

## The taxonomy and zoogeography of the family Trachyleberididae (Crustacea: Ostracoda) from the Equatorial Continental Shelf of Brazil

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**ABSTRACT** – A study of the family Trachyleberididae Sylvester-Bradley from the Equatorial Continental Shelf of Brazil (almost 1400 km in length) revealed the presence of five new species, which are described herein. These are: *Cletocythereis atlantica*, *Cativalva paratranslucens*, *Cativalva reticulocostata*, *Henryhowella tuberculoclaviforma* and *Australimoosella polypleuron*. Two sub-species of the genus *Costa*, *C. variabilicostata brasiliensis* subsp. nov. and *C. variabilicostata* aff. *recticostata* Bold, are placed within the *variabilicostata* group. The genus *Neocaudites* is represented by two species, *N. subimpressus* Edwards and *N. triplistriatus* Edwards, originally described from the Upper Miocene and Pliocene of the Duplin Marl, North Carolina, USA. The genus *Puriana* is represented by *P. convoluta* Teeter and *P. variabilis* Chukewiski & Purper, described originally from Belize (British Honduras) and the Brazilian coast, respectively. The geographical distribution of the studied fauna, reveals the presence of two assemblages on the Equatorial Continental Shelf of Brazil, a Northwest and a Southwest assemblage, separated by the area of discharge of the Amazon and Pará rivers and each with its distinctive oceanographical and sedimentological characteristics. *J. Micropalaeontol.* 23(2): 107–118, November 2004.

### INTRODUCTION

This contribution is part of a larger study of the Recent marine Ostracoda of the Brazilian margin. It is concerned solely with the taxonomy and zoogeography of the family Trachyleberididae from the Equatorial Continental Shelf. The first study of Ostracoda from the Brazilian Equatorial Shelf began with the classical study of Brady (1880), but only in the last 25 years has important modern research been undertaken in this extensive geographical area (almost 1400 km in length). Thus, studies in the same area, based on the genera *Puriana*, *Pseudoceratina*, *Paracytheridea*, *Caudites*, *Orionina*, *Kangarina*, *Cornucoquimba*, *Coquimba*, *Krithe*, *Callistocythere*, *Auradilus* and *Radimella* were conducted by Chukewiski & Purper (1985a, b), Ornellas & Coimbra (1985), Coimbra & Ornellas (1986, 1987, 1989), Purper & Ornellas (1987a, b), Medeiros & Coimbra (1989), Ramos (1994, 1996), do Carmo & Sanguinetti (1995), Coimbra *et al.* (1995) and Fauth & Coimbra (1998). Coimbra *et al.* (1999a) undertook an overview of the origin and zoogeography of the Holocene ostracods from this part of the Brazilian Shelf and Coimbra *et al.* (1999b) studied the family Cytheruridae from the same area. Coimbra & Carreño (2002) studied the distribution patterns of the family Bairdiidae along the Equatorial Shelf of Brazil. Finally, Coimbra & Fauth (2002) and Coimbra & do Carmo (2002), described new species for the families Bythocytheridae and Pectocytheridae, and the subfamily Coquimbinae, respectively.

### STUDY AREA

The area studied embraces the Brazilian Continental Shelf located between Orange Cape (4°24'N), Amapá State and São Roque Cape (5°29'S), Rio Grande do Norte State (Fig. 1). The area extends from the coastline out to 200 m, with a median declivity of 0.1° and a maximum width of 330/350 km in the

mouth of Amazonas/Pará rivers (Martins & Coutinho, 1981). Thirty-one samples have been collected from deeper areas, 15 located to the SE and 16 to the NW of the Amazon estuary (Fig. 1).

### Sedimentology

Martins *et al.* (1975) recognized two physiographical provinces in the shelf of this area: (1) Orange Cape–Parnaíba River Delta; and (2) Parnaíba River Delta–Cape São Roque (Fig. 2).

**Orange Cape–Parnaíba River Delta.** According to previous studies, terrigenous sediments in the inner shelf and reworked sands in the middle and outer shelf are of common occurrence. According to Martins & Coutinho (1981) and Martins (1974), the terrigenous sediments to the north of the mouth of the Amazon/Pará rivers are essentially pelitic on the inner shelf, reaching a maximum depth of 30 m.

The middle and outer shelf are dominated by a sandy sequence that changes from quartz to bioclastics, extending out to the slope. Calcareous facies on the outer shelf are poorly developed, due to the fluvial influence, with fluvial deposits covering the carbonatic facies. The presence of oolites on the shelf can be explained by the presumed presence of an ancient hypersaline lagoon environment.

From southeast of the mouth of the Pará River to that of the Parnaíba River, the dominant quartzose sands are completely different petrographically from those derived from the Amazon River. In this facies, there is a high level of reworking and low fluvial contribution, at least since the last sedimentary cycle. Only at the mouths of the Gurupi and Parnaíba rivers are there fluvial influences. Carbonate sediments, according to Kowsmann & Costa (1979), frequently reach CaCO<sub>3</sub> levels higher than 95%, recorded as a continuous band on the outer

