in right valves; five to six denticles at posterior, where a weakly developed flange tab occurs.

Hinge of right valve consists of an elongate anterior element with 11 to 12 teeth, and a relatively smooth, shallow, median groove which rises posteriorly into nine to 10 quadrangular teeth. Hinge of left valve complementary.

Strong dimorphism, as in many *Hemicyprideis* species. Females slightly higher, shorter than males.

Juveniles shaped more like males, with dorsal margin sloping down sharply posteriorly. Ventral margin straight. Two surface nodes develop posteriorly to muscle scars on both valves.

Muscle scars consist of four adductors; the topmost scar is composite and shaped like the capital Greek letter gamma (Figure 7). A U-shaped antennal scar occurs anteriorly to the uppermost fused adductor. The lower mandibular scar is fused and dorsoventrally elongate. A group of four or five elongated dorsal scars occurs immediately below the anterior hinge elements of either valve.

Occurrence—Primarily modern micrites and organic sediments, Stations 29, 30, 35, 36, and 42, Nichupte, Amor, and Ingles Lagoons, State of Quintana Roo, Yucatán Peninsula, Mexico (Appendix 1). Station 6 in the marine strait contains rare specimens.

Ecologic ranges—Salinity 20.0 to 34.8 ppt, temperature 27.0 to 32.5 °C, depth 0.6 to 2.5 m, dissolved oxygen 1.8 to 6.6 ppm.

Name derivation—The species is named for the prominent coastal lagoon, Laguna Nichupte, in which it occurs.

Materials—Two male carapaces and one female carapace (Plate 1, figures 1, 2, 8) and right and left female valves (Plate 1, figures 3-7; HVH numbers 10,892-10,896); HVH 10,893, a female carapace, is designated holotype, others are paratypes; a male right valve from station 42 (Figure 7; HVH paratype 10,928); additional unfigured paratypes include male right valves, HVH 10,897 and 10,898 from Station 42. The writers have several hundred specimens of both sexes in their topotype collections.

Comparisons and remarks—This species resembles closely *Cytheridea kirkbii* Brady (1866, p. 369, pl. 58, figs. 14a-c), a Honduran species. Brady spelled the specific name two different ways - *kirkbii* on p. 369, and *kirkbyi* on plate 58. The latter spelling is correct. *Hemicyprideis nichuptensis* n. sp. is larger, longer and higher than *C. kirkbii*. It lacks the short, thick posteroventral spines on right valves. Teeter (1975, p. 428, figs. 5i, j, 6d) placed *C. kirkbii* (*sic.*) in the genus *Haplocytheridea* and noted that it characterizes Chetumal Bay, a bay on the boundary between Quintana Roo, Mexico, and Belize. Hazel (1983, p. 101) assigned this same species to *Peratocytheridea*. Bold (1988, table 2, p. 150) included the species in *Hemicyprideis* (*H. kirkbyi* [*sic.*]) and noted its occurrence in

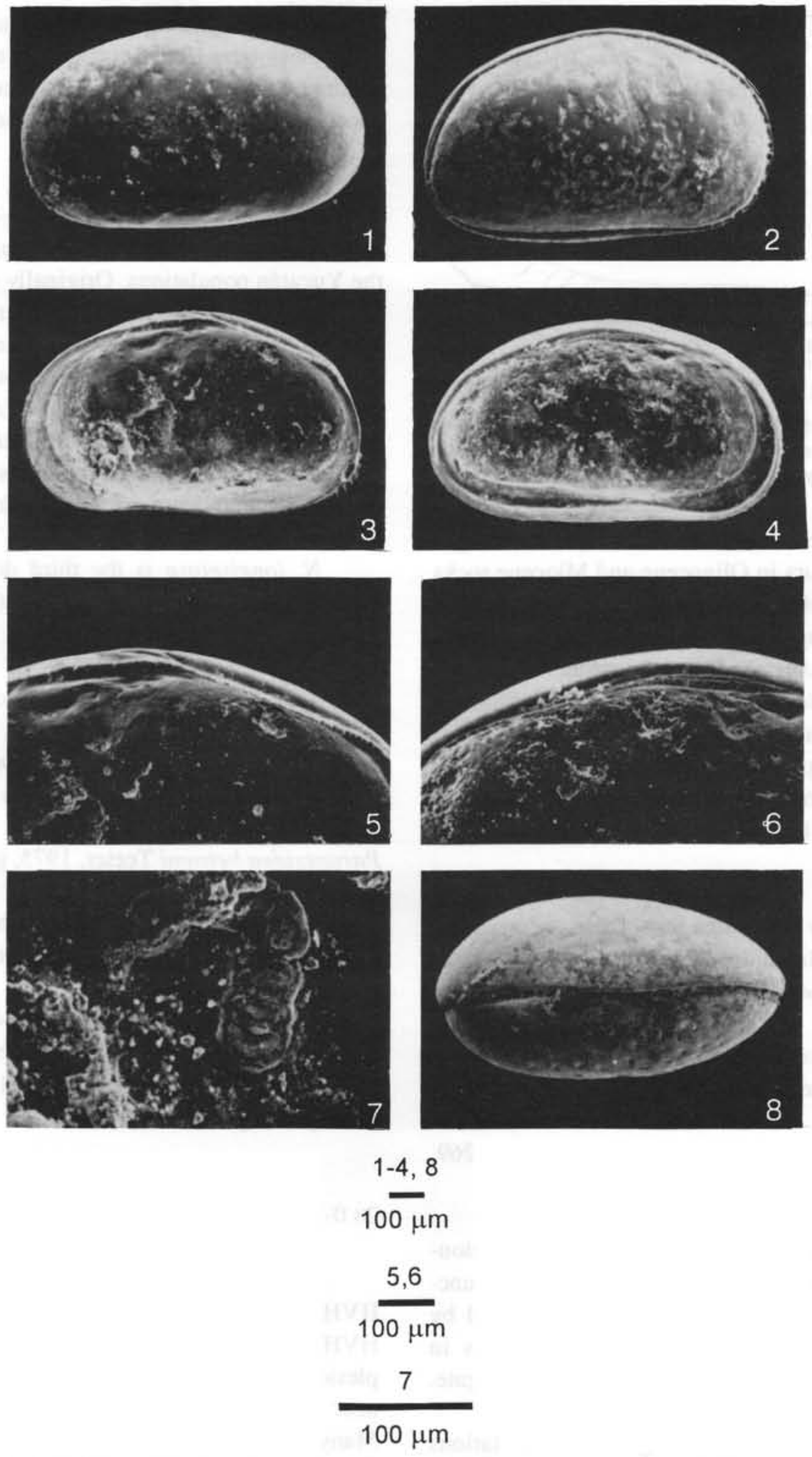


Plate 1.- *Hemicyprideis nichuptensis* Krutak n. sp. Figure 1—Left valve view of male carapace, HVH paratype 10,892, Station 42, L-1300, H-780, W-630. Figure 2—Right valve view of female carapace, HVH holotype 10,893, Station 42, L-1490, H-840, W-780. Figure 3—Right interior of female valve, HVH paratype 10,895, Station 42, L-1250, H-720. Figure 4—Left interior of female valve, HVH paratype 10,896, Station 42, L-1340, H-780. Figure 5—Hinge of female right valve, HVH paratype 10,895. Figure 6—Hinge of female left valve, HVH paratype 10,896. Figure 7—Muscle scars of female valve, HVH paratype 10,896. Figure 8—Dorsal view (left valve uppermost) of male carapace, HVH paratype 10,894, Station 42, L-1400, H-840, W-620. Explanation of plates: Figures in all plates are scanning electron photomicrographs. Bar scales in micrometers. Numbers refer to types on deposit in the Henry V. Howe (HVH) collection, Museum of Geoscience, Louisiana State University, Baton Rouge, Louisiana. Measurements are in micrometers: L = length, H = height, W = width. Station numbers as in Figure 2.

Hemicyprideis nichuptensis Krutak n. sp.

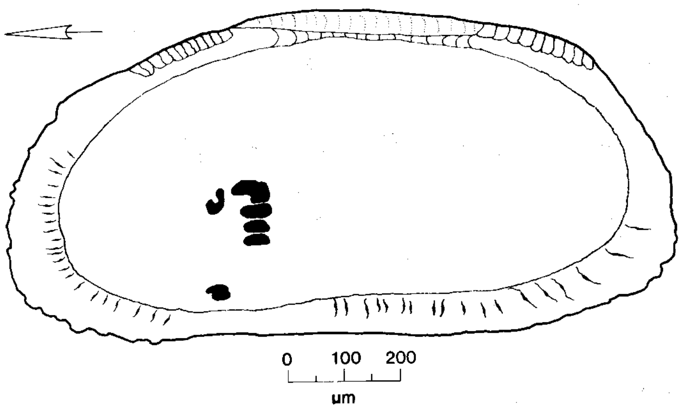


Figure 7.- Camera lucida sketch of right interior of a male right valve of *Hemicyprideis cancunensis* n. sp. from Station 42 showing characteristic muscle scar pattern (HVH paratype 10,928).

