FRESH AND BRACKISH WATER OSTRACODA FROM THE NEOGENE OF NORTHERN VENEZUELA

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CONTENTS

ILLUSTRATIONS

I. ABSTRACT

Twenty-four species of ostracodes are recorded from the Siquire, Tuy and Cumaca formations of the State of Miranda and from the Guiria Formation of the State of Sucre. Three new species are described: *Cytheridea? purperae*, *Callistocythere? macsotayi* and *Xestoleberis bermudezi*. The lower Siquire Formation is correlated with the lowermost unit (Unit J) of the Guiria Formation and with the Caparo clay member of the Talparo Formation of Trinidad (Pliocene). The upper Siquire Formation is correlated with the upper Talparo Formation, and the Tuy Formation and Unit E of the Guiria Formation are tentatively assigned to the Pleistocene.

RESUMEN

En las formaciones Siquire, Tuy y Cumaca del Estado de Miranda y en la formación Guiria del Estado Sucre se registran veinticuatro especies de ostrácodos. Aquí se describen tres especies nuevas: *Cytheridea? purperae*, *Callistocythere? macsotayi* y *Xestoleberis bermudezi*. La parte inferior de la formación Siquire se correlaciona con la parte inferior (Unidad J) de la Formacion Guiria y con el miembro argilloso Caparo de la formación Talparo de Trinidad (Plioceno). La parte superior de la formación Siquire se correlaciona con la parte superior de la formación Talparo; la formación Tuy y la Unidad E de la formación Guiria superior se ponen con reserva en el Pleistoceno.

II. INTRODUCTION

One of the frustrating problems for a paleontologist is the dating of Cenozoic fresh or brackish water deposits. They often contain only endemic, and specialized, environmentally controlled faunas. They are usually not overlain by datable younger sediments and often overlie much older deposits unconformably. Within the Caribbean Region there are several examples, including in Venezuela, the Siquire, Cumaca and Tuy Formations of Miranda (Picard and Pimentel, 1968), and the Guiria Formation of Sucre (Macsotay, 1976); and in Hispaniola, the Jimaní Formation of the Hoya de Enriquillo and its equivalents in the Cul-de-Sac continuation (Bold, 1975). In Brasil, Ivone Purper (1977, 1979) encountered a similar situation with the Pebas Formation of the upper Amazon basin, as did Sheppard and Bate (1980) in

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Colombia and Peru. In Colombia I have found the dating of the so-called "*Chara*-zone" in the upper Magdalena Valley of the department of Huila equally difficult.

Additional problems may occur when foraminifer and ostracode-rich unconsolidated sediments are reworked into lacustrine environment, where the fauna consists of very thin-shelled and fragile species, which are destroyed in sample preparation. I recently encountered this in the Neogene of the Camp Perrin Basin of southern Haiti, where the fresh water ostsracodes disintegrate completely on washing so that the residue contains only well preserved (but reworked) marine forms. A similar situation is present in the Llanos region of Ecuador where Cretaceous planktonic foraminifera have been redeposited in Tertiary fresh and brackish water sediments (Tschopp, 1953). The result of all this is that specialists on different groups of fossils will inevitably come to totally different conclusions about the age and environment of such sediments.

The purpose of this paper is to discuss the biostratigraphic distribution of the ostracodes of the Siquire, Cumaca, Tuy and Guiria formations and their relations to faunas from Trinidad and Hispaniola. The results of the study are at variance with previous paleontological interpretations.

III. ACKNOWLEDGMENTS

I am indebted to Christian Beck (University of Lille, France) and Oliver Macsotay (Universidad de Oriente, Cumaná, Venezuela) for providing the samples on which this study is based. I dedicate this paper to the late Pedro Bermúdez, who also contributed material. I wish to thank R. M. Forester for the numerous notations made in reviewing the manuscript; I have followed many of his suggestions.

IV. MATERIAL STUDIED

BASIN OF SANTA LUCIA - OCUMARE DEL TUY

In this basin (Estado Miranda) two formations are present, which have yielded a small number of fresh and brackish water ostracodes. The Siquire Formation unconformably overlies metamorphic rocks and underlies the Tuy Formation with local unconformity (Picard and Pimentel, 1968). Dr. C. Beck (University of Lille, France) sent me samples of the Siquire Formation, which were taken along a section about 2 km long, running from about 1 km south of Sta. Teresa to the north-northwest (Text-Fig. 1). From the late Dr. P. J. Bermúdez I received a sample from the Tuy Formation (Picard and Pimentel, 1968, p. 284). Dr. Bermúdez also furnished a sample of the Cumaca Formation, which is the supposed equivalent of the Siquire Formation in the Lower Tuy-Barlovento basin (Picard and Pimentel, 1968).

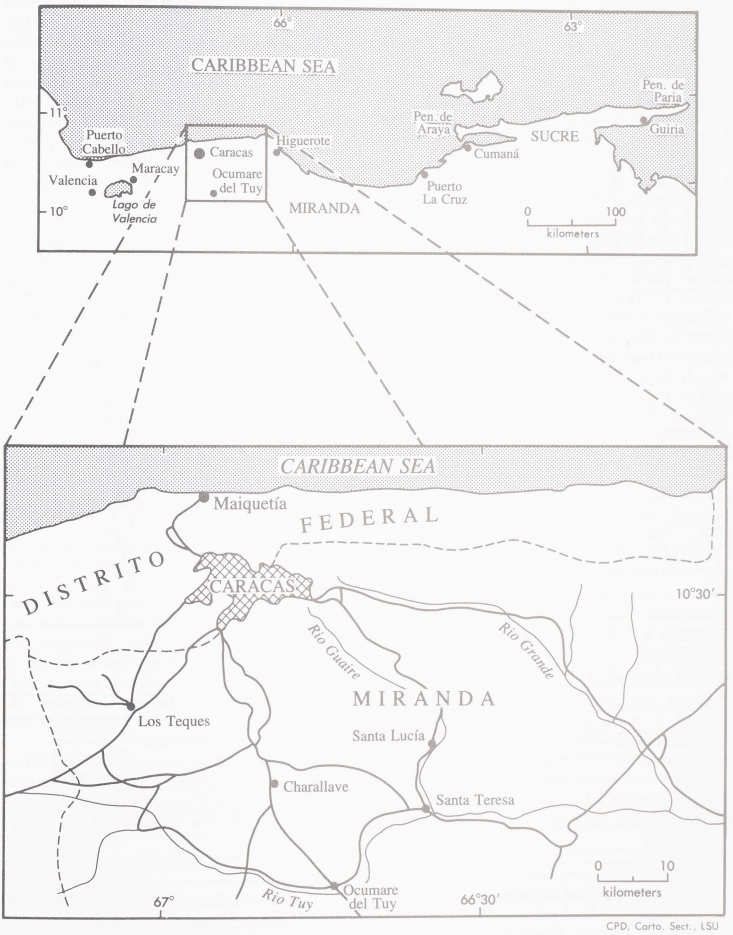
In the Siquire Formation (Table 1) the most common ostracodes are species of *Darwinula* and *Limnocythere*, usually characteristic of ephemeral or permanent lakes. Many of the freshwater ostracodes are represented only by casts with occasionally adherent parts of shell material; thus, generic determinations are somewhat uncertain and specific determinations unreliable. Only two samples show a more diverse fauna which, in addition to fresh water forms, also contains some (probably) brackish water Cytheracea. It is especially in these samples that shell material is slightly thicker and, therefore, partly or even completely preserved.