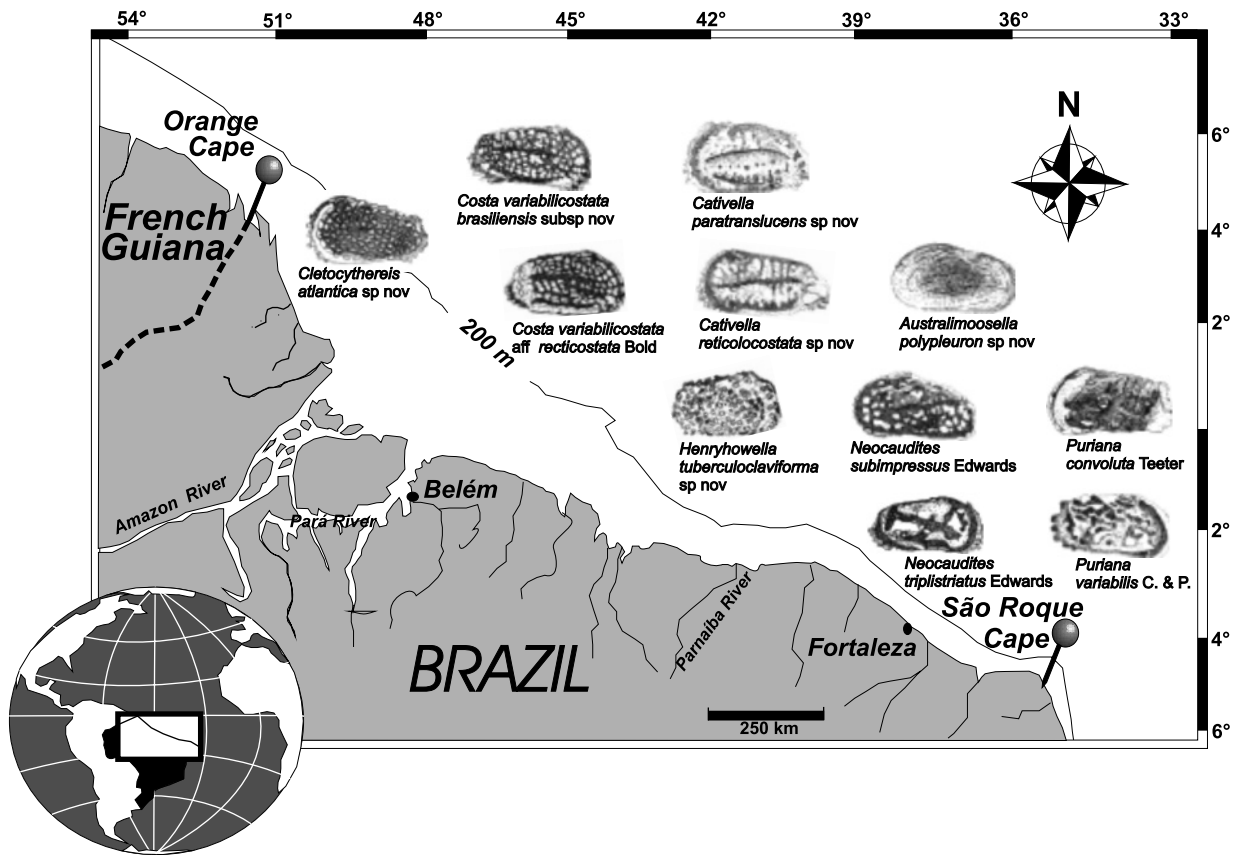


Fig. 1. Map of the study area and the species of Trachyleberididae.

shelf. These organic carbonate sediments are derived from algae, coralline algae, benthic foraminifers and molluscs. The large-scale distribution of algal reefs can be explained by the low terrigenous contribution to this part of the Equatorial Continental Shelf.

**Parnaíba River Delta–Cape São Roque.** The continental shelf gradually narrows towards São Roque Cape (5°29'S) and the carbonate contribution is higher than the terrigenous. Accord-

ing to Kowsmann & Costa (1979), the CaCO<sub>3</sub> level is higher than 75% for almost the entire area. The terrigenous component is essentially constituted by reworked sands and it is better developed on the Ceará coast. The predominance of carbonate in this area is due to the depth of the shelf (<60 m), relatively warm water, semi-arid climate and solid substrate, permitting the proliferation of a calcareous benthic fauna.

The carbonate sediments are mainly constituted by sand and gravel, with coralline algae from *Lithothamnium*, *Lithophyllum*

MOUTH OF THE AMAZON/PARÁ RIVERS	NORTHWESTERN				SOUTHEASTERN												
	ORANGE CAPE - DELTA OF THE PARNAÍBA RIVER																
	ORANGE CAPE - MOUTH OF THE PARÁ RIVER				MOUTH OF THE PARÁ RIVER - DELTA OF THE PARNAÍBA RIVER				DELTA OF THE PARNAÍBA RIVER - SÃO ROQUE CAPE								
GEOGRAPHICAL INDEX	LONGITUDES																
SPECIES	51°W	50°W	49°W	48°W	47°W	46°W	45°W	44°W	43°W	42°W	41°W	40°W	39°W	38°W	37°W	36°W	35°W
<i>Costa variabilicostata brasiliensis</i> subsp. nov.																	
<i>Cativella reticulocostata</i> sp. nov.																	
<i>Neocaudites subimpressus</i> (Edwards)																	
<i>Costa variabilicostata</i> aff. <i>recticostata</i> Bold																	
<i>Cativella paratranslucens</i> sp. nov.																	
<i>Cletocythereis atlantica</i> sp. nov.																	
<i>Neocaudites triplistriatus</i> (Edwards)																	
<i>Puriana variabilis</i> Chukewiski & Purper																	
<i>Henryhowella tuberculoclaviforma</i> sp. nov.																	
<i>Puriana convoluta</i> Teeter																	
<i>Australimoosela polypleuron</i> sp. nov.																	

Fig. 2. Zoogeographical distribution of Trachyleberididae along the Brazilian Equatorial shelf.

## Taxonomy and zoogeography of Trachyleberididae, Brazil

or *Halimeda*. The presence of molluscs and/or benthic foraminifers is restricted to particular areas (Kowsmann & Costa, 1979). Ancient and modern sediments can be mixed in this area and the phenomenon of iron staining is taken to represent exposure during the Wisconsin Regression.

### Oceanography

The Equatorial South Atlantic Current reaches the Brazilian continental margin at Cape São Roque, where it divides into the Guianas and Brazil currents, the former flowing northwestwards and the latter to the southeast. The Equatorial Continental Shelf is influenced by the Guianas Current that, according to Martins (1984), flows NW, with a mean temperature of 27°C, a salinity of 36‰ and maximum velocity of 4.0 knots. The influence of the Amazon River is dominant, its enormous freshwater discharge radically changing the physico-chemical characteristics of the oceanic area adjacent to the estuary.

### MATERIAL AND METHODS

The 339 samples, on which this study is based, were collected by Van Veen grab during a series of cruises. 177 samples are from REMAC Project (Legs 4, 5, 5A and 6) and 162 are from the Geomar I, II, III Project. Of these, 207 yielded ostracods and 132 were barren. The data of the samples, with the studied ostracod families, are shown in Figure 2. The preparation of the samples was by standard methods. Specimens were illustrated using the Phillips SEM from the Departamento de Metalurgia at UFRGS.