Belize. The present authors concur with Bold's generic assignment. *Hemicyprideis* occurs in Oligocene and Miocene rocks of Europe (Malz and Triebel, 1970). *Cyprideis*, whose oldest species occurs in the upper Oligocene, is thought to be a descendant of *Hemicyprideis*. As far as the writers are aware, the new species and *Hemicyprideis kirkbyi* of Bold (1988) are the first occurrences of modern *Hemicyprideis*.

H. nichuptensis n. sp. is the first dominant in four of five stations in Nichupte Lagoon (Stations 29, 35, 36 and 42; *cf.* Table 3 and Figure 10). It is not present in samples from the marine strait.

Superfamily Bairdiacea Sars, 1866
Family Bairdiidae Sars, 1888
Genus *Neonesidea* Maddocks, 1969

Neonesidea longisetosa (Brady, 1902)
(Plate 2, figures 1-6)

Neonesidea longisetosa (Brady, 1902), Krutak; 1982, p. 269, pl. 5, figs. 1-6

Diagnosis—*Neonesidea* species characterized by elongate, strongly pointed posterior margin; smooth to finely punctate carapace with simple normal pore canals penetrated by smooth setae; vertically elongate, external opaque areas in central portions of valves; adductor muscle scars very elongate.

Occurrence—Modern carbonate grainstones, Stations 6, 7, 24, 26 and 27, southeast end of marine strait between Isla Mujeres and Puerto Juárez, State of Quintana Roo, Mexico. In lagoonal sediments, Stations 29 and 30 (Appendix 1).

Ecologic ranges—Salinity 36.2 to 37.6 ppt, temperature 28.0 to 29.0°C, depth 4.0 m, dissolved oxygen 6.3 to 6.5 ppm.

Materials—Three male? carapaces (Plate 2, figures 1, 2 and 5; HVH plesiotypes 10,899-10,901) and right (Plate 2, figure 3; HVH plesiotype 10,902) and left (Plate 2, figure 4; HVH plesiotype 10,903) male? valves from Station 27 off the southwest end of Isla Mujeres. Several other valves and carapaces occur in writers' topotype slides from Stations 26 and 27.

Comparisons and remarks—Specimens from the Veracruz-Antón Lizardo Reefs, Mexico, are almost identical with the Yucatán populations. Originally described by Brady from St. Thomas Island in the northeastern Caribbean, *N. longisetosa* may be synonymous with *Neonesidea gerda* (Benson and Coleman, 1963). Teeter (1975) encountered this species in the carbonate platform biofacies in Belize. Bold (1988, table 2, p. 150) identified this species as *Bairdia longisetosa* Brady, 1902. He indicated that the modern species ranges throughout the Caribbean (Nicaragua, Belize, Cozumel) and into the Gulf of Mexico (Alacrán Reef).

N. longisetosa is the third dominant of marine strait grainstones at Stations 26 and 27 (Table 2, Figure 9). It is uncommon in lagoonal sediments.

Genus *Paranesidea* Maddocks, 1969

Paranesidea cf. *P. bensoni* Teeter, 1975
(Plate 3, figures 1-7)

Paranesidea bensoni Teeter, 1975, p. 417, figs. 3b-d, 4b.

Diagnosis—*Paranesidea* with subhorizontal swellings on the anterior and posterior angulations of both valves.

Occurrence—Stations 6, 7, 24, 26, 27, 29, and 30 (Appendix 1). Specimens occur in carbonate grainstones of the marine strait off Isla Mujeres as well as in organic micrites of Nichupte Lagoon.

Ecologic ranges—Salinity 34.8-37.6 ppt, temperature 28.0-31.5°C, depth 2.1-3.0 m, dissolved oxygen 6.2-6.8 ppm.

Materials—Three carapaces (Plate 3, figures 1, 2, 7; HVH plesiotypes 10,904-10,906) and right (Plate 3, figure 3; HVH plesiotype 10,907) and left (Plate 3, figure 4; HVH plesiotype 10,908) valves from Station 24 in shallow-water near the beach at El Garrafón Reef, Isla Mujeres, Mexico. Many more specimens exist in the authors' topotype slides from the stations mentioned under Occurrence.

Comparisons and remarks—Yucatán specimens have less well-defined sub-horizontal swellings than Belize individuals. Nevertheless, the antero- and posteroventral margin of the right valve displays the typical striate frills of the Belize populations. The adductor muscle scar field of the Mexican specimens consists of a cluster of 10 subcircular scars (Plate 3, figure 6); whereas the Belize form illustrated by Teeter (1975,

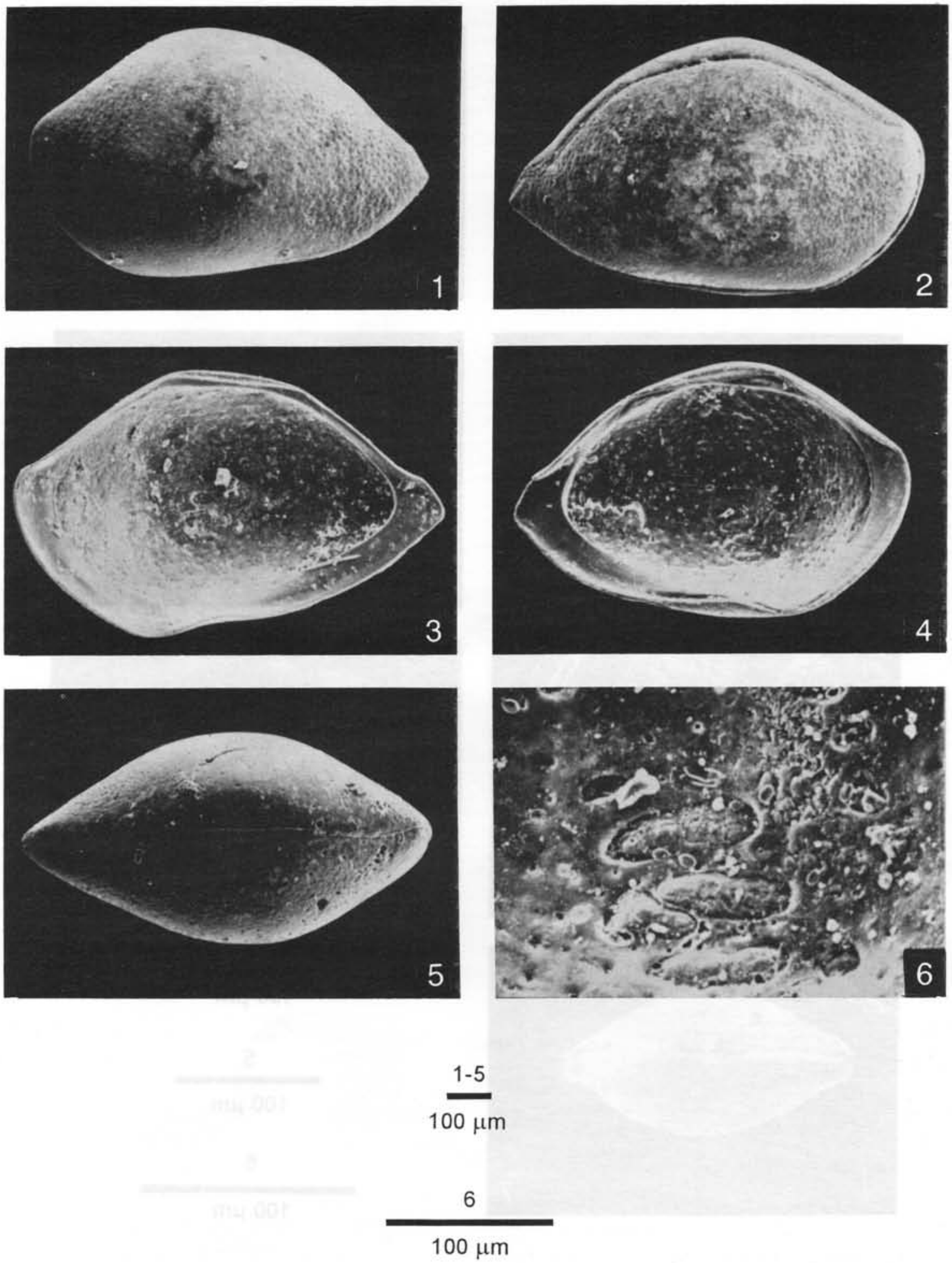


Plate 2.- *Neonesidea longisetosa* (Brady) 1902. Figure 1—Left valve view of male? carapace, HVH plesiotype 10,899, Station 27, L-1321, H-810, W-650. Figure 2—Right valve view of male? carapace, HVH plesiotype 10,900, Station 27, L-1313, H-719, W-688. Figure 3—Right interior of male? right valve, HVH plesiotype 10,902, Station 27, L-1344, H-719. Figure 4—Left interior of male? left valve, HVH plesiotype 10,903, Station 27, L-1313, H-719. Figure 5—Dorsal view (left valve uppermost) of male? carapace, HVH plesiotype 10,901, Station 27, L-1281, H-688, W-594. Figure 6—Muscle scars of HVH plesiotype 10,903, Station 27; anterior to right. Explanation is in Plate 1.