In the lower part of the Siquire Formation (Samples 858-886) the fauna is dominated by *Limnocythere* sp. 1 and 3. Sample 885 yielded *Darwinula* sp. aff. *D. olivencae* Purper, *Pseudocandona*? sp. and *Limnocythere* sp. 3, as well as *Cytheridea? rohri* (Bold, 1963), which is known from the Talparo Formation of Trinidad and the Guiria Formation of the Paria peninsula (Bold *in* Macsotay, 1968, p. 64; Bold, 1972, Table 2).

The upper part of the Siquire Formation (samples 890-952) is characterized by *Limnocythere* sp. 2. Sample 898 contains, in addition to *Stenocypris?* sp. and *Heterocypris?* sp., also *Cytheridella boldi* Purper, *Cytheridea? rohri* (Bold) and *Cytheridea? purperae* n. sp. Conspicuous in this sample is the absence of *Darwinula* and *Limnocythere*, which suggests an interruption of lacustrine deposition by a brackish water invasion. *Cytheridella boldi* is living in Lago de Valencia (Text-fig. 1), and has been found as a fossil in the Jimaní Formation of Hispaniola (Bold, 1975) and in the upper part of the Talparo Formation of

Trinidad (M. Dempsey, Texaco Trinidad, letter and material, 1972.

Bermúdez' sample (VB-2) from the Cumaca Formation (Bold, 1972, p. 1012) only contains *Limnocythere staplini* Gutentag and Benson (1962), originally described from the Pleistocene of Kansas and subsequently reported from the upper Las Salinas Formation and the Jimaní Formation of Hispaniola (Bold, 1975), late



Text-fig. 1. Map of the study area.

Pliocene or Pleistocene in age. In North America this species is found in lakes in which the water is enriched in Na, Mg, Ca, SO2, and Cl, and depleted in HCO_3 (Forester, 1983), which suggests that similar conditions may have been present in the Cumaca lake(s).

The Bermúdez sample from the Tuy Formation (VB-1, Bermúdez, 1966, p. 344; Bold, 1972, p. 1012) contains *Darwinula* sp. aff. *D. olivencae* Purper, *Pseudocandona?* sp., Ostracode sp., *Limnocythere* sp. 4, and *Cytheridea? purpera* n. sp., the latter also occurring in the Siquire and Guiria Formations.

The fauna of the lower "brackish water" intercalation of the Siquire Formation (885) correlates well with the brackish-marine lower part of the Guiria Formation (Unit J of Macsotay, 1968, p. 55) and the brackish water parts of the Talparo Formation (Table 1). The upper "brackish water" intercalation (898) is somewhat similar in fauna to the upper part of the Guiria Formation (Unit E of Macsotay, 1968, p. 56), which lacks, however, *Cytheridea rohri*, and to the fresh water upper part of the Talparo Formation. According to this evidence the Siquire Formation should be of late Pliocene age. This is in complete disagreement with other investigators, who assigned it an early to middle Miocene age (Picard and Pimentel, 1968; Macsotay, 1968). The Tuy Formation (also without *Cytheridea rohri*) could be contemporaneous with the upper part of the Guiria Formation and of late Pliocene to early Pleistocene age. This is still much younger than Macsotay's conclusion of a late Miocene to Pliocene age.