The numbers of specimens in the systematic descriptions are represented in the following manner: very abundant >300; abundant 101–300; common 51–100; frequent: 21–50; rare: 15–20. The following abbreviations are used in the species descriptions: LV, left valve; RV, right valve; C, carapace. The type material used in this study is held in the collections of the 'Museu de Paleontologia', Universidade Federal do Rio Grande do Sul, Section of Ostracoda, to which the prefix MP-O refers.

### SYSTEMATIC DESCRIPTIONS

Suborder **Podocopina** Sars, 1866

Superfamily **Cytheracea** Baird, 1850

Family **Trachyleberididae** Sylvester-Bradley, 1948

Subfamily **Trachyleberidinae** Sylvester-Bradley, 1948

Genus *Henryhowella* Puri, 1957

*Henryhowella tuberculoclaviforma* sp. nov.

(Pl. 1, figs 1–6)

**Derivation of name.** L. With reference to the clavate spines with which this species is covered.

**Diagnosis.** A large sub-rectangular species of *Henryhowella* with strong marginal rims and an ornament of strong clavate tubercles.

**Holotype.** Female RV, MP-O-1761.

**Material.** Abundant.

**Locality and horizon.** Project REMAC, Leg 6, sample 3699, lat. 02°21'S– long. 39°56'W, 35 m. Recent.

**Description.** Large. Thick-shelled. Sub-rectangular in lateral view. Anterior margin widely rounded with numerous short, blunt marginal denticles. Posterior margin with blunt apex at mid-height in RV and truncated in LV. Dorsal margin with prominent anterior hinge ear; straight, but rendered corrugate by ornament and gently inclined towards the posterior. Ventral margin straight. Strong marginal rims surround the end margins, separated from the lateral surface by distinct crescentic furrows. Entire carapace covered by large, irregular, clavate tubercles, superimposed upon an underlying reticulation. The ornament largely masks the subcentral tubercle. Eye tubercle large and prominent. In dorsal view both valves are biconvex with a distinct depressed central area. Internal characters and sexual dimorphism as for the genus.

### Dimensions (mm).

	Length	Height
Holotype		
Female RV, MP-O-1761	0.88	0.54
Paratypes		
Female LV, MP-O-1760	0.86	0.57
Female C, MP-O-1762	0.86	0.55
Male LV, MP-O-1763	0.87	0.51
Male RV, MP-O-1764	0.89	0.52

**Distribution.** Recent sediments from the Equatorial Shelf of Brazil. In the present study it occurs in the following samples: Leg 5, samples 3430, 3433, 3441, 3459; Leg 6, samples 3607, 3608, 3637, 3686, 3690, 3699, 3743, 3754, 3756; Geomar I, samples 21, 24, 29, 33, 34; Geomar II, sample 101; Geomar III, sample 192.

**Remarks.** This species differs from all other species of the genus known to the authors in the nature of its ornament of clavate tubercles.

Genus *Costa* Neviani, 1928

*Costa variabilicostata* Bold, 1963

*Costa variabilicostata brasiliensis* subsp. nov.

(Pl. 1, figs 7–9)

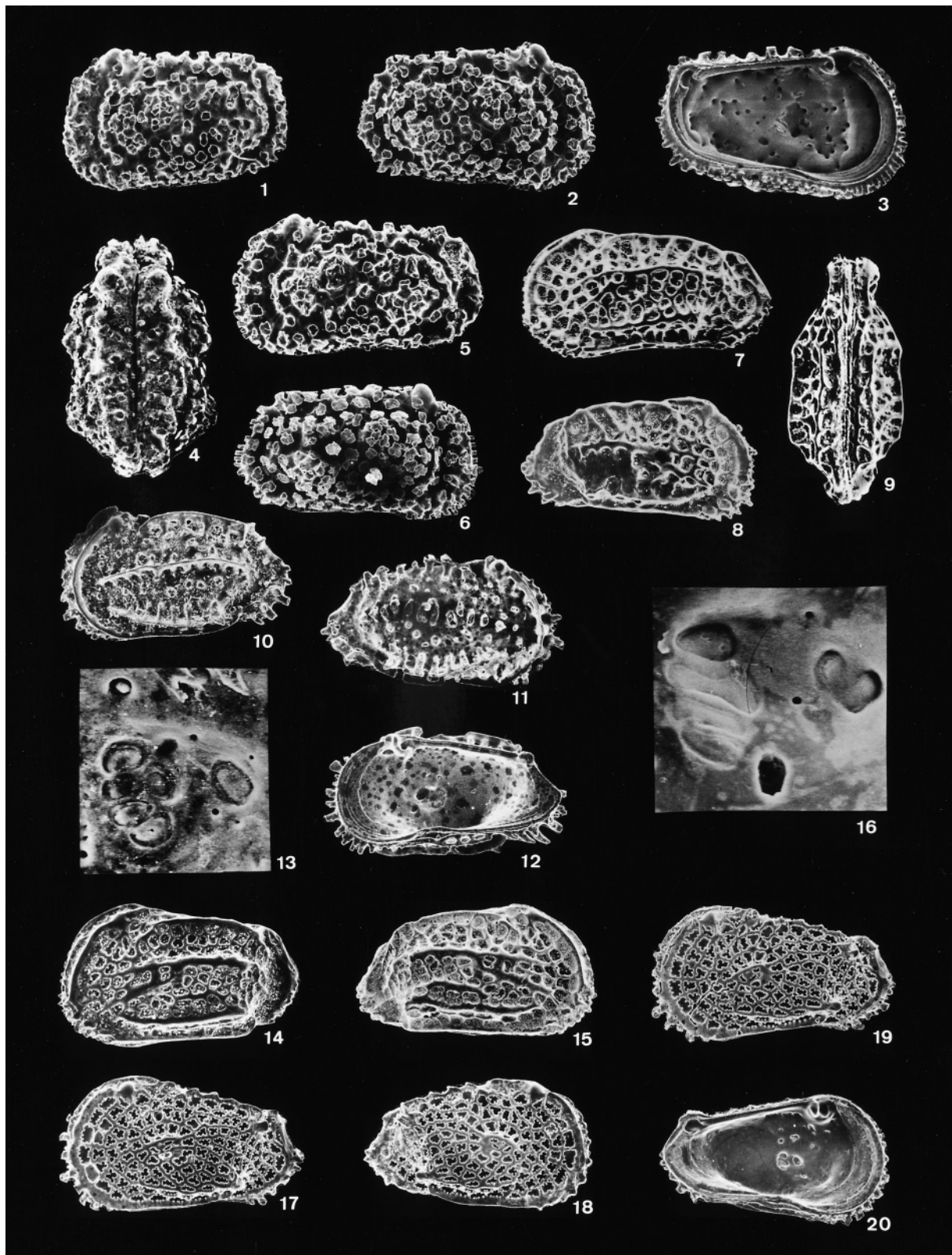
**Derivation of name.** With reference to its occurrence in Brazilian waters.