Neonesidea longisetosa (Brady, 1902)

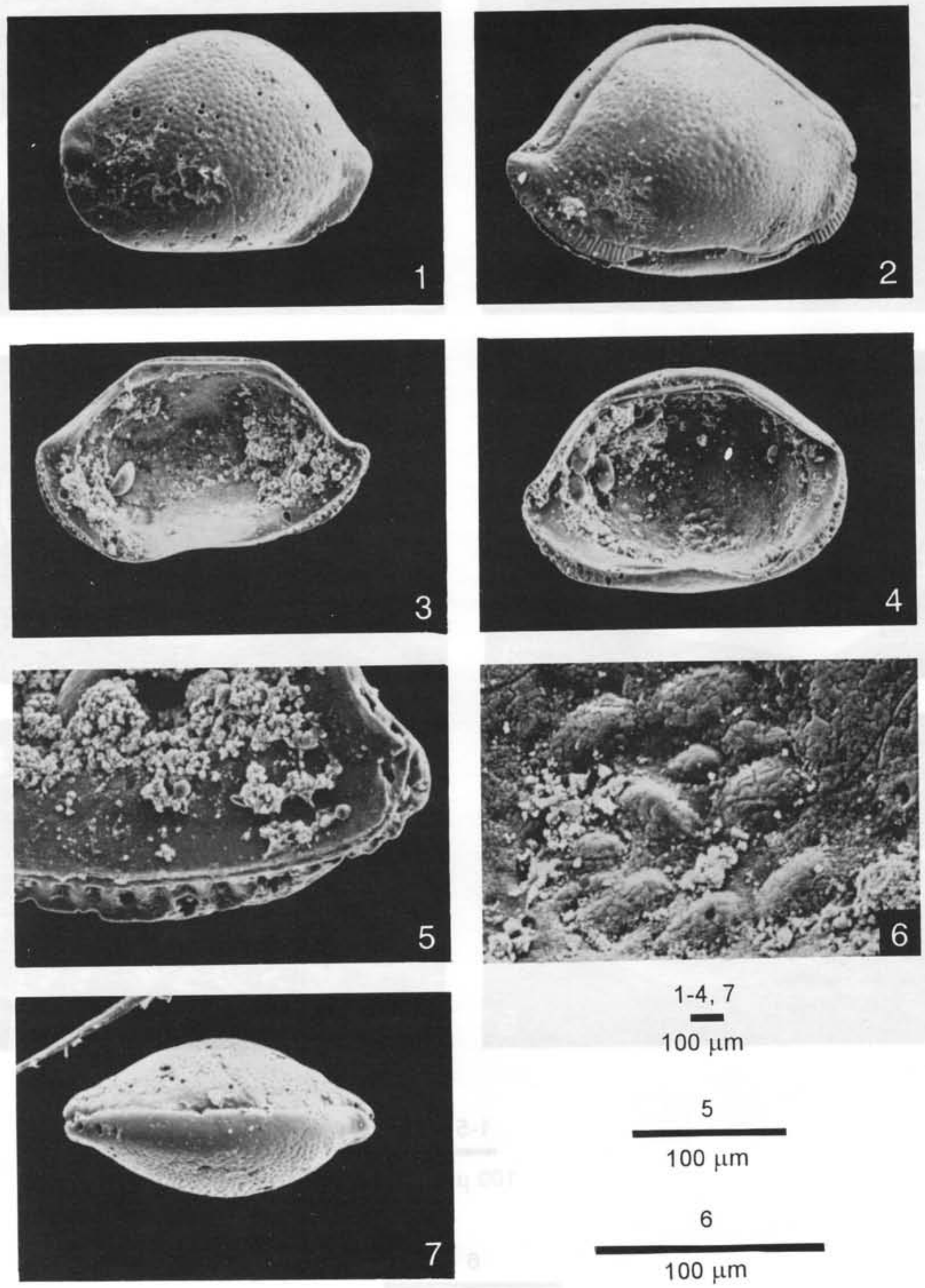


Plate 3.- *Paranesidea* cf. *P. bensoni* Teeter 1975. Figure 1—Left exterior of male? carapace, HVH plesiotype 10,904, Station 24, L-1125, H-688, W-594. Figure 2—Right exterior of male? carapace, HVH plesiotype 10,905, Station 24, L-1375, H-938, W-656; note striate frills on anteroventral and posteroventral margins. Figure 3—Interior of male? right valve, HVH plesiotype 10,907, Station 24, L-1094, H-625. Figure 4—Interior of female left valve, HVH plesiotype 10,908, Station 24, L-1219, H-719. Figure 5—Interior posteroventral region of HVH plesiotype 10,907; note bottom and posterior edges which display marginal extensions of exterior frills. Figure 6—Internal view of 10 subcircular adductor scars of HVH plesiotype 10,908; anterior to right. Figure 7—Dorsal view (left valve lowermost) of HVH plesiotype 10,906, a male? carapace, Station 24, L-1125, H-625, W-500. Explanation is in Plate 1.

Paranesidea cf. *P. bensoni* Teeter, 1975 fig. 4b) has only seven or eight scars. Bold (1988) encountered this species in samples from the Caribbean, Nicaragua, Belize, Cozumel, and Alacrán Reef. He indicated that this species is a Caribbean reef endemic. Teeter (1975) reported it occasionally from the Florida reef tract and from the Bahamas. *P.* cf. *P. bensoni* is the second dominant in marine strait grainstones of Station 6 (Table 2, Figure 7) and occurs as the third dominant at Station 24. It comprises the second and third dominant, respectively, in lagoonal sediments at Stations 29 and 30 (Table 3, Figure 10).

Paranesidea cancunensis Krutak n. sp.
(Plate 4, figures 1-7; Figure 8)

Diagnosis—Species of *Paranesidea* with heart-shaped opaque areas in valve center; simple normal pore canals with smooth setae; eight subcircular, spirally-arranged adductor muscle scars with four smaller anterior scars and two small scars dorsal to the main adductor field.

Description:

Appendages.- Unknown. Some of the specimens in the writers' collections contain soft parts, but these have not been studied.

Carapace.- Adult female and male valves are elongate in lateral view; male valves somewhat longer and lower, female valves being more strongly arched; anterior ends of both dimorphs broadly rounded anteroventrally, more sharply produced posteriorly, especially in left valves; in transmitted light, a large, heart-shaped opaque area covers the central portion of each valve (Figure 8). Valves are smooth externally, with widely spaced, simple normal pore canals; canals penetrated by simple, smooth setae (Plate 4, figures 1, 7).

In dorsal view, left valve strongly overlaps right; a peculiar posteroventral inward-projecting flange locks the right to the left valve (Plate 4, figures 3, 4, 6).

Internally, a relatively wide marginal area borders the ventral, anteroventral, and posteroventral margins; numerous extremely minute, very closely spaced radial pore canals, discernible with transmitted light and a compound microscope, occur along the anteroventral and infolded anterior edge of the valve marginal areas; a weakly developed vestibulum occurs along the posteroventral margin of either valve; posterior margins of left valves smooth; right valve posterior margins are minutely denticulate.

Muscle scars consist of a tight spiral of eight subcircular scars (Plate 4, figure 5). Four additional auxiliary scars occur anteriorly and two scars occur dorsally—a total of six ancillary scars.

Occurrence—Marine strait carbonate grainstones from Stations 6, 7, 24, 26, and 27, Quintana Roo, Mexico (Appendix 1).

Name Derivation—Named for the resort of Cancún, México, which lies immediately west-southwest of the samples.

Ecologic ranges—Salinity 36.2 ppt, temperature 28.0 to 29.0 °C, depth 2.1 to 5.0 m, dissolved oxygen 5.0 to 6.5 ppm.

Materials—One male and two female? carapaces (Plate 4, figures 1, 2, 6, 7; HVH paratypes 10,909-10,911) and one male right (Plate 4, figure 3; HVH holotype 10,912) and left female valve (Plate 4, figures 4, 5; HVH paratype 10,913) from Station 27. One female? carapace from Station 24 (HVH paratype 10,927). Additional specimens occur in samples from Stations 6, 7, 24, 26, 27, and from Station 30 in Nichupte Lagoon.

Comparisons and remarks—*Bairdoppilata* (*Bairdoppilata*) *cushmani* (Tressler, 1949) of Teeter (1975, p. 418, figs. 3f, 4d) is related; however, its anterodorsal margin is upturned strongly and it is a much smaller species (male and female carapaces average more than 200 micrometers shorter than *Paranesidea cancunensis* n. sp.). It has exterior marginal, lobate opaque areas. *Bairdoppilata* (*Bairdoppilata*) *fasciata* (Brady, 1870) of Teeter (1975, figs. 3g, 4e) resembles *P. cancunensis* n. sp., but *B.* (*B.*) *fasciata* displays a slightly different muscle scar pattern and has minute denticulations on the anterior and posterior cardinal areas of the left valve; it also has a remarkably consistent arrangement of opaque areas, including an ovate central spot and variously lobed, marginal patches. *P. cancunensis* n. sp. is dominant at Station 27 in the marine strait grainstones and at Station 30 in Nichupte Lagoon (Tables 2 and 3; Figures 9 and 10); however, it is more common as either the third or second dominant in marine strait grainstones (Table 2, Figure 9), which seems to be its preferred habitat.