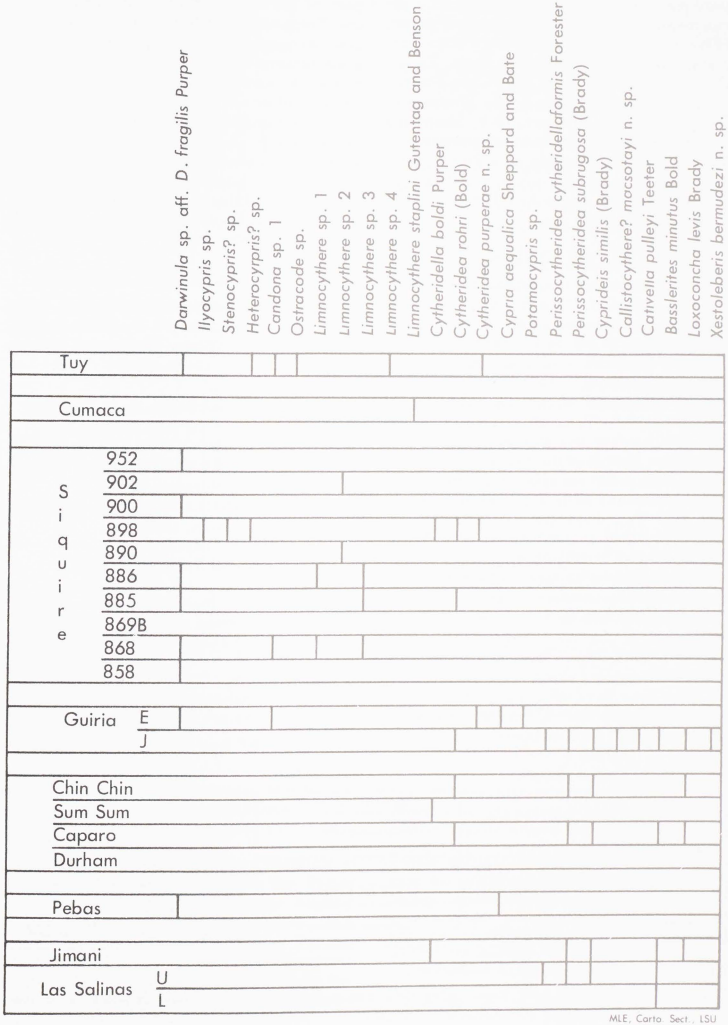
PARIA PENINSULA

From the Guiria Formation (State of Sucre) I have only two samples that yielded ostracodes. One (496a), collected by Bermúdez from the base of Macsotay's Unit J, 4-5 m above the base of the formation (Macsotay, 1968, p. 56), contains *Cyprideis similis* (Brady), *Cytheridea? rohri* (Bold), *Perissocytheridea subrugosa* (Brady), *P. cytheridellaformis* Forester, *Cativella pulleyi* Teeter, *Basslerites minutus* Bold, *Loxoconcha levis* Brady, *Callistocythere? macsotayi* n. sp., and *Xestoleberis bermudezi* n. sp. The *Cativella* and *Basslerites* species are marine forms with a fairly long stratigraphic range in the Neogene. *Cytheridea? rohri* occurs in the Caparo and Chin-Chin clay members of the Talparo Formation. *Perissocytheridea subrugosa* is known from Pliocene to Recent in the Greater Antilles and Trinidad, whereas the other brackish water species *P. cytheridellaformis* has been found so far only in the upper Las Salinas Formation of Hispaniola (*Cyprideis salebrosa* zone, late Pliocene - Recent). *Cyprideis similis* has the same range as *C. salebrosa*. *Loxoconcha levis* is known from Pliocene to Recent brackish water deposits in the Caribbean; it occurs throughout the Talparo Formation, except the Sum-Sum sand member (Table 1).

In the Caribbean the brackish water Pliocene can be subdivided into a late and early division on the basis of the presence or absence of *Cyprideis salebrosa* and *C. similis*. The boundary should lie close to that of the zones N 18 and N 19 of the planktonic foraminiferal zonation (Bold, 1983). In this scheme the upper Las Salinas Formation and most of the Talparo Formation, as well as the lower part of the Guiria Formation belong to the late Pliocene. Macsotay (1968), in contrast, places all of the Guiria Formation in the Pleistocene. The regional and local brackish water ostracode zonation of the Pliocene of Trinidad is shown in Text-fig. 2, which is based on Bold (1963), with additions by M. Dempsey (Texaco Trinidad, Company report, 1972). Here also the position of the *C.? rohri* zone is indicated.

The other sample was collected by Macsotay from his Unit E (42-45 m above the base of the Guiria Formation) and contains a fresh water fauna (except for the inclu-

Table 1: Distribution of Ostracoda in northeastern Venezuela (Tuy, Cumaca, Siquire and Guiria formations), northern Trinidad (Chin Chin, Sum Sum, Caparoi and Durham members of the Talparo Formatiuons), the upper Amazon basin (Pebas Formation) and the Enriquillo basin in Hispaniola (Jimaní and Las Salinas formations). >


Darwinula sp. aff. D. fragilis Purper
Ilyocypris sp.
Stenocypris? sp.
Heterocypris? sp.
Candona sp. 1
Ostracode sp.
Limnocythere sp. 1
Limnocythere sp. 2
Limnocythere sp. 3
Limnocythere sp. 4
Limnocythere staplini Gutentag and Benson
Cytheridella baldi Purper
Cytheridea rohri (Bold)
Cytheridea purperae n. sp.
Cypria aequalica Sheppard and Bate
Potamocypris sp.
Perissocytheridea cytheridelliformis Forester
Perissocytheridea subrugosa (Brady)
Cyprideis similis (Brady)
Callistocythere? macsotayi n. sp.
Cativella pulleyi Teeter
Bassleriites minutus Bold
Loxoconcha levis Brady
Xestoleberis bermudezi n. sp.
Tuy
Cumaca
Siquire
952
902
900
898
890
886
885
869B
868
858
Guiria
E
J
Chin Chin
Sum Sum
Caparo
Durham
Pebas
Jimani
Las Salinas
U
L
MLE, Carto. Sect., LSU

sion of *Cytheridea purperae* n. sp.) *Darwinula* sp. aff. *D. olivencae* Purper, *Potamocypris* sp., *Cypria aequalica* Sheppard and Bate, and *Heterocypris?* sp. *Cypria aequalica* (= *Cypria?* sp. 2, Purper, 1979) was described from the Pebas Formation of the upper Amazon basin. Tentative age assignments of the Pebas Formation generally agree on a late Pliocene to Pleistocene age, (Purper, 1979, Sheppard and Bate, 1980). *Cytheridea? purperae* is known from the Siquire and Tuy Formation and is probably closely related to species from the upper Amazon basin (see Systematic Descriptions).

V. DISCUSSION

The position of the *Cytheridea? rohri* zone in Trinidad (Text-fig. 2) in the late Pliocene puts some restrictions on the stratigraphic position of Unit J of the Guiria Formation and the whole of the Siquire Formation. The fact that *C? rohri* and *C? purperae* occur together in the Upper Siquire Formation may indicate that this part of the formation is slightly older than Unit E of the Guiria Formation, where only the latter species is found. Unit E may be more or less contemporaneous with the Tuy Formation. However, we know very little about environmental preferences of *C? purperae* and its upper Amazon relatives. It may conceivably have lived in an almost pure fresh water environment and thereby have been a tropical equivalent of the boreal form *Cytherissa lacustris* (Sars). Such forms have not been found in Recent tropical pools and lakes, but they may have enjoyed a brief period of development during the late Neogene time of climatic deterioration.

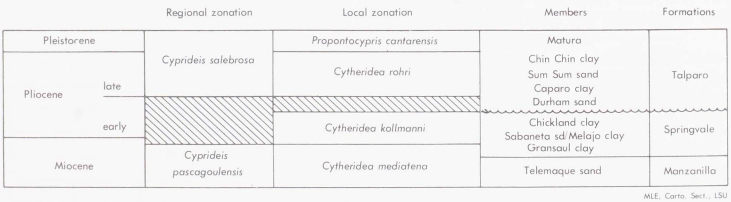
Therefore, it is quite possible that *C? rohri* is eliminated in low salinities that were tolerated by *C? purperae* in the upper part of the Guiria Formation, whereas in the Talparo Formation salinity may have been excessive for *C? purperae*. However, if we assume that the two species are indicative of more or less the same degree of salinity (after all, they do occur together in the same sample) and that, therefore, their presence or absence is stratigraphically significant, a tentative correlation between the Northern basin of Trinidad, the Paria Peninsula and the Sta. Lucia-Ocumare del Tuy basin, as shown in Text-fig. 3, would appear plausible.

VI. SYSTEMATIC DESCRIPTIONS

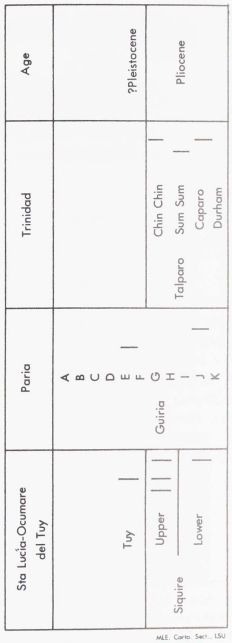
Types and illustrated specimens have been deposited in the H. V. Howe collections, Louisiana State University, Baton Rouge: HVH nos. 10750-10789.