**Diagnosis.** A new sub-species of *Costa variabilicostata*, ornamented with strong ribs and intercostal reticulae, the latter being secondary papillate in the solum. Three large nodes occur on the anteromarginal rib antero-ventrally and dorsal rib is sinuous.

**Holotype.** LV, MP-O-1765.

**Material.** Common.

**Locality and horizon.** Geomar II, sample 97, lat. 2°24'N-Long. 48°38'W, 77 m. Recent.



**Description.** Similar in shape and outline to the nominate sub-species but with the antero-marginal rib embellished by three prominent nodes and blunt marginal denticles. The median, dorsal and ventro-lateral ribs are all strongly developed with the former characteristically bifurcating at approximately the position of the adductor muscle scars, and the latter being a sub-alar projection postero-ventrally. The bifurcations of the median rib become lost in coarse reticulation anteriorly and the dorsal rib is sinuous due to 'erosion' by the strong intercostal reticulation. These ribs are connected posteriorly by a dorsal and a ventral loop. Intercostal areas strongly reticulate, the reticulae somewhat 'eroding' the dorsal rib. Reticulae with numerous minute papillae. Internal features as for species. Sexual dimorphism not developed.

**Dimensions (mm).**

	Length	Height
Holotype		
LV, MP-O-1765	0.74	0.39
Paratypes		
RV, MP-O-1766	0.72	0.36
C, MP-O-1767	0.74	0.39

**Distribution.** Recent sediments from the Brazilian Equatorial Shelf, northeast of the mouth of the River Amazon. In the present study it occurred in the following samples: Leg 5A, sample 3568; Geomar II, samples 97, 99, 106, 108, 109, 111, 119, 166, 180, 182, 185, 186, 187, 188, 191, 198, 202, 203, 204, 209, 210, 212, 1500, 2476, 2522.

**Remarks.** This sub-species is probably closest to *Costa variabilicostata muhlemani* Van den Bold, 1966a, but differs in possessing three nodes antero-ventrally.

*Costa variabilicostata* aff. *C. v. recticostata* Bold, 1970  
(Pl. 1, figs 14–16)

1963 *Costa variabilicostata* (Bold); Bold: 370, table 6.

1964 *Costa variabilicostata* (Bold); Bold: 9–11.

1966 *Costa variabilicostata variabilicostata* (Bold); Baker & Hulings: 116, pl. 2, fig. 4.

1966a *Costa variabilicostata variabilicostata* (Bold); Bold: 183, pl. 22, fig. 5.

1966b *Costa variabilicostata variabilicostata* (Bold); Bold: pl. 1, figs 10a–b.

1966c *Costa variabilicostata* (Bold); Bold: 10, table 1; 11, table 2; 27.

1970 *Costa variabilicostata recticostata* Bold; Bold: 68, fig. 1, pl. 1, figs 4a–d.

1975 *Costa variabilicostata recticostata* Bold; Teeter: 456, figs 14b, 15d.

1988b *Costa variabilicostata recticostata* Bold; Bold: 146, 150, 154, tables 1, 2.

**Material.** Abundant.

**Dimensions (mm).**

	Length	Height
Homotypes		
Female LV, MP-O-1771	0.67	0.39
Female RV, MP-O-1772	0.66	0.37

**Distribution.** Previously recorded from the Upper Miocene of Colombia (Tubara Fm.), the Pleistocene? of Costa Rica (Moin Fm.) and the Recent of Trinidad, Venezuela, Colombia, Belize, Lesser Antilles and Puerto Rico. In the present study it occurs in LEG 5, samples 3459, 3477; Geomar I, samples 8, 11, 21, 33, 34; Geomar II, samples 105, 2447; Geomar III, samples 188, 189, 190, 199, 200, 2471.

**Remarks.** This sub-species was first described by Bold (1970) from Costa Rica and has been widely recorded subsequently as one or other of two sub-species from the Gulf of Mexico, Caribbean region. The authors suggest tentatively that the present material species is most closely related to the sub-species *recticostata* because, although it is very similar to *Costa variabilicostata variabilicostata* Bold, 1950, the presence of reticulation in front of the anterior sub-marginal rib; sub-rectilinear dorsal, central and ventral ribs; and the presence of sexual dimorphism clearly favours the former sub-species. Bold (1970) found specimens larger (0.71–0.75 mm) than the specimens from the type-locality, on the North Trinidad Shelf at depths between 54 m and 86 m. The adult specimens in the present material are also larger than those from Costa Rica but do not reach 0.7 mm.