Paranesidea gigacantha (Kornicker, 1961)
(Plate 5, figures 1-7)

Paranesidea gigacantha (Kornicker, 1961); Teeter, 1975, p. 418, figs. 3e, 4c.

Diagnosis—Characterized externally by irregularly lobate opaque areas, the largest of which occur in the central valve areas; hundreds of oval-shaped, simple normal pore canals (Plate 5, figures 5, 6) are visible internally.

Occurrence—Stations 6, 7, 24, 26, and 27 in the marine strait; stations 29, 30 and 36 in Amor Lagoon (Appendix 1).

Ecologic ranges—Salinity 20.4 to 37.6 ppt, temperature 28.0 to 31.5 °C, depth 2.1 to 5.0 m, dissolved oxygen 1.8 to 6.8 ppm.

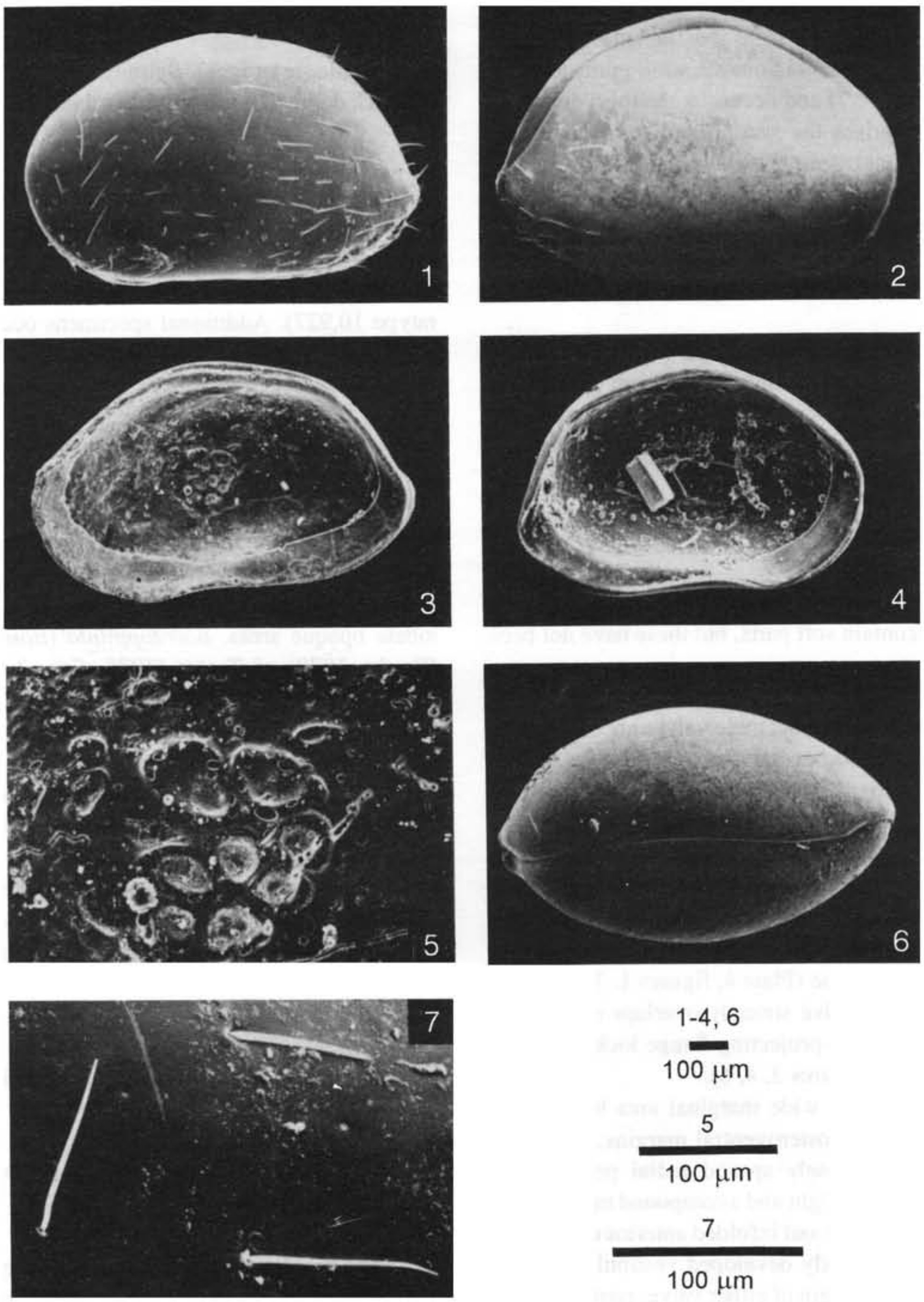


Plate 4.- *Paranesidea cancunensis* Krutak n. sp. Figure 1—Left exterior of male carapace, HVH paratype 10,909, Station 27, L-1344, H-781, W-781; note projecting, smooth setae. Figure 2—Right exterior of female carapace, HVH paratype 10,910, Station 27, L-1406, H-906, W-719. Figure 3—Interior of male right valve, HVH holotype 10,912, Station 27, L-1344, H-781. Figure 4—Interior of female left valve, HVH paratype 10,913, Station 27, L-1250, H-688. Figure 5—Muscle scar field of HVH holotype 10,912; note tight spiral of eight scars and two dorsal and four anterior ancillary scars; anterior to left. Figure 6—Dorsal view of female? carapace (left valve uppermost), HVH paratype 10,911, Station 27, L-1406, H-875, W-688. Figure 7—Smooth setae projecting from simple normal pore canals, HVH paratype 10,909. Explanation is in Plate 1.

Paranesidea cancunensis Krutak n. sp.