Subclass OSTRACODA Latreille, 1806
Order PODOCOPIDA Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily DARWINULACEA Brady and Norman, 1889
Family DARWINULIDAE Brady and Norman, 1889
Genus DARWINULA Brady and Robertson, 1885
DARWINULA sp. aff. D. OLIVENCAE Purper
Plate 1, fig. 1

Darwinula sp. PURPER, 1977, p. 364, pl. 4, figs. 5-8.
Darwinula fragilis PURPER, 1979, p. 225, pl. 1, figs. 4-10 (*not* Schneider, 1948).
Darwinula sp. SHEPPARD and BATE, 1980, p. 117, pl. 13, fig.a 7.



Text-fig. 2. Regional and local ostracode zonation, Formations and Members of the Upper Miocene to Pleistocene in the Northern Basin of Trinidad.



Text-fig. 3. Correlation of Plio-Pleistocene formations of the Sta. Lucia-Ocumare del Tuy basin, the Paria Peninsula and the Northern Basin of Trinidad. Presence of *Cytheridea? rohri*, *Cytheridea? purperae* and *Cytheridella boldi* is indicated.

Darwinula olivencae PURPER, 1984, p. 1371.

Dimensions: Female Left valve: L 0.54 mm, H 0.23 mm; right valve: L 0.53 mm, H 0.24 mm. Male right valve: L 0.55 mm, H 0.24 mm.

Distribution: Tuy, Siquire, and upper Guiria formations.

Remarks: The specimens are identical in outline to *Darwinula* sp. from the Pebas Formation of Peru, but very slightly larger. They are a bit less slender than Purper's species from the Pebas Formation of Brazil, but appear to have the same outline. In view of the great similarity between all *Darwinula* species, its identity cannot be proven.

Superfamily CYPRIDACEA Baird, 1846
Family CYCLOCYPRIDIDAE Kaufmann, 1900
Genus CYPRIA Zenker, 1864
CYPRIA AEQUALIS Sheppard and Bate
Plate 1, fig. 3

Cypria aequalis SHEPPARD and BATE, 1979, p. 116, pl. 13, figs. 1-6.

Cypria? sp. 2 PURPER, 1980, p. 247, pl. 8, figs. 17-18.

Dimensions: L 0.39 mm, H 0.28 mm.

Remarks: Forester, in reviewing this paper, suggested that this species might rather belong to *Physocypria* Vavra, 1898. Only juvenile specimens have been found in the upper part of the Guiria Formation. They have the same outline and length/height ratio as Sheppard and Bate's specimens from Peru and Colombia and those of the Pebas Formation of Brazil. Adults have been found in the "*Chara* zone" of Huila, Colombia.

Family CANDONIDAE Kaufmann, 1900
Genus PSEUDOCANDONA Kaufmann, 1900
PSEUDOCANDONA? sp.

Dimensions: L 0.90 ;mm, H 0.46 mm.

Distribution: Tuy, lower Siquire, and upper Guiria formations.

Remarks: This species is similar in outline to *P. antilleana* Broodbakker (1983, p. 296, fig. 4A-K, 5A-J) but slightly larger. As all recovered specimens were casts no further identification is attempted.

Family CYPRIDIDAE Baird, 1845
Subfamily CYPRINOTINAE Bronstein, 1947
Genus HETEROCYPRIS Claus, 1893
HETEROCYPRIS? sp
Plate 1, fig. 5

Description: Carapace in side view elongate bean-shaped, highest just behind the middle. Anterior margin almost evenly rounded; dorsal margin slightly angled at the greatest height, gently convex on both sides of it; ventral margin almost straight, very slightly concave just behind the middle; posterior margin slightly obliquely rounded; posterior end slightly lower than anterior. Dorsal view pod-shaped; posterior end slightly wider than anterior, greatest width in the middle.

Dimensions: L 0.75 mm; H 0.35 mm; W 0.30 mm.

Distribution: Upper Siquire and Tuy formations.

Subfamily HERPETOCYPRIDIDAE
Kaufmann, 1900

Genus STENOCYPRIS Sara, 1899
STENOCYPRIS? sp.
Plate 1, fig. 2

Description: Carapace in side view elongate, highest at 3/8 of the length from the anterior extremity. Anterior margin evenly rounded in lower 2/3 with long, straight dorsal slope; dorsal margin straight, converging posteriorly towards the sinuate ventral margin; posterior margin narrowly rounded subventrally, obliquely truncate above. Dorsal view pod-shaped, widest in the middle, ends acuminate.

Dimensions: L 1.18 mm, H 0.53 mm, W 0.38 mm. The larger specimens are accompanied by internal casts of smaller dimensions of about the same shape, probably juveniles: L 0.88 mm, H 0.40 mm; L 0.74 mm, H 0.34 mm. It is uncertain if the larger specimens are adults.

Distribution: Upper Siquire Formation.

Remarks: As the marginal area could not be studied in the present material, the assignment to *Stenocypris* is based on external morphology only. *Stenocypris major* (Baird) (see Triebel, 1953, pl. 1, fig. 1-6; pl. 2, fig. 7-14) is larger, has parallel dorsal and ventral margins and a less steeply truncate posterodorsal margin.

Family CYPRIDOPSIDAE
Kaufmann, 1900

Genus POTAMOCYPRIS Brady, 1870
POTAMOCYPRIS sp.
Plate 1, fig. 6

Description: Carapace triangular in side view, highest at about 1/3 of the length from the anterior extremity. Anterior margin obliquely rounded; dorsal margin gently convex, sloping down from the greatest height and continuing into the more steeply sloping posterior margin, which is narrowly rounded ventrally; ventral margin sinuate.

Dimensions: L 0.55 mm, H 0.29 mm.

Distribution: Upper Guiria Formation (Unit E).

Remarks: This form shows similarity with *P. schubarti* Klie (1940, p. 65, figs. 11-19) from northeastern Brasil, but has the greatest height more anteriorly located. It is ventrally less concave and posterodorsally less angulate than *P.* sp. aff. *P. schubarti* (Bold, 1976, table 9) from Lago de Valencia, Recent, Venezuela.