Genus *Cativella* Coryell & Fields, 1937

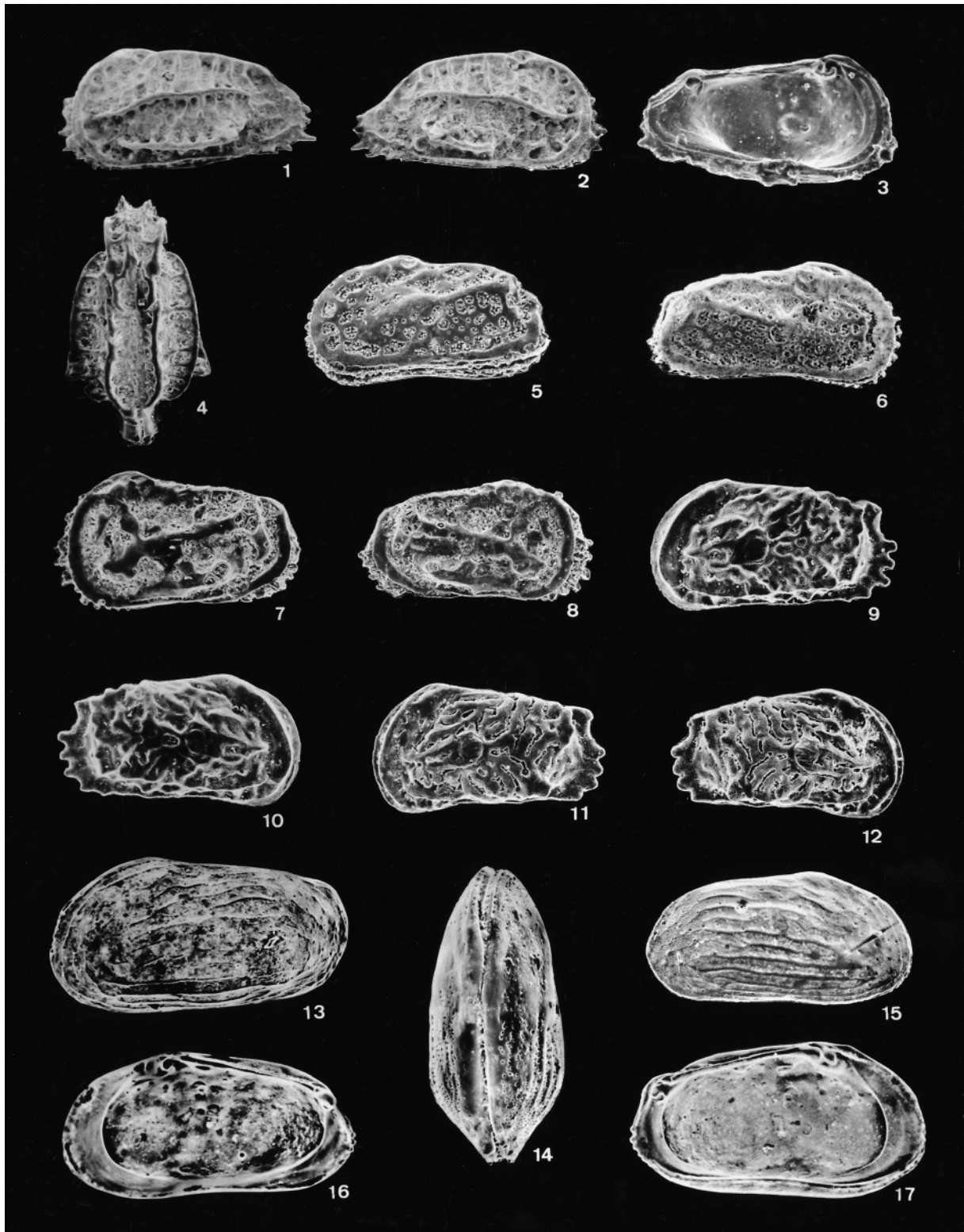
*Cativella paratranslucens* sp. nov.  
(Pl. 1, figs 10–13)

**Derivation of name.** L. Named for the superficial similarity of this species to *Cativella semitranslucens* (Crouch, 1949).

**Diagnosis.** A species of *Cativella* with three distinctly ponticulate ribs and tuberculate intercostal areas. The median rib does not extend to the anterior rib.

**Explanation of Plate 1.**

**figs 1–6.** *Henryhowella tuberculoclaviforma* sp. nov.: **1**, female left valve, external lateral view,  $\times 121$ , MP-O-1760; **2**, female right valve, external lateral view,  $\times 126$ , MP-O-1761 (holotype); **3**, female left valve, internal view,  $\times 132$ , MP-O-1760; **4**, female carapace, dorsal view,  $\times 132$ , MP-O-1762; **5**, male left valve, external lateral view,  $\times 123$ ; MP-O-1763; **6**, male right valve, lateral external view,  $\times 117$ , MP-O-1764. **figs 7–9.** *Costa variabilicostata brasiliensis* ssp. nov.: **7**, left valve, external lateral view,  $\times 217$ , MP-O-1765 (holotype); **8**, right valve, external lateral view,  $\times 201$ , MP-O-1766; **9**, carapace, dorsal view,  $\times 210$ , MP-O-1767. **figs 10–13.** *Cativella paratranslucens* sp. nov.: **10**, female left valve, external lateral view,  $\times 135$ , MP-O-1768 (holotype); **11**, female right valve, external lateral view,  $\times 135$ , MP-O-1769; **12**, female right valve, internal view,  $\times 135$ , MP-O-1770; **13**, female left valve, detail of central muscle scars,  $\times 235$ , MP-O-1768. **figs 14–16.** *Costa variabilicostata* aff. *recticostata* Bold, 1970: **14**, female left valve, external lateral view,  $\times 162$ , MP-O-1771; **15**, female right valve, lateral external view,  $\times 162$ , MP-O-1772; **16**, female left valve, central muscle scars,  $\times 264$ , MP-O-1771. **figs 17–20.** *Cletocythereis atlantica* sp. nov.: **17**, female left valve, external lateral view,  $\times 150$ , MP-O-1773; **18**, female right valve, external lateral view,  $\times 150$ , MP-O-1774 (holotype); **19**, male left valve, external lateral view,  $\times 150$ , MP-O-1775; **20**, female left valve, internal view,  $\times 150$ , MP-O-1776.



**Holotype.** Female LV, MP-O-1768.

**Material.** Common.

**Locality and horizon.** Project REMAC, Leg 6, sample 3685, lat. 02° 12' S–long. 40° 20' W, 49 m. Recent.

**Description.** Large. Shell of medium thickness. Carapace sub-rectangular in lateral view. Anterior margin broadly rounded but rendered angular by its marginal denticles and flange. Posterior margin with one postero-dorsal and three postero-ventral spines and blunt apex just below mid-height. Dorsal margin straight and inclined slightly towards the posterior; largely obscured by the convex dorsal rib. Ventral margin slightly sinuous. Valves convex in dorsal view and anterior margin strongly rimmed. Ornament costate and tuberculate. From a distinct dorsal loop, which is not connected to the median rib, the dorsal rib extends in an arcuate manner, above the dorsal margin, to its termination behind the eye. The median rib extends across the valve from a mid postero-lateral to a mid antero-lateral position. The ventro-lateral rib increases in height posteriorly; five small riblets extend dorsally from this. All these ribs are ponticulate. From the distinct eye tubercle, a short arcuate rib extends posteriorly and another, longer rib parallels the anterior margin to its antero-ventral termination. Intercostal areas smooth with intermittent tubercles of different sizes; a distinct row of large tubercles bisects and parallels the median and ventro-lateral ribs. Internal characters as for the genus. Sexual dimorphism not strongly marked; males a little lower and longer than females.