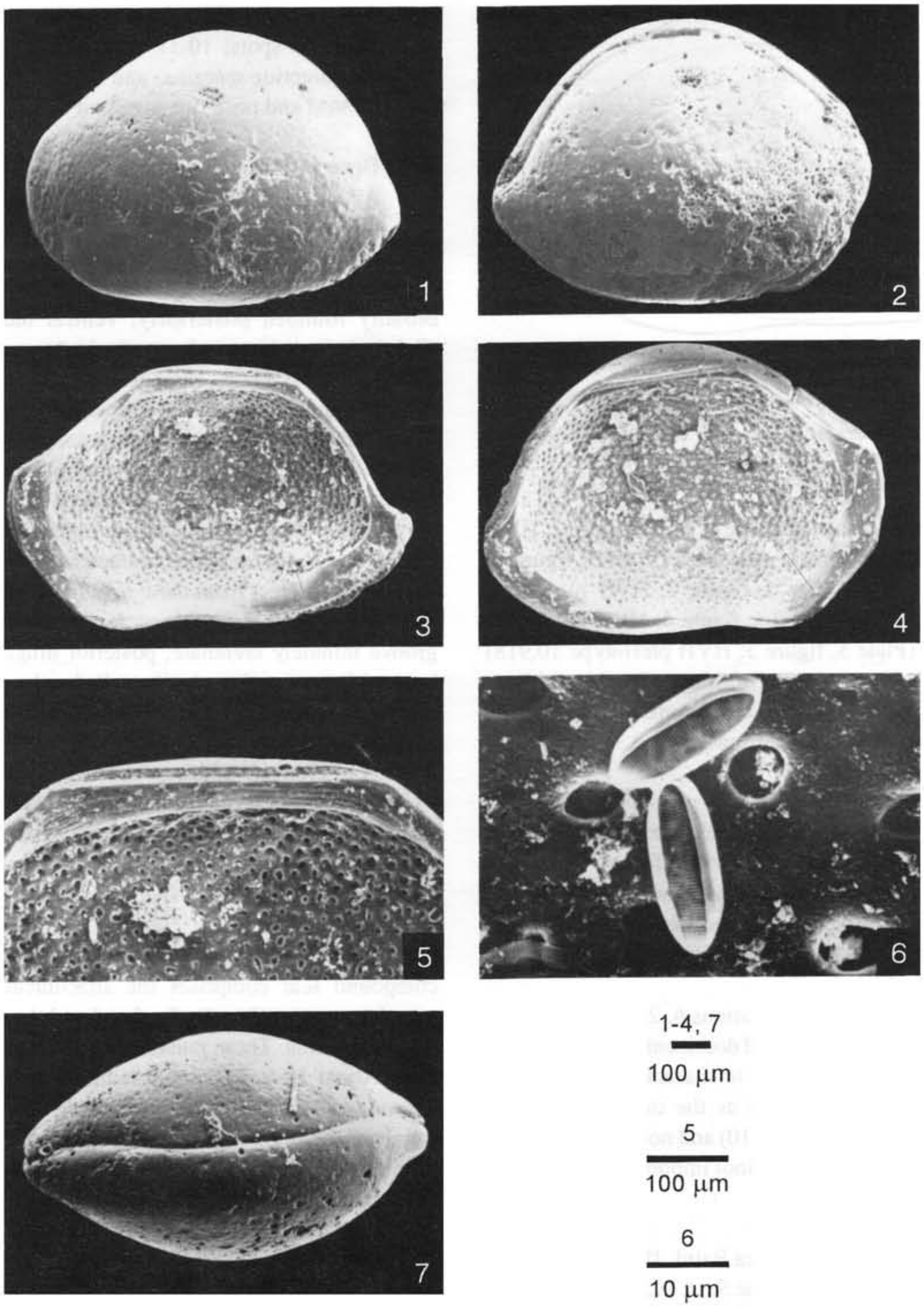


Plate 5.- *Paranesidea gigacantha* (Kornicker) 1961. Figure 1—Left exterior of female carapace, HVH plesiotype 10,915, Station 24, L-1344, H-969, W-844. Figure 2—Right exterior of female carapace, HVH plesiotype 10,916, Station 24, L-1313, H-844, W-813. Figure 3—Interior of female right valve, HVH plesiotype 10,918, Station 24, L-1250, H-719. Figure 4—Interior of female left valve, HVH plesiotype 10,917, Station 24, L-1344, H-906. Figure 5—Closeup of hinge and interior of HVH plesiotype 10,918, Station 24; note abundant simple normal pore canals. Figure 6—Ultracloseup of interior of HVH plesiotype 10,917, Station 24; note internal openings of oval, simple normal pore canals. Two pennate diatoms furnish additional scale. Figure 7—Dorsal view of male carapace (left valve lowermost), HVH plesiotype 10,914, Station 24, L-1406, H-938, W-813.

Paranesidea gigacantha (Kornicker, 1961)

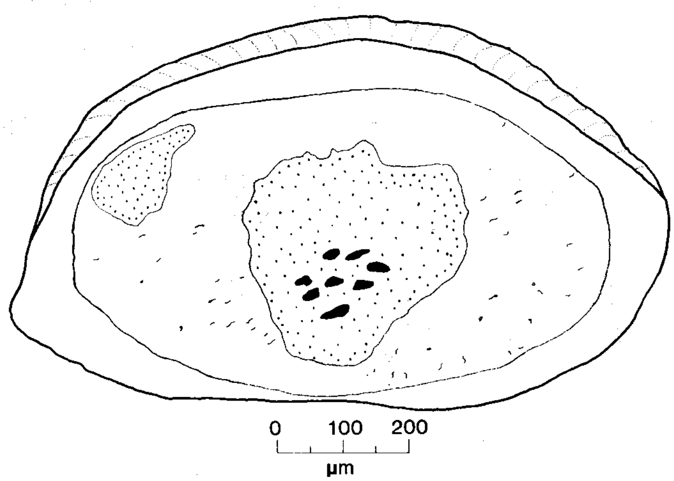


Figure 8.- Camera lucida sketch of right exterior of a female? carapace of *Paranesidea cancunensis* n. sp. from Station 24 showing characteristic heart-shaped opaque area in valve center (HVH paratype 10,927).

Materials—One male carapace (Plate 5, figure 7; HVH plesiotype 10,914), two female carapaces (Plate 5, figure 1; HVH plesiotype 10,915; Plate 5, figure 2; HVH plesiotype 10,916); and a female left (Plate 5, figure 4; HVH plesiotype 10,917) and right (Plate 5, figure 3; HVH plesiotype 10,918) valve from carbonate grainstones of Station 24. Several hundred valves and carapaces of both sexes were recovered from the stations mentioned under occurrence.

Comparisons and remarks—*P. gigacantha* is related to "*Bairdia*" *victrix* Brady, 1869, which is more produced at the anterior and posterior ends. Bold (1988) found *P. gigacantha* in samples from Nicaragua, Belize, and Cozumel; however, it is absent on the Alacrán Reef and apparently in the Gulf of Mexico. Teeter (1975, p. 418) encountered the species in the Bahamas and in Florida.

The species is dominant at stations 6, 24, and 26 (Table 2, Figure 9); it comprises the second dominant at stations 7 and 27 (Table 2, Figure 9) and appears to characterize the marine strait environment. Its occurrence as the third dominant at stations 29 and 36 (Table 3, Figure 10) and nowhere else in the lagoonal facies shows that it is of minor importance in lagoonal biotopes.

Superfamily Cytheracea Baird, 1850
Family Xestoleberidae Sars, 1928
Genus *Xestoleberis* Sars, 1866

Xestoleberis sp. aff. *X. margaritea* G.S. Brady, 1869
(Plate 6, figures 1-8)

Xestoleberis sp. aff. *X. margaritea* G.S. Brady, 1869; Bold, 1966, p. 52, pl. 14, figs. 11a, b; pl. 5, fig. 3.

Diagnosis—*Xestoleberis* species with widely spaced, simple normal pore canals whose external margins are bordered by low, elevated rims; very large, compound, comma-shaped dorsal scars (*Xestoleberis*-spots) exist just behind the prominent eye spots; 10-11 simple radial pore canals occur along the anterior margins, and 25-30 similar canals occur along ventral and posterior marginal areas.

Description:

Appendages.- Unknown.

Carapace.- Ovoid in lateral view; males lower and slightly longer than females; anterior end rounded below, very broadly rounded posteriorly; ventral margin of carapace slightly indented just in front of middle.

In dorsal view, carapace sharply pointed anteriorly, broadly rounded posteriorly. Left valve strongly overlaps right valve at the anterior and is slightly longer. Contact margin of valves sinuous, with greatest degree of sinuosity anterior of center. Sub-concentric rows of widely spaced, simple normal pore canals whose perimeters are bordered by slightly raised rims (Plate 6, figure 5) are characteristic; simple setae (Plate 6, figure 7) project from these openings.

Nine-10 anterior hinge teeth in right valve; median groove minutely crenulate; posterior hinge element denticulate, with two or three teeth well developed at posterior. A weakly developed anterior vestibulum occurs around the anterior end of both valves.

Four elongate adductor scars (Plate 6, figures 4, 8) and a U-shaped frontal scar occur anteroventrally; a small elliptical mandibular scar is positioned in front of the lowermost adductor. Viewed internally, a large, compound, comma-shaped dorsal scar (*Xestoleberis*-spot) exists just behind the prominent eye-spot.

Keyser (1988, p. 184, figs. 2, 3) has shown that this compound scar comprises the attachment point of sets of muscles connected to the forehead and the protopodite of the second antenna. These muscles enclose the spinning gland.

About 10 to 11 simple radial pore canals occur in the anterior marginal area; approximately 25 to 30 radial pore canals occur along the ventral and posterior marginal areas.

Occurrence—Stations 6, 7, and 24 in marine strait grainstones, and stations 30, 35, and 36 in Bojórquez and Amor lagoons just west of Isla Cancún (Appendix 1).

Ecologic ranges—Salinity 20.0 to 20.4 ppt, temperature 27.0 to 28 °C, depth 1.9 to 5.0 m, dissolved oxygen 1.80 to 5.0 ppm.

Materials—Three carapaces: a female (Plate 6, figure 1; HVH plesiotype 10,919) and male? (Plate 6, figure 2; HVH plesiotype 10,920) and female? (Plate 6, figures 5, 6; HVH plesiotype 10,921) from Station 35 in Amor Lagoon. Male right (Plate 6, figure 3; HVH plesiotype 10,922) and male left (Plate 6, figures 4-6; HVH plesiotype 10,923) valve from