Family ILYOCYPRIDIDAE
Kaufmann, 1900
Genus ILYOCYPRIS Brady and
Norman, 1889
ILYOCYPRIS sp.
Plate 1, fig. 4

Description: Carapace large, subelliptical to rectangular. Anterior end evenly rounded, dorsal and ventral margin almost straight and parallel, posterior end slightly obliquely rounded. Surface finely pitted. Two sulci extend from the

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PLATE 1

Figures

1. *Darwinula* sp. aff. *D. fragilis* Purper, HVH 10780, right valve view. loc. CB 77-885. Siquire Formation. 90 x.
2. *Stenocypris*? sp., HVH 10782, right valve view, loc. CB 77-898, Siquire Formation. 40 X.
3. *Cypria aequalica* Sheppard and Bate, HVH 10781, right valve, Unit E, Guiria Formation. 90 X.
4. *Ilyocypris* sp., HVH 10785, left valve view, loc. CB 77-898, Siquire Formation. 30 X.
5. *Heterocypris* sp., HVH 10784, right valve view, loc. CB 77-898, Siqurie Formation. 60 X.
6. *Potamocypris* sp., HVH 10783, right valve view, Unit E, Guiria Formation. 150 X.

7-11. *Cytheridea purperae* n. sp., loc. VB-1, Tuy Formation. 50X. 7, HVH 10755, holotype, right valve, female; 8, HVH 10756, left valve, female; 9, HVH 10757, dorsal view, female; HVH 10758, left valve, male; 11, HVH 10759, right valve, male.

12. *Pacambocythere campana* (Sheppard and Bate), HVH 10771, right valve view, female, loc. Ka 116b "*Chara* Zone," Huila, Colombia. 85 X.

13-14. *Perissocytheridea subrugosa* (Brady), HVH 10770, Unit J. Guiria Formation. 85 X. 13, Dorsal view, female; 14, dorsal view, male.

PLATE 1

dorsal margin slightly obliquely downward and backward to just above median height, one at 2/5 of the length from the anterior extremity, the other centrally located. Adductor muscle scars situated below and slightly in front of the central sulcus. Left valve slightly overlapping the right along dorsal margin, right valve slightly overlapping in the posterior end. Dorsal view lanceolate, widest at about 1/4 of the length from the posterior extremity.

Dimensions: L 1.35 mm, H 0.78 mm, W 0.55 mm.

Distribution: Only sample 898, Siquire Formation (common, but all specimens damaged).

Superfamily CYTHERACEA Baird, 1850
Family CYTHERIDEIDAE Sars, 1925
Genus CYTHERIDEA Bosquet, 1852
CYTHERIDEA? ROHRI (Bold)
Plate 3, figs. 1-7

Cyprideis rohri BOLD, 1963, p. 378, pl. 2, figs. 4a, b; pl. 3, figs. 1 a-c; pl. 11, fig. 4; table 5 (part).

Cytheridea rohri (Bold), SANDBERG, 1964, p. 168, pl. 13, fig. 8; BOLD *in* MACSOTAY, 1968, p. 64; BOLD, 1972a, table 2.

Cytheridea? rohri (Bold), BOLD, 1976, p. 31.

Distribution: Talparo Formation, Trinidad; Siquire and Guiria formations, Venezuela.

Remarks: The record of this species from the Gransaul member of the Springvale Formation (Bold, 1963, table 5) is a drafting error, it should have been reported as *Cytheridea mediatena* Bold (1963, p. 376, pl. 2, figs. 3 a-d; pl. 11, fig. 3).

CYTHERIDEA? PURPERAE n. sp.
Plate 1, figs. 7-11

Cyprideis sp. aff. *C. pascagoulaensis* (Mincher), BOLD, 1972, p. 1012.

Diagnosis: A species of *Cytheridea*? with smooth to weakly pitted surface, very shallow submedian sulcus, flattened marginal area in anterior end, obliquely truncate posterior end, and projecting posterior cardinal angle in the left valve.

Description: FEMALE: Left valve in side view elongate subrectangular, highest in the middle third of the carapace. Anterior margin evenly rounded, laterally flattened to a carina; dorsal margin convex, flattened in the middle third where it is parallel to the slightly sinuate ventral margin; posterior margin obliquely rounded, more narrowly rounded below the middle, upper portion obliquely truncate. In the right valve the dorsal margin more strongly convex, posterior end obliquely truncate and narrowly rounded ventrally. Dorsal view with strongly compressed anterior margin, width about equal in anterior and posterior portions with a shallow-compressed area in between. Surface smooth to weakly punctate.

MALE: More elongate and lower; posterior end more obliquely truncate, narrowly rounded ventrally. Marginal area narrow, radial pore canals numerous, evenly spaced, about 30 in anterior end, short, mostly straight, a few bifurcating. Line of conscrescence and inner margin coinciding throughout. Hinge in the left valve with a very elongate anterior socket, about 0.20 mm long and crenulate, anteromedian element a very short tooth, posteromedian element a long (0.25 mm) shallow, crenulate groove, posterior socket short. Muscle scars forming a vertical row of four, located in the submedian sulcus and two small frontal scars, situated close together. Mandibular fulcral point between frontal scars and first and second adductor scars; two small, mandibular muscle-scars located vertically below the frontals.

Dimensions: Tuy Formation: Female left valve: L 0.68 mm, H 0.36 mm; right valve: L 0.64

PLATE 2

Figures

1-2. *Limnocythere* sp. 1, HVH 10787, loc. CB 77-868, Siquire Formation. 75 X. 1, Left valve view; 2, dorsal view.

3-4. *Limnocythere* sp. 2, HVH 10789, loc. CB 77-902, Siquire Formation. 3, Left valve view. 100 X; 4, dorsal view. 75 X.

5-6. *Limnocythere* sp. 3, HVH 10750, loc. CB 77-885, Siquire Formation. 85 X. 5, Left valve view; 6, dorsal view.

7-8. *Limnocythere* sp. 4, HVH 10752, loc. VB-1, Tuy Formation. 95 X. 7, Left valve view; 8, dorsal view.

9-10. *Cytheridella boldi* Purper, HVH 10754, loc. CB-77-898, Siquire Formation. 50 X. 9, Right valve view, female; 10, dorsal view, female.

11-13. *Callistocythere? macsotayi*, n. sp., Unit J, Guiria Formation. 11, HVH 10772, right valve view, female, holotype. 75 X; 12, left valve view, female, HVH 10773. 75 X; 13, HVH 10774, right valve view, male. 100 X.