**Dimensions (mm).**

	Length	Height
Holotype		
Female LV, MP-O-1768	0.77	0.43
Paratype		
Female RV, MP-O-1769	0.79	0.42
Female RV, MP-O-1770	0.77	0.42

**Distribution.** Equatorial Shelf of Brazil. Leg 5, sample 3477; Leg 5A, sample 3567; Leg 6, samples 3635, 3672, 3685, 3692, 3717; Geomar I, samples 8, 11; Geomar II, samples 97, 99, 109, 111, 120, 128; Geomar III, samples 146, 154, 166, 180, 184, 185, 186, 188, 191, 198, 202, 204, 209, 210, 217, 2471, 2500, 2522.

**Remarks.** Some specimens have the dorsal and anterior ribs united. The present species differs from *C. semitranslucens* (Crouch, 1949) by virtue of its ponticulate ribs.

*Cativella reticulocostata* sp. nov.

(Pl. 2, figs 1–4)

**Derivation of name.** L. From the combination of ribs and reticulæ which form the ornament of this species.

**Diagnosis.** A slender, rather elongate species of *Cativella* with strong ribs and intercostal reticulæ in which the vertical muri predominate.

**Holotype.** LV, MP-O-1777.

**Material.** Frequent.

**Locality and horizon.** Project REMAC, Leg 6, sample 3684, lat. 02° 19' S–long. 40° 21' W, 33 m. Recent.

**Description.** Large. Fairly thick-shelled. Subhastate in dorsal view. Carapace elongate, subpyriform in lateral view and strongly acuminate posteriorly. Anterior margin well-rounded with strong flange and marginal denticles antero-ventrally. Posterior margin pointed, especially in RV with apex just below mid-height and with strong marginal denticles below. Dorsal margin straight and sloping towards the posterior. Ventral margin largely obscured by valve tumidity. End margins paralleled by strong marginal rib; the same rib also extending along the ventral margin and, in a slightly arcuate manner along the dorsal margin to its termination just behind the eye tubercle, which is situated on the antero-marginal rib. Intercostal areas strongly reticulate. The vertical components of the muri predominating. Internal characters as for genus. Sexual dimorphism not developed.

**Dimensions (mm).**

	Length	Height
Holotype		
LV, MP-O-1777	0.75	0.39
Paratypes		
RV, MP-O-1778	0.77	0.34
LV, MP-O-1779	0.74	0.39
C, MP-O-1780	0.74	0.42

**Distribution.** Recent sediments from the Equatorial Shelf of Brazil. Leg 5, samples 3459, 3477; Leg 6, sample 3684; Geomar I, samples 21, 24, 34; Geomar II, samples 99, 108, 113, 209, 210, 2466, 2475.

**Remarks.** This species differs from *Cativella iyemojai* Omatsola 1972, from West Africa, mainly in its shorter median and

**Explanation of Plate 2.**

**figs 1–4.** *Cativella reticulocostata* sp. nov.: **1**, left valve, external lateral view, × 120, MP-O-1777 (holotype); **2**, right valve, external lateral view, × 120, MP-O-1778; **3**, left valve, internal view, × 120, MP-O-1779; **4**, carapace, dorsal view, × 120, MP-O-1780. **figs 5–6.** *Neocaudites subimpressus* (Edwards, 1944): **5**, female carapace, external lateral view, × 162, MP-O-1781; **6**, male carapace, external lateral view, × 162, MP-O-1782. **figs 7–8.** *Neocaudites triplistriatus* (Edwards, 1944): **7**, female left valve, external lateral view, × 160, MP-O-1783; **8**, female right valve, external lateral view, × 160, MP-O-1784. **figs 9–10.** *Puriana variabilis* Chukewiski & Purper, 1985a: **9**, female left valve, external lateral view, × 190, MP-O-1785; **10**, female right valve, external lateral view, × 190, MP-O-1786. **figs 11–12.** *Puriana convoluta* Teeter, 1975: **11**, female left valve, external lateral view, × 190, MP-O-1787; **12**, female right valve, external lateral view, × 190, MP-O-1788. **figs 13–17.** *Australimoosella polypleuron* sp. nov.: **13**, left valve, external lateral view, × 198, MP-O-1789; **14**, carapace, dorsal view, × 205, MP-O-1790; **15**, right valve, external lateral view, × 165, MP-O-1791 (holotype); **16**, right valve, internal view, × 205, MP-O-1793; **17**, left valve, internal view, × 205, MP-O-1792.

ventro-lateral ribs, being less acuminate posteriorly, and its less strongly pronounced eye tubercle.

Genus *Cletocythereis* Swain, 1963

*Cletocythereis atlantica* sp. nov.  
(Pl. 1, figs 17–20)

**Derivation of name.** L. with reference to the fact that this is the first species of *Cletocythereis* described from the Atlantic Ocean.

**Diagnosis.** A species of *Cletocythereis* with sub-rectangular carapace, ornamented with ‘trefoil’ (*sensu* Sylvester-Bradley & Benson, 1971) and ‘quadrifoil’ reticulation produced by cellation, ribs and tubercles. Anterior rim smooth. Flat marginal denticles distributed in different planes on the anterior, antero-ventral and postero-ventral margins.

**Holotype.** Female RV, MP-O-1774.

**Material.** Frequent.

**Locality and horizon.** Geomar III, sample 188, lat. 3°47'N- long. 50°01'W, 88 m. Recent.

**Description.** Large. Moderately thick-shelled. Sub-rectangular in lateral view. Anterior margin well-rounded with apex at about mid-height. Posterior acuminate at mid-height in LV, below mid-height in RV. Dorsal margin straight but appearing irregular due to the over-reach of the dorsal ornament inclined towards the posterior and rendered slightly irregular by the surface ornament. Ventral margin straight in lateral view but with wide oral incurvature in internal view; convergent posteriorly. Anterior and postero-ventral margins embellished with flat marginal denticles in a number of planes. Ornament of trefoil and quadrifoil reticulation brought about by cellation, distributed in a somewhat radiate pattern about the sub-central tubercle. Some muri of the reticulum are sufficiently strongly developed to become discrete ribs, especially ventro-laterally. Some ribs bear small spinose tuberculae. A salient marginal rib extends from the eye tubercle around the anterior and ventral margins, with a less well defined rib occurring around the dorsal and posterior margins. A distinct node occurs postero-dorsally and a sub-alar spine occurs postero-ventrally. Subcentral tubercle not salient and this area is traversed by a short, oblique rib. Internal features typical of the genus. Median element of holamphidont hinge in LV strongly buttressed internally, as is the anterior terminal element. Central muscle scars with four long scars in a vertical row. ‘V’-shaped frontal scar. Sexual dimorphism distinct; males more elongate than females.