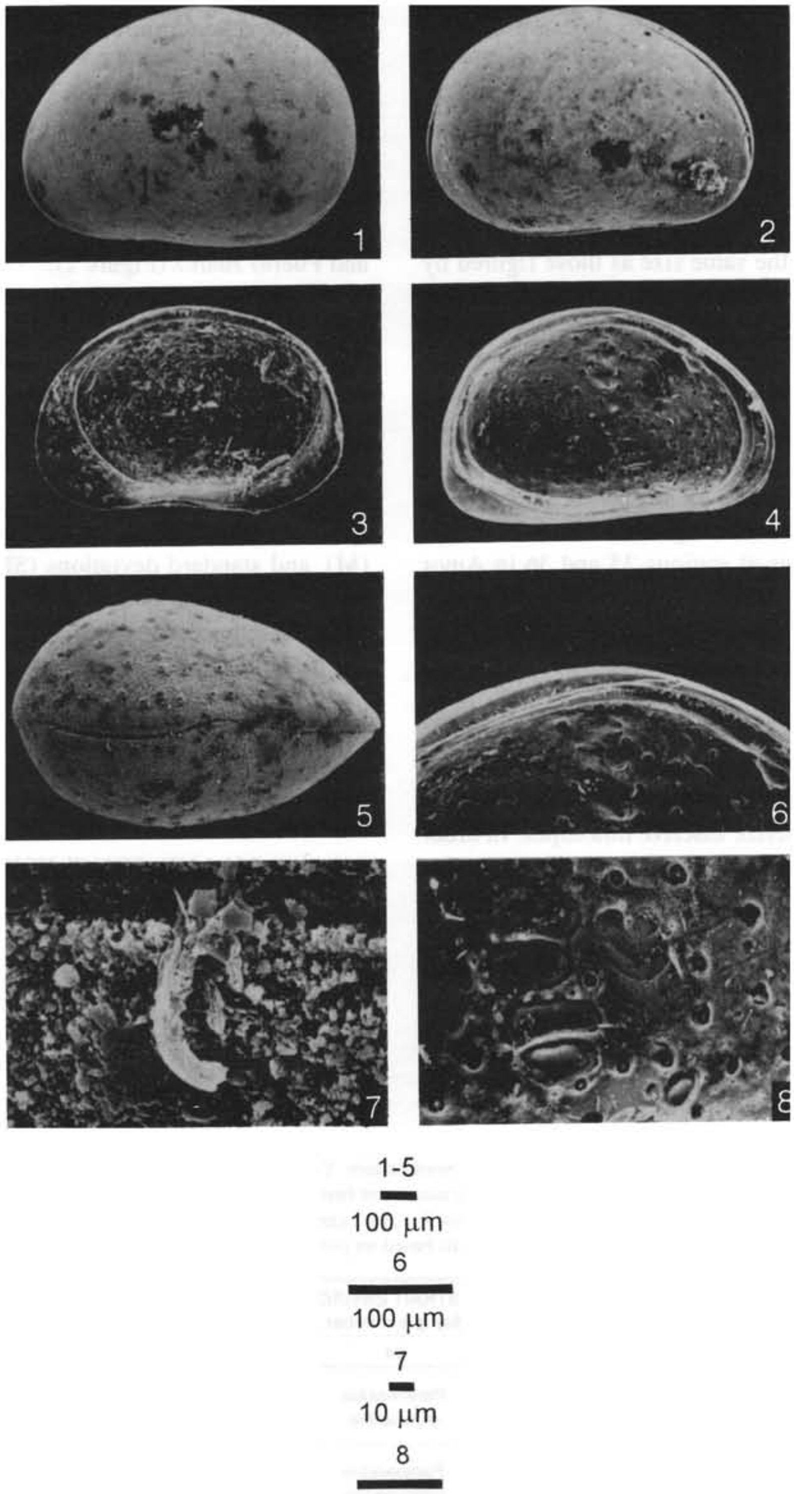


Plate 6.- *Xestoleberis* sp. aff. *X. margaritea* Brady, 1869. Figure 1—Left exterior of female carapace, HVH plesiotype 10,919, Station 35, L-719, H-500, W-500. Figure 2—Right exterior of male? carapace, HVH plesiotype 10,920, Station 35, L-750, H-500, W-500. Figure 3—Interior of right male? valve, HVH plesiotype 10,922, Station 35, L-625, H-438. Figure 4—Interior of left male valve, HVH plesiotype 10,923, Station 35, L-688, H-438. Figure 5—Dorsal view of female? carapace, HVH plesiotype 10,921, Station 35, L-844, H-594, W-531; note elevated rims of normal pore canals; anterior to right (left valve uppermost). Figure 6—Closeup of left valve hinge, HVH plesiotype 19,923, Station 35. Figure 7—Broken simple seta on dorsal hinge margin of HVH plesiotype 10,921, Station 35. Figure 8— Adductor muscle scar field of HVH plesiotype 10,923, Station 35; four adductors occur with a U-shaped frontal scar and an elliptical mandibular scar; anterior to right.

Xestoleberis sp. aff. *X. margaritea* Brady, 1869

Station 35. Additionally, two separated female carapaces and one male carapace from station 43 near Punta Nizuc (HVH plesiotypes 10,924-10,926) comprise comparative material together with many additional specimens on the authors' topotype slides.

Comparisons and remarks—This species has the same shape and is almost exactly the same size as those figured by Bold (1966, p. 52, pl. 4, figs. 11a, b; pl. 5, fig. 3) from Recent sediments in Colón Harbor, Panama (HVH 8288). It resembles *X. rigbyi* Morales, 1966, from Laguna de Términos, Campeche, Mexico (HVH 8190); however, the Yucatán species depicted here is slightly larger and has wider anterior marginal areas.

X. sp. aff. *X. margaritea* is dominant at station 7 in marine strait grainstones (Table 2, Figure 9). It occurs as the second most common species at stations 35 and 36 in Amor Lagoon (Table 3, Figure 10). These occurrences indicate that it may prefer lagoonal rather than open marine habitats.

FAUNAL ANALYSIS

Analysis of Tables 2, 3 and 4 and Figures 9 and 10 reveals that six ostracode species are the most common ones in the study area and characterize discrete lithotopes. In order of dominance, three bairdiid species (*Paranesidea gigacantha*, *Paranesidea cancunensis* n. sp., and *Neonesidea longisetosa*) typify high-energy marine strait samples (Table 2 and Figure 9). These species combined make up 59% of the total ostracode fauna. The average ostracode species diversity—number of species—for the marine strait is 11.4 (Appendix 1). These ostracode species live in, or on, oolitically-coated grainstones with these ranges, means (M) and standard deviations (SD) of physicochemical properties (Tables 4 and 5): salinity 20.4 to 37.6 ppt, M 37.13, SD 0.81; temperature 28.0 to 31.0 °C, M 28.80, SD 1.30; depth 2.1 to 5.0 m, M 1.11, SD 1.22; dissolved oxygen 5.0 to 6.8 ppm, M 6.16, SD 0.69. The substrates—lithotopes-sedimentary environments—generally consist of spill-over lobes, submarine sand-waves and sand bars accumulating in the high energy marine strait between Isla Mujeres and Puerto Juárez (Figure 2).

Similarly, *Hemicyprideis nichuptensis* n. sp., *Xestoleberis* sp. aff. *X. margaritea*, and *Paranesidea* cf. *P. bensoni*-*Paranesidea gigacantha* occur most often in low-energy lagoonal muds and organic-rich samples (Table 3 and Figure 10). Together, these species comprise 78% of the total ostracode fauna. The average ostracode species diversity (number of species) for lagoonal samples is 7.4 (Appendix 1). These species inhabit sediments with the following ranges, means (M), and standard deviations (SD) of hydrochemical characteristics (Tables 4 and 5): salinity 20.0 to 37.6 ppt, M 27.75, SD 9.10; temperature 27.0 to 32.5 °C, M 29.50, SD 2.85; depth 0.6 to 5.00 m, M 1.94, SD 0.77; dissolved oxygen 1.8 to 5.0 ppm, M 3.86, SD 2.66. The substrates (sedimentary environments) generally consist of mud flats, channels, and mangrove swamp materials being laid down in Nichupte and Bojórquez lagoons (Figure 2).

SUMMARY AND CONCLUSIONS

Muddy carbonate sediments on the inner shelf of northeastern Yucatán are distributed in shallow, brackish-water lagoons and bays. Seaward, in higher energy environments, shelf sediments increase granulometrically to oolitic sand and even gravel size.

Three of five samples from oolitic grainstones in the

Table 2.- Ostracode species characteristic of marine-strait grainstones, northeastern Yucatán Shelf, Quintana Roo, Mexico. Species represent the first three dominants of each sample. Under Dominant Species, AB. # 1D = Absolute number of first dominant. % 1D = percentage abundance of first dominant. Seventh row (% of fauna of first three dominants) is quotient of row four divided by row five; for example, under sample 6, 103/263=39%). In Summary, 3/5 signifies species is first dominant in three of five samples. See Figure 9 for ternary diagrams based on percentage data listed in row six.

DOMINANT SPECIES	MARINE STRAIT ENVIRONMENT Sample number					SUMMARY
	6	7	24	26	27	
1st dominant	*Paranesidea gigacantha*	*Xestoleberis* sp. aff. *X. margaritea*	*Paranesidea gigacantha*	*Paranesidea gigacantha*	*Paranesidea cancunensis* n. sp.	*Paranesidea gigacantha* 3/5
2nd dominant	*Paranesidea* cf. *P. bensoni*	*Paranesidea gigacantha*	*Paranesidea cancunensis* n. sp.	*Paranesidea cancunensis* n. sp.	*Paranesinea gigacantha*	*P. gigacantha* 2/5 *P. cancunensis* n. sp. 2/5
3rd dominant	*Paranesidea cancunensis* n. sp.	*Paranesidea cancunensis* n. sp.	*Paranesidea* cf. *P. bensoni*	*Neonesidea longisetosa*	*Neonesidea longisetosa*	*P. cancunensis* n. sp. 2/5 *N. longisetosa* 2/5
Absolute number of first 3 dominants	103	142	233	167	203	848
Total number of specimens	263	280	283	266	348	1440
AB. # 1D, 2D, 3D	40 35 28	54 51 37	160 48 25	68 61 38	121 51 31	
% 1D, 2D, 3D	39 34 27	38 36 26	69 20 11	41 37 22	60 25 15	
% of fauna (first 3 dominants)	39	51	82	63	58	59