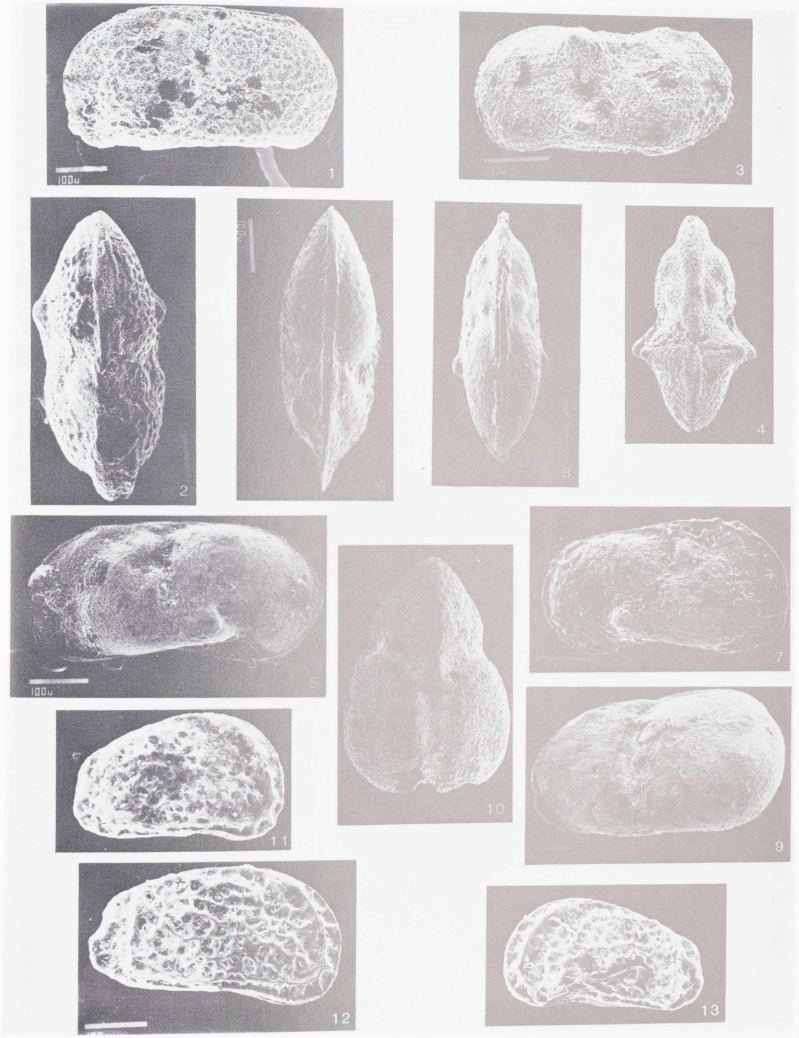

PLATE 2

mm, H 0.34 mm; Male left valve: L 0.77 mm, H 0.38 mm; large female left valve: L 0.72 mm, H 0.36 mm.

Guiria Formation: Female left valve: L 0.67 mm, H 0.36 mm, right valve: L 0.67 mm, H 0.35 mm; Male carapace: L 0.76 mm, H 0.37 mm, W 0.24 mm; left valve: L 0.76 mm, H 0.37 mm.

Name: In honor of Dr. Ivone Purper, Instituto de Geosciencias, Universidade Federal do Rio Grande do Sul, BRASIL.

Holotype: HVH no. 10755: right valve, female.

Paratypes: Male and female left and right valves: HVH nos. 10756-10760.

Type locality: VB-1 (Coll. P. J. Bermúdez), roadcut between Charallava and Santa Teresa, Estado Miranda, Venezuela (Bermúdez, 1966, p. 344).

Stratigraphic horizon: Tuy Formation.

Distribution: Upper part of Siquire Formation, Tuy Formation, upper part of Guiria Formation (Unit E).

Remarks: Cytheridea? purperae differs in some respects from typical *Cytheridea* and can only be assigned questionably to this genus. It probably does not belong to the "*Cytheridea*" group that developed in northern Venezuela and Trinadad from a stock of questionable *Hemicyprideis*? species (e.g., *Hemicyprideis? cagigalensis*). (See Bold, 1976, p. 31 for discussion.) *Cytheridea pebasae* Purper (1979, p. 228, pl. 2, figs. 11-25) is similar in size and in side view outline, but more rectangular in dorsal view and has a more distinctly pitted surface and a dentate anterior end. Sheppard and Bate (1980) combined this species with *Cytheridea graciosa* Purper and *Cytheridea longispina* Purper under the name *Cyprideis purperi purperi* (1980, p. 99, pl. 7, figs. 1-13). Ivone Purper compared some of my specimens with her Brasilian material and concluded that although similar the two species are not identical (letter 16 March, 1979).

Family LIMNOCYTHERIDAE Klie, 1938
Genus LIMNOCYTHERE Brady, 1868

In the Sta. Lucia-Ocumare del Tuy basin four species of *Limnocythere* occur. Originally it was thought that two of the species might be molts of the other two, but all four show distinct sexual dimorphism. These species are not named because I do not have exact localities and the interior could not be studied.

LIMNOCYTHERE sp. 1
Plate 2, figs. 1-2

Description: Carapace subrectangular in side view, dorsal and ventral margin roughly parallel. Anterior margin evenly rounded, posterior margin bluntly angled in the middle, obliquely truncate above and below. Lower part of posterior margin extending below the ventral margin with a small notch just in front of the posteroventral angulation. Ventral surface concave. Surface finely reticulate. Subcentrally a deep median sulcus separating an anterocentral and a posterodorsal swelling. A posteroventral swelling with a broad knob, separated from the posterodorsal swelling by a shallow depression. From the middle of the subcentral sulcus a shallower sulcus extends upward and foreward, enclosing a small knob, separated from the inconspicuous eye-node by a shallow depression. Dorsal view irregular in outline with compressed anterior end, greatest width at the node of the posteroventral swelling at about 1/5 of the length from the posterior extremity. Interior not studied. Male much more elongate, highest in

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PLATE 3

Figures

1-7. *Cytheridea rohri* (Bold). 1, HVH 10761, right valve view, female, loc. CB 77-885, Siquire Formation. 50 X; 2, HVH 10762, right valve view, female, loc. CB 77-898, Siquire Formation. 50 X; 3, HVH 10763, dorsal view, female loc. CB 77-885, Siquire Formation. 50 X; 4, HVH 10764, right valve view, male, loc. CB 77-885, Siquire Formation. 50 X; 5, HVH 10765, dorsal view, male, loc. CB 77-885, Siquire Formation. 50 X; 6, HVH 10766, right valve, male, Unit J, Guiria Formation. 50X; 7, HVH 10767, left valve, male, Unit J, Guiria Formation. 60 X.

8-11. *Xestoleberis bermudezi* n. sp., Unit J, Guiria Formation. 110 X. 8, HVH 10776, holotype, right valve view, female; 9, HVH 10777, dorsal view, female; 10, HVH 10778, right valve view, male; 11, HVH 10779, dorsal view, male.