**Dimensions (mm).**

	Length	Height
Holotype		
Female RV, MP-O-1774	0.75	0.42
Paratypes		
Female LV, MP-O-1773	0.77	0.43

Female LV, MP-O-1776	0.76	0.41
Male LV, MP-O-1775	0.75	0.41

**Distribution.** Occurring in Recent sediments from the Brazilian Equatorial Shelf, northeast of the mouth of the River Amazon. Geomar II, sample 105; Geomar III, samples 188, 189, 190.

**Remarks.** *Cletocythereis atlantica* sp. nov. is similar to *Cletocythereis bradyi* Holden, 1967 from the Indo-Pacific, but differs mainly in lacking small perpendicular fossae on the anterior margin.

Genus *Cletocythereis* Swain, 1963

*Neocaudites subimpressus* (Edwards, 1944)  
(Pl. 2, figs 5–6)

- 1944 *Cythereis subimpressa* Edwards: 523, pl. 87, figs 29, 30.  
1971 *Neocaudites pacifica* Allison & Holden: 201, figs 26a–e.  
1971 *Neocaudites pacifica minima* Allison & Holden: 202, figs 26f–i.  
1975 *Neocaudites scottae* Teeter: 455, figs 12j; 13k–m.  
1983 *Neocaudites subimpressus* (Edwards); Hazel: 103, pl. 5, fig. 4.  
1988 *Neocaudites subimpressus* (Edwards); Cronin: 884.  
1988 *Neocaudites pacifica* Teeter; Cronin: 884.  
1988a *Neocaudites scottae* Teeter; Bold: 40, p. 3, fig. 14.  
1993 *Falsocythere subimpressus* (Edwards); Witte: 49.  
1999a *Neocaudites subimpressus* (Edwards); Coimbra *et al.*: 377.

**Material.** Abundant.

**Dimensions (mm).**

	Length	Height
Homotypes		
Female C, MP-O-1781	0.58	0.30
Male C, MP-O-1782	0.60	0.29

**Distribution.** Previously recorded from the Pliocene of North Carolina (USA), the Pliocene to Recent of Cuba, the Dominican Republic and Costa Rica, the Recent of Clipperton Island (Eastern Pacific) and Belize. In the present study it was found in the following samples: Leg 4, sample 3391; Leg 6, samples 3607, 3608, 3609, 3610, 3611, 3615, 3616, 3624, 3646, 3686, 3690, 3700, 3710, 3721, 3722; Geomar I, samples 8, 21, 22; Geomar II samples 97, 103, 105, 106, 108, 109, 111, 113, 115, 118, 119, 125, 129; Geomar III, samples, 153, 166, 169, 180, 181, 182, 184, 185, 186, 187, 188, 189, 190, 191, 192, 198, 199, 200, 214, 218, 2469, 2471, 2522, 2528.

**Remarks.** *Neocaudites subimpressus* is very similar to *N. terryi* Holden, 1967, especially in the distribution of its punctation and reticulation. Both species exhibit a degree of intraspecific variation with respect to their ornament and size. Considering that the two species are widely distributed, occurring both in the Atlantic and the Pacific, it is probable that this variation is environmentally controlled, as suggested by Witte (1993).



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*Neocaudites triplistriatus* (Edwards, 1944)  
(Pl. 2, figs 7–8)

- Non 1951 *Trachyleberis?* cf. *T.?* *triplistriata* (Edwards); Swain: 37, pl. 6, figs 2, 3.  
1944 *Cythereis triplistriatus* Edwards: 522, pl. 87, figs 24–26.  
1954 ? *Trachyleberis* aff. *lauta* (Brady); Keij: 222, pl. 4, fig. 11, pl. 6, fig. 9.  
1954 *Retrotrachyleberis* cf. *R. triplistriata* (Edwards); Puri: 264, pl. 11, figs 1, 2.  
1963 *Neocaudites triplistriatus* (Edwards); Bold: 389, pl. 8, fig. 4.  
1965 *Costa triplistriata* (Edwards); Hall: 33, pl. 7, figs 6, 9, 10.  
1966 *Neocaudites triplistriata* (Edwards); Morales: 84, pl. 8, fig. 5.  
Non 1967 *Neocaudites triplistriata* (Edwards); Hulings: 654, text-figs 4a, 7i.  
1968 *Neocaudites triplistriatus* (Edwards); Swain: D16, text-fig. 14, pl. 3, figs 1a–d.  
1975 *Neocaudites triplistriatus* (Edwards); Bold: 148, pl. 17, fig. 11.  
1977 *Neocaudites triplistriatus* (Edwards); Bold: 504, table 4.  
1977 *Neocaudites triplistriatus* (Edwards); Hazel: 377, figs 3, 7d.  
1983 *Neocaudites triplistriatus* (Edwards); Hazel: 104, pl. 6, fig. 1.  
1988 *Coquimba* sp. 6. Dias-Brito, Moura & Würdig: 481, pl. 2, fig. 33.  
1992 *Neocaudites triplistriatus* (Edwards); Coimbra, Ramos & Sanguinetti: pl. 1, fig. 18, tables 1–4.

**Material.** Rare.

**Dimensions (mm).**

	Length	Height
Homotypes		
Female LV, MP-O-1783	0.55	0.30
Female RV, MP-O-1784	0.53	0.27

**Distribution.** This species is widely distributed in shallow marine waters from the NE coast of the USA to the coast of Rio de Janeiro State, Brazil and in a number of localities in the Caribbean. It occurs in the Upper Miocene of Florida and the Caribbean, the Pliocene of the Caribbean and the Plio-Pleistocene of Virginia and the Carolinas. In the present study it was found in Leg 5, sample 3455; Leg 6, sample 3718; Geomar III, samples 189, 190.