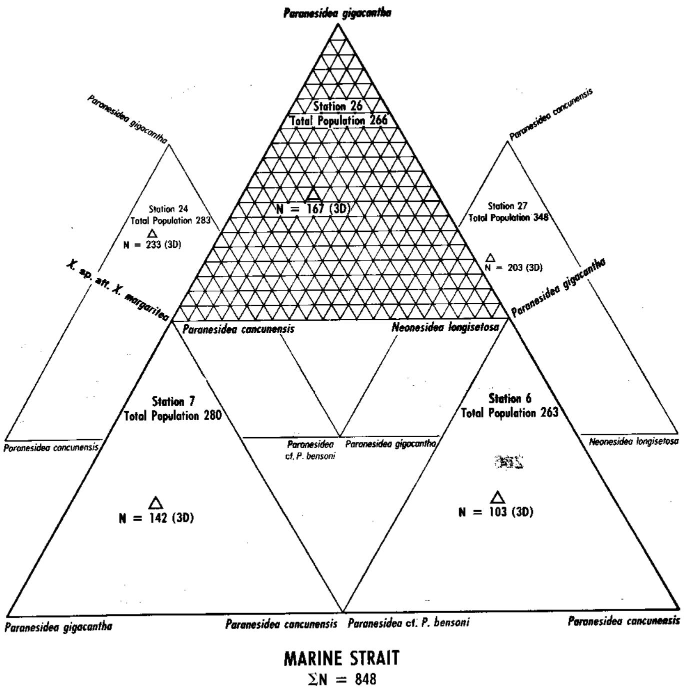
Table 3.- Ostracode species characteristic of brackish-water lagoons, northeastern Yucatán Shelf, Quintana Roo, Mexico. Species represent first three dominants of each sample. Under Dominant Species, AB. # 1D = Absolute number of first dominant. % 1D = percentage abundance of first dominant. Seventh row (% of fauna of first three dominants) is quotient of row four divided by row five; for example, under sample 29, 149/288=52%). In Summary, 4/5 indicates species is first dominant in four of five samples. See Figure 10 for ternary diagrams based on percentage data listed in sixth row.

DOMINANT SPECIES	LAGOONAL ENVIRONMENT Sample number 29	30	35	36	42	SUMMARY
1st dominant	*Hemicyprideis nichuptensis* n. sp.	*Paranesidea cancunensis* n. sp.	*Hemicyprideis nichuptensis* n. sp.	*Hemicyprideis nichuptensis* n. sp.	*Hemicyprideis nichuptensis* n. sp.	*Hemicyprideis nichuptensis* n. sp. 4/5
2nd dominant	*Paranesidea* cf. *P. bensoni*	*Peratocytheridea* sp.	*Xestoleberis* sp. aff. *X. margaritea*	*Xestoleberis* sp. aff. *X. margaritea*	*Radimella?* sp.	*Xestoleberis* sp. aff. *X. margaritea* 2/5
3rd dominant	*Paranesidea gigacantha*	*Paranesidea* cf. *P. bensoni*	*Radimella?* sp.	*Paranesidea gigacantha*	*Echinocythereis* sp.	*Paranesidea* cf. *P. bensoni* 1/5; *P. gigacantha* 2/5
Absolute number of first 3 dominants	149	164	279	286	303	1181 (Total)
Total number of specimens	288	331	297	304	306	1508 (Total)
AB. # 1D, 2D, 3D	70 46 33	82 41 41	165 65 49	244 29 13	300 2 1	
% 1D, 2D, 3D	47 31 22	50 25 25	59 23 18	85 10 5	99 1 <0.01	
% of fauna (first 3 dominants)	52	50	94	94	99	78 (Total)

marine strait between Isla Mujeres and Puerto Juárez, Quintana Roo, Mexico, contain an ostracode fauna dominated by *Paranesidea gigacantha*. Second-order dominants are almost equally divided between *Paranesidea cancunensis* n. sp. and *P. gigacantha*. Third-order dominants are almost equally divided between *P. cancunensis* n. sp. and *Neonesidea longisetosa*. Combined, these species comprise 59% of the total ostracode fauna. Average ostracode species diversity—number of species—for this environment is 11.4. The percentage spread among the five samples of the first-order dominants is about 32% (Figure 11). This spread is approximately 16% among the second and third-order dominants. This suite of ostracode species characterizes the high-energy grainstones comprising the sand waves and unstable carbonate sediments of the marine strait in this area. At the time of collection, the range of environmental characteristics was: salinity 20.4 to 37.6 ppt, temperature 28.0 to 31.0°C, water depth 2.1 to 5.0 m, dissolved oxygen 5.0 to 6.8 ppm. Average environmental characteristics of the five strait samples where these species were encountered indicate that the strait is 9.38 ppt more

Table 4.- Marine strait versus lagoonal ostracode species and ecological variables, northeastern Yucatán Shelf, Quintana Roo, Mexico. See Figure 2 for location of sampling stations and Table 1 for summary of ecological measurements at all 46 sampling stations. Tables 2 and 3 contain dominance data on listed species.

ENVIRONMENT	SPECIES/ STATIONS	ECOLOGICAL VARIABLE Salinity [ppt]	Temperature [°C]	Depth [m]	Dissolved O_2 [ppm]
MARINE STRAIT	*Paranesidea cancunensis* n. sp. 6, 7, 26	36.2	28.0 - 29.0	2.1 - 5.0	5.0 - 6.5
	Paranesidea gigacantha 6, 7, 24, 27, 29, 36	20.4 - 37.6	28.0 - 31.6	2.1 - 5.0	1.8 - 6.8
	Neonesidea longisetosa 26, 27	36.2 - 37.6	28.0 - 29.0	4.0	6.3 - 6.5
	Range	20.4 - 37.6	28.0 - 31.0	2.1 - 5.0	5.0 - 6.8
	Difference	17.2	3.0	2.9	1.8
LAGOON	*Hemicyprideis nichuptensis* n. sp. 29, 35, 36, 42	20.0 - 34.8	27.0 - 32.5	0.6 - 2.5	1.8 - 6.6
	Paranesidea cf. *P. bensoni* 6, 24, 29, 30	34.8 - 37.6	28.0 - 31.5	2.1 - 3.0	6.2 - 6.8
	Xestoleberis sp. aff. *X. margaritea* 7, 35, 36	20.0 - 20.4	27.0 - 28.0	1.9 - 5.0	1.8 - 5.0
	Range	20.0 - 37.6	27.0 - 32.5	0.6 - 5.0	1.8 - 6.8
	Difference	17.6	5.5	4.4	5.0



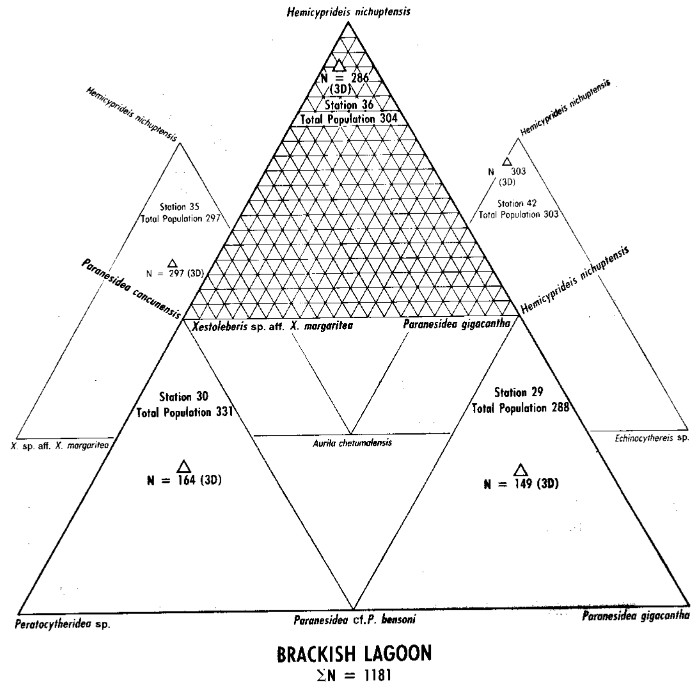


Figure 9.- Ternary diagrams of three dominant ostracode species present in five bottom samples (6, 7, 24, 26, 27) from marine strait carbonate sediments, northeastern Yucatán Shelf, Mexico. Dominant species ("First" dominants) plotted on top vertices of each triangle. Second-ranked species ("Second" dominants) plotted at lower left of triangles. Third-ranked species ("Third" dominants) are on lower right of triangles. Numbers below each small triangle are total number of individuals comprising first three dominants (3 D). The total number of individuals encountered in all five samples (Σ N) = 848. See Figure 2 for map distribution of sample locations, and Plates 1 - 6 for illustration of dominant species.

Figure 10.- Ternary diagrams of three dominant ostracode species present in five bottom samples (29, 30, 35, 36, 42) from brackish lagoon carbonate sediments, northeastern Yucatán Shelf, Mexico. Dominant species ("First" dominants) plotted on top vertices of each triangle. Second-ranked species ("Second" dominants) plotted at lower left of triangles. Third-ranked species ("Third" dominants) are on lower right of triangles. Numbers below each small triangle are total number of individuals comprising first three dominants (3 D). The total number of individuals encountered in all five samples (Σ N) = 1181. See Figure 2 for map distribution of sample locations, and Plates 1 - 6 for illustration of dominant species.