12-15. *Perissocytheridea cytheridellaformis* Forester, Unit J, Guiria Formation. 12, HVH 10769, right valve view, female 80 X; 13, HVH 10769, left valve view, male. 85 X; 14, HVH 10769, dorsal view, female. 80 X; 15, HVH 10769, dorsal view, male. 85 X.

PLATE 3

the posterior fourth with anteriorly converging dorsal and ventral margins.

Dimensions: Female: L 0.61 mm, H 0.33 mm, W 0.28 mm; Male: L 0.73 mm, H 0.36 mm, W 0.27 mm.

Distribution: Basal Siquire Formation.

LIMNOCYTHERE sp. 2
Plate 2, figs. 3-4

Description: Very similar in side view to *Limnocythere* sp. 1, but much smaller; posterior and more regularly rounded. Node on ventral swelling the most conspicuous tubercle at 0.36 of the length from the posterior extremity; greatest width in this position. Almost vertically above it a dorsal node; both very prominent in dorsal view. This species is believed to be a descendant of *Limnocythere* sp. 1.

Dimensions: Female: L 0.43 mm, H 0.23 mm, W 0.26 mm; Male: L 0.46 mm, H 0.23 mm, W 0.20 mm.

Distribution: Upper Siquire Formation.

LIMNOCYTHERE sp. 3
Plate 2, figs. 5-6

Description: Carapace in side view subrectangular. Anterior margin almost regularly rounded, dorsal margin straight, ventral margin strongly concave, posterior margin rounded in the middle, gently convex above and below. A vertical subcentral sulcus containing the adductor scars; a shallow depression at the place of attachment of the frontal muscles. Central part of the carapace swollen, the ventral termination of the swelling converging posteriorly towards the dorsal margin and ending abruptly at about 1/3 of the length from the posterior extremity in front of a depressed area. Behind this the carapace exhibits a posteroventral swelling connected to a posterodorsal swelling. Only one carapace with very weak reticulation, others smooth. Dorsal view narrow, spindle-shaped, ends compressed, especially the anterior. Greatest width at the posterior end of the ventral swelling at 1/3 of the length from the posterior; in the male the greatest width at about 1/4. Males longer and having the greatest height in the posterior fourth of the carapace. Dorsal and ventral margin converging anteriorly.

Dimensions: Female: L 0.59 mm, H 0.28 mm, W 0.22 mm; Male: L 0.63 mm, H 0.27 mm, W 0.20 mm.

Distribution: Lower Siguire Formation.

Remarks: Similar in general appearance to *L. sappaensis* Staplin (1963, p. 1197, pl. 160, figs. 4-6) from the Pleistocene of South Dakota, Nebraska, Iowa, and Kansas but that species is more clearly reticulate and lacks the posteroventral swelling.

LIMNOCYTHERE sp. 4
Plate 2, figs. 7-8

Description: Very similar to sp. 3, but much smaller. In the female the posterior end of the ventral swelling projects laterally as a tubercle.

Dimensions: Female: L 0.44 mm, H 0.23 mm, W 0.20 mm; Male: L 0.51 mm, H 0.25 mm.

Distribution: Tuy Formation.

LIMNOCYTHERE STAPLINI Gutentag and Benson

Limnocythere staplini GUTENTAG and BENSON, 1962, p. 51, pl. 1, figs. 1-3, text-fig. 15; BOLD, 1975a, p. 612, pl. 59, fig. 8a, b.

Limnocythere sp. BOLD, 1972a, p. 1012.

Dimensions: L 0.57 mm, H 0.30 mm (HVH 10753).

Distribution: Pleistocene, Kansas; Las Salinas and Jimaní Formations (Late Pliocene to Pleistocene?) Hispaniola; Cumaca Formation, Venezuela; Recent, Bahamas, North America.

Genus CYTHERIDELLA Daday, 1905

CYTHERIDELLA BOLDI Purper
Plate 2, figs. 9-10

Cytheridella boldi PURPER, 1974, p. 654, pl. 10, figs. 1-4.

Cytheridella ilosvayi Daday, BOLD, 1975a, p. 613, pl. 58, fig. 1 a-g; pl. 6, fig. 3a, b (not DADAY, 1905).

Dimensions: Female: L 0.87 mm, H 0.49 mm, W 0.60 mm; Male: L 0.86 mm, H 0.47 mm, W 0.48 mm.

Distribution: Siquire Formation, Recent, Lago de Valencia, Venezuela; upper Talparo Formation, Trinidad; Jimaní Formation, Hispaniola.

Remarks: The specimens from the Siquire Formation and from cuttings of a well (material from M. Dempsey) in the Talparo Formation (northern basin, Trinidad) are all slightly distorted, but show the typical "square" posterior portion of the female, different from *C. ilosvayi* and *C. danielopoli* Purper (1979, p. 243, pl. 7, figs. 21-27). I am not certain if the distinct pattern of pitting in *C. postornata* Sheppard and Bate (1980, p. 108, pl. 10, figs. 1-7) is sufficient to separate this species from *C. danielopoli*. Typical (but again distorted) specimens of *C. postornata* have been found in the "*Chara* zone" of Huila (Colombia), where they occur together with specimens of *Darwinula fragilis* Purper, *Cypria aequalica* Sheppard and Bate, *Pelocypris zilchi* Triebel,

Proparacytheridea acuminata Purper, *Perissocytheridea* n. sp., and *Pacambocythere campana* (Sheppard and Bate) (=*Ambocythere? campana* Sheppard and Bate, 1980, p. 110, pl. 11, figs. 1-9), which is the most common ostracode there (Pl. 1, fig. 12). This suggests a possible correlation of the "*Chara* zone" with the Pebas Formation and its southeast Colombian equivalents.

Family CYTHERIDAE Baird, 1850
Subfamily PERISSOCYTHERIDEINAE Bold, 1963
Genus PERISSOCYTHERIDEA Stephenson, 1938

PERISSOCYTHERIDEA SUBROGOSA (Brady)
Plate 1, figs. 13-14

Cythere subrugosa BRADY, 1870, p. 238, pl. 30, figs. 18, 19.

Perissocytheridea subrugosa (Brady), BOLD, 1958a, p. 71, tables 1, 3; 1963, p. 380, pl. 4, fig. 2 a-d; 1966, pl. 1, fig. 7 a, b; TEETER, 1975, p. 432, figs. 6 j, 7 f, g; BOLD, 1978 b, table 9.

Distribution: Pliocene to Recent: Greater Antilles, Northern South America, Costa Rica; Lower Guiria Formation, Venezuela.