**Remarks.** This species is rather similar to *Neocaudites nevanii* Puri, 1960, *N. atlantica* Cronin, 1979 and *N. variabilis* Hazel, 1983. The morphological differences exhibited by these three species are clearly outlined by Witte (1993).

Genus *Puriana* Coryell & Fields, 1953

*Puriana variabilis* Chukewiski & Purper, 1985a  
(Pl. 2, figs 9–10)

- 1985a *Puriana variabilis* Chukewiski & Purper: 314–316, pls 2–6.  
1985b *Puriana variabilis* Chukewiski & Purper: 331, 332, 336, chart 1.  
1992 *Puriana variabilis* Chukewiski & Purper; Coimbra, Ramos & Sanguinetti: 100, pl. 2, fig. 10, tables 1–4.

**Material.** Very abundant.

**Dimensions (mm).**

	Length	Height
Homotypes		
Female LV, MP-O-1785	0.59	0.28
Female RV, MP-O-1786	0.60	0.30

**Distribution.** This species seems to be restricted to the Equatorial Shelf of Brazil. In the present study it occurs in the following samples: Leg 4, samples 3391, 3396, 3404, 3419, 3444, 3445, 3459; Leg 6, samples 3622, 3624, 3625, 3635, 3636, 3637, 3646, 3652, 3674, 3677, 3678, 3679, 3680, 3684, 3689, 3692, 3698, 3699, 3704, 3709, 3710, 3711, 3716, 3717, 3718, 3719, 3721, 3722, 3726, 3727, 3731, 3736, 3737, 3740, 3747, 3750; Geomar I, samples 6, 8, 11, 17, 19, 33, 38; Geomar II, samples 99, 109, 129; Geomar III, samples 141, 146, 147, 149, 155, 169, 2465, 2467, 2475, 2531.

*Puriana convoluta* Teeter, 1975  
(Pl. 2, figs 11–12)

- 1971 *Puriana* sp. B Valentine: D8.  
1975 *Puriana convoluta* Teeter: 458, figs 14E, 15H–J.  
1977 *Puriana convoluta* Teeter; Hazel: 386, fig. 8f.  
1979 *Puriana convoluta* Teeter; Cronin: 147, pl. 16, fig. 8.  
1983 *Puriana convoluta* Teeter; Hazel: 88, pl. 26, figs 1–4.  
1983 *Puriana convoluta* Teeter; Palacios-Fest, Gío-Argaéz & Krutak: table 1.  
1985b *Puriana convoluta* Teeter; Chukewiski & Purper: 313, 314, pl. 1, figs 1–6.  
1988b *Puriana convoluta* Teeter; Bold: 146, 150, 155, tables 1, 2.  
1990 *Puriana convoluta* Teeter; Machain-Castillo, Pérez-Guzmán & Maddocks: 349, 350, table 2.

**Material.** Frequent.

**Dimensions (mm).**

	Length	Height
Homotypes		
Female LV, MP-O-1787	0.48	0.26
Female RV, MP-O-1788	0.50	0.27

**Distribution.** Plio-Pleistocene, North Carolina; Recent. Florida, Texas, Gulf of Mexico, Belize, the Caribbean and southeast to the mouth of the River Amazon. In the present study the species occurs in the following samples: Leg 4, sample 3396; Leg 6, samples 3612, 3616, 3700, 3706, 3721, 3737; Geomar III, sample 2465.

Tribe **Moosellini** Hartmann, 1978

Genus *Australimoosella* Hartmann, 1978

*Australimoosella polypleuron* sp. nov.  
(Pl. 2, figs 13–17)

- 1999a gen. et sp. indet. 1 Coimbra *et al.*: 370, pl. 2, fig. 2, table 1

**Derivation of name.** Gr. *πολυ*, meaning ‘many’, plus *πλευρον*, meaning ‘ribs’, i.e. *πολυπλευρον* ‘many ribs’. With reference to the numerous longitudinal ribs which constitute the principal ornament on the lateral surface of this species.

**Diagnosis.** A species of *Australimoosella* ornamented with numerous rather weak longitudinal ribs on the lateral surface, slightly reticulate in the posterior region. Secondary ornament punctate.

**Holotype.** Female RV, MP-O-1791.

**Material.** Common.

**Locality and horizon.** Projeto REMAC, LEG 6, sample 3692, lat. 2°21'N–long. 41°24'W, 37 m. Recent.

**Description.** Medium, moderately thick-shelled carapace. Sub-ovate in lateral view. Anterior margin rounded. Posterior margin slightly rounded, angled medially. Dorsal margin sinuous, stepped posteriorly, with prominent posterior cardinal ear. Ventral margin slightly concave medially. Posterior cardinal angle salient. Right valve smaller than left. Ornament with numerous, rather weak and parallel horizontal ribs on the lateral surface. Three narrow anterior ribs extend from the anterodorsal margin to the postero-ventral margin. Posterior region slightly reticulate. Intercostal areas sparsely punctate. Antero-medial region moderately celled. Normal pore canals located in the muri, regularly distributed over entire surface. In dorsal view, both valves are parallel, slightly flat in central region, inflated in the posterior region. Internal view: hinge holamphidont with median bar finely crenulated; frontal muscle scar in V-shape followed by four muscle scars in a vertical row. Sexual dimorphism inconspicuous.

#### Dimensions (mm).

	Length	Height
Holotype		
RV, MP-O-1791	0.67	0.35
Paratypes		
LV, MP-O-1789	0.67	0.35
C, MP-O-1790	0.68	0.38
LV, MP-O-1792	0.67	0.36
RV, MP-O-1793	0.66	0.35

**Distribution.** In the present study this species occurs in the following samples: Leg 6, samples 3637, 3672, 3677, 3692, 3616, 3617; Geomar I, samples 8, 17. This species seems to be restricted to the equatorial shelf to the SW of the mouth of the River Amazon.

**Remarks.** *Australimoosella polypleuron* sp. nov. resembles *A. tomokoae* (Ishizaki, 1968) in general outline and surface ornamentation, but differs in details of ornamentation, especially in the number of longitudinal ribs. The Brazilian specimens are smaller than those from Japan. Besides, the holotype of *A. tomokoae* has four adductor muscle scars not well described, the middle two of which appear to be subdivided, whereas *A. polypleuron* sp. nov. has all adductor muscle