Table 5.- Ecologic data collected at selected sampling stations in marine strait and lagoonal environments, northeastern Yucatán Shelf, Quintana Roo, Mexico, 7-08-81 to 7-17-81. Salinities are in parts per thousand (ppt), temperatures in degrees Celsius (°C), depths in meters (m), and dissolved oxygen in parts per million (ppm). Salinities, temperatures and dissolved oxygen values are bottom measurements made near or at the sediment-water interface. Positions where no data were obtained indicated by "n. da". Data compiled from Table 1. S.D. = standard deviation of the mean; V. = variance.

Environment	Sample	Date	Time	Salinity [ppt]	Temp. [°C]	Depth [m]	Diss. Ox. [ppm]
MARINE STRAIT	6	7/17/81	11:15	n. da	31.00	2.10	6.20
	7	7/17/81	10:32	n. da	28.00	5.00	5.00
	24	7/08/81	10:37	37.60	28.00	3.00	6.80
	26	7/08/81	12:00	36.20	29.00	4.00	6.50
	27	7/08/81	11:10	37.60	28.00	4.00	6.30
	Sum			111.40	144.00	18.10	30.80
	Mean			37.13	28.80	3.62	6.16
	Count			3	5	5	5
	Minimum	7/08/81	10:32	36.20	28.00	2.10	5.00
	Maximum	7/17/81	12:00	37.60	31.00	5.00	6.80
	S.D.			0.81	1.30	1.11	0.69
	V.			0.66	1.70	1.22	0.47
LAGOON	29	7/14/81	10:40	34.80	31.50	2.20	6.60
	30	7/13/81	14:17	36.80	30.50	2.00	5.89
	35	7/14/81	13:50	19.40	26.00	2.40	0.40
	36	7/14/81	12:35	20.40	27.00	2.50	1.80
	42	7/15/81	11:55	n. da	32.50	0.60	4.60
	Sum			111.00	147.50	9.70	19.29
	Mean			27.75	29.50	1.94	3.86
	Count			4	5	5	5
	Minimum	7/13/81	10:40	19.40	30.50	0.60	0.40
	Maximum	7/15/81	14:17	36.40	32.50	2.50	6.60
	S.D.			9.10	2.85	0.77	2.66
	V.			82.76	8.13	0.60	7.10

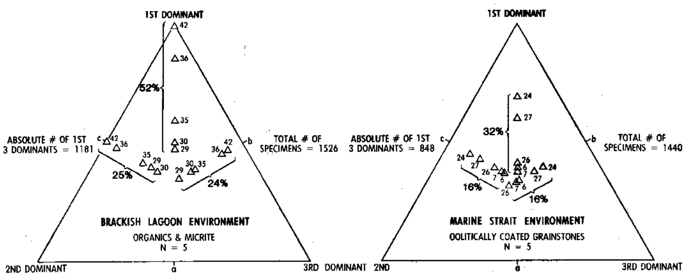


Figure 11.- Summary triangular diagrams of three dominant ostracode species present in five marine strait (right) versus five brackish lagoon (left) samples, northeastern Yucatán Shelf, Mexico. Numbered triangles represent sample stations (see Figure 2 for map locations, and Figures 9 and 10 for ternary diagrams of ostracode species present). Percentage distribution of first dominants on "a" axes; percentage distribution of second dominants on "b" axes; third dominants on "b" axes; third dominants are plotted on "c" axes. The smaller "spread" (32%, 16%) of the ostracodes living in oolitically coated grainstones separates these sediments from the larger "spread" (52%,°24%) of the ostracodes inhabiting the organics and micrites of the brackish-water lagoons of this area.

saline, 0.70°C colder, 1.68 m deeper, and 2.30 ppm richer in dissolved oxygen than the lagoons of this area.

Four of five samples from fine-grained, low-energy, high Mg-calcite-rich muds of Nichupte and Bojórquez lagoons have an ostracode fauna dominated by *Hemicyprideis nichuptensis* n. sp.

Second order dominants are usually *Xestoleberis* sp. aff. *X. margaritea*, with some *Paranesidea* cf. *P. bensoni Peratocytheridea* sp. and *Radimella*? sp. Third-order dominants consist of *Paranesidea* cf. *P. bensoni* and *Paranesidea gigacantha*. These species make up 78% of the total ostracode fauna. Average ostracode species diversity (number of species) for this environment is 7.4. The percentage spread among the five samples of the first-order dominants is about 52% (Figure 11). This spread is approximately 24% among the second and third-order dominants. These ostracode species are characteristic of the low-energy micrites and organic muds of lagoonal sediments of northeastern Yucatán. The range of hydrochemical conditions in these environments was: salinity 20.0 to 37.6 ppt, temperature 27.0 to 32.5°C, depth 0.6 to 5.0 m, dissolved oxygen 1.8 to 6.8 ppm. Environmental conditions prevailing at the five stations where these species predominate indicate that, on average, the lagoons are 9.38 ppt less saline, 0.70°C warmer, 1.68 m shallower, and 2.30 ppm less rich in dissolved oxygen than the marine strait environment.

ACKNOWLEDGMENTS

Funding for field and laboratory work was by a George Holmes Memorial Faculty Summer Research Fellowship provided to the senior author by the University of Nebraska, Lincoln. Dr. Agustín Ayala-Castañares, of the Instituto Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, provided logistical support. Biol. Roberto de la Torre-Alegría, Director (in 1981) of the Centro de Investigaciones Pesqueras in Isla Mujeres, Quintana Roo, provided a boat, motor, and storage space for our field equipment. Sr. Gonzalo Chale-Velásquez, of the Centro de Investigaciones Pesqueras, was field guide and very capable codiver. Dr. Joseph E. Hazel's constructive criticism of an early draft of this manuscript is greatly appreciated. Dr. W.A. van den Bold offered very helpful taxonomic advice. Drs. Roger L. Kaesler, of the Paleontological Institute, University of Kansas; Mervin Kontrovitz, of the Department of Geosciences, Northeast Louisiana University; and Paul L. Steineck, of the Division of Natural Science, State University of New York, College at Purchase, read preliminary versions of the manuscript and offered invaluable constructive criticisms. Dr. Elisabeth Brouwers, of the United States Geological Survey, Denver, Colorado, critically read a final draft and Dra. María Luisa Machâin-Castillo provided thoughtful suggestions for the final version.

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Manuscript received: March 26, 1992.
Corrected manuscript received: March 20, 1994.
Manuscript accepted: April 2, 1994.

Appendix 1.- Occurrence of common ostracode species, Isla Mujeres, Cancún area, Quintana Roo, Mexico.

SPECIES	**STRAIT Stations**					**LAGOON Stations**				
	6	**7**	**24**	**26**	**27**	**29**	**30**	**35**	**36**	**42**
(1) *Actinocythereis bahamensis* (Brady, 1870)						x	x			
(2) *Aglaiocypris croneisi* Teeter, 1975					x				x	x
(3) *Aurila chetumalensis* Teeter, 1975						x	x	x		x
(4) *Bairdia* sp. 1			x							
(5) *Caudites highi* Teeter, 1975	x	x		x	x		x			
(6) *Cyprideis* sp. 1							x			
(7) *Cytherelloidea praecipua* Bold, 1963	x	x		x	x					
(8) *Glyptobairdia coronata* (Brady, 1870)	x									
(9) *Hemicytherura cranekeyensis* Puri, 1960		x								
(10) *Hemicyprideis nichuptensis* n. sp.	x					x	x	x	x	x
(11) *Loxocorniculum postdorsoalata* (Puri, 1960)	x	x	x		x	x		x	x	
(12) *Loxocorniculum tricornatum* Krutak, 1971	x	x		x	x					
(13) *Macrocyprina propinqua* Triebel, 1960	x	x		x	x					
(14) *Neonesidea longisetosa* (Brady, 1902)	x	x	x	x		x	x			
(15) *Orionina bradyi* Bold, 1963	x									
(16) *Paracypris* sp. 1					x		x			
(17) *Paranesidea* cf. *P. bensoni* Teeter, 1975	x	x	x	x	x	x	x			
(18) *Paranesidea cancunensis* n. sp.	x	x	x	x	x					
(19) *Paranesidea gigacantha* (Kornicker, 1961)	x	x	x	x	x	x	x		x	
(20) *Paranesidea* sp. 1						x				
(21) *Peratocytheridea setipunctata* (Brady, 1869)						x	x			
(22) *Peratocytheridea* sp. 1			x					x		
(23) *Propontocypris multiporifera* Teeter, 1975		x		x	x		x	x		
(24) *Protocytheretta pumicosa* (Brady, 1866)			x		x					
(25) *Pumilocytheridea* sp. 1						x				
(26) *Quadracythere producta* (Brady, 1866)			x		x					x
(27) *Xestoleberis* sp. aff. *X. margaritea* (Brady, 1869)	x	x	x				x	x	x	
Simple species diversity (number of species)	13	12	10	9	13	10	12	4	7	4
Average diversity/environment	11.4					7.4				