PERISSOCYTHERIDEA CYTHERIDELLAFORMIS Forester
Plate 3, figs. 12-15

Perissocytheridea n. sp. BOLD *in* MACSOTAY 1968, p. 64.

Perissocytheridea cytheridellaformis FORESTER *in* BOLD, 1975a, pp. 610, 818, pl. 60, fig. 8 a-e; pl. 61, fig. 1 a, b; pl 62, fig. 1 a, b, tables 3, 6, 7.

Distribution: Upper Las Salinas Formation, Hispaniola; lower Guiria Formation, Venezuela.

Family LEPTOCYTHERIDAE Haai, 1957
Genus CALLISTOCYTHERE Ruggieri, 1953

CALLISTOCYTHERE? MACSOTAYI n. sp.
Plate 2, figs. 11-13

Diagnosis: A species of *Callistocythere*? with a prominent, vertical, posterior ridge.

Description: Carapace in side view trapezoid to subrectangular, highest at 2/5 of the length from the anterior extremity, Anterior margin obliquely rounded, dorsal margin gently convex, ventral margin sinuate, converging posteriorly; posterior margin steeply truncate above, narrowly rounded ventrally. Ventral and dorsal surface flattened, but only barely delineated by longitudinal ridges. Surface irregularly reticulate. A pronounced anterior rim paralleling the anterior margin with 5-6 radial ridges projecting forward toward the margin. At 1/7 of the length from the posterior extremity a vertical ridge, the carapace strongly compressed behind. Weak ventral, dorsal and subdorsal ridges extend forward from the posterior ridge, becoming obscure in the middle of the valve. Dorsal view wedge-shaped, widest just in front of the posterior ridge.

Sexual dimorphism present. Male elongate-trapezoid in side view, lower and narrower than the female, with dorsal and ventral margin more nearly parallel in the posterior half. Greatest width at the posterior ridge. Interior not observed. Only closed carapaces were found.

Dimensions: Female: L 0.46 mm, H 0.26 mm, W 0.18 mm; Male: L 0.43 mm, H 0.21 mm, W 0.26 mm.

Name: After Oliver Macsotay, Oceanographic Institute, University of Oriente, Venezuela, in honor of his work on the Guiria, Siquire and Tuy formations.

Holotype: HVH no. 10772, female carapace.

Paratypes: HVH no. 10773-10775, male and female carapaces.

Type locality: Sample 496a (Macsotay, 1968, p. 55), in small ravine 500 m NE of the stone pier at Guiria.

Distribution: Only in Unit J of the Guiria Formation.

Remarks: This species differs from other species of *Callistocythere* described from the Atlantic and Pacific coast of America by having a vertical posterior ridge instead of the general gradual curvature of ridges in the posterior end.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948
Genus CATIVELLA Joryell and Fields, 1938

CATIVELLA PULLEYI Teeter

Cativella aff. *semitranslucens* (Crouch), BOLD, 1958b, p. 404, pl. 3, fig. 3; 1963, p. 389, pl. 11, fig. 6; 1978b, table 9.

Cativella pulleyi TEETER, 1975, p. 451, figs. 12 f, 12 c-e; BREMAN, 1982, pl. 4, fig. h.

Distribution: Middle Miocene to Recent: Carribbean; Unit J of the Guiria Formation, Venezuela.

Subfamily CAMPYLOCYTHERINAE Puri, 1960
Genus BASSLERITES Howe, 1937

BASSLERITES MINUTUS Bold

Basslerites minutus BOLD, 1956, p. 405, pl. 3, fig. 8; pl. 5, fig. 5 a-c; MORALES, 1966, p. 62, pl. 5, fig. 3 a, b; BREMAN, 1982, p. 237.

Distribution: Lower Miocene to Recent, Caribbean; Unit J of the Guiria Formation, Venezuela.

Family LOXOCONCHIDAE Sars, 1925
Genus LOXOCONCHA Sars, 1965
LOXOCONCHA LEVIS Brady

Loxoconcha levis BRADY, 1870, pp. 238, 242, pl. 32, figs. 7, 8; BOLD, 1963, p. 393, pl. 9, fig. 10 a, b; TEETER, 1975, p. 473, fig. 18g, 19 a, b; BOLD, 1968, pp. 22, 25, 30; 1975a, pp. 577, 578, 583, 585, 590, 604; 1975b, pp. 122, 127; 1978, table 9; 1981, p. 81, pl. 5, fig. 11 a, b.

Distribution: Pliocene to Recent, Caribbean; Unit J of the Guiria Formation, Venezuela.

Family XESTOLEBERIDIDAE Sars, 1928
Genus XESTOLEBERIS Sars, 1866
XESTOLEBERIS BERMUDEZI n. sp.
Plate 3, figs. 8-11

Description: FEMALE: In side view almost forming a 120 degree circle-sector, elongate, highest at 3/5 of the length from the anterior extremity. Anterior margin with dorsal slope from the greatest height, narrowly rounded ventrally; dorsal margin short, gently convex, converging to ventral posteriorly; posterior margin rounded subventrally, dorsal slope steep and slightly convex. Ventral surface strongly flattened, somewhat concave. Dorsal view bullet-shaped, widest at 1/3 of the length from the posterior end, acuminate anteriorly, broadly rounded posteriorly.

MALE: Similar in shape but lower in side view, greatest height just behind the middle, slope of the dorsal part of posterior margin less steep than in female, more narrowly rounded ventrally. Dorsal view widest in the middle, posterior end less broadly rounded than in female.

Dimensions: Female: L 0.38 mm, H 0.19 mm, W 0.23 mm; Male: L 0.35 mm, H 0.16 mm, W 0.19 mm.

Name: After the late Dr. P. J. Bermúdez.

Holotype: HVH No. 10776, female carapace.

Paratypes: HVH No. 10777 (female carapace), 10778, 10779 (male carapaces).

Type locality: 496a of Macsotay, 1968, p. 55, in small ravine, 500m NE of the stone pier at Guiria.

Stratigraphic horizon: Base of Unit J of Macsotay, Guiria Formation.

Distribution: Only in Unit J of the Guiria Formation.

Remarks: The species is similar in side view to *X. chilensis* Hartmann (1962, p. 219, figs. 118-130), but has the greatest height more posteriorly. In dorsal view, the greatest width is also more posteriorly. In side-view it is almost a duplicate of *X. tomkilenyii* Bate *et al.*, 1982 (p. 68, pl. 68, figs. 42 K-S, 43 A-Q, 44F) from the Galapagos islands, except for the lack of posteroventral nodes. The male, however, is more tapering posteriorly in side-view.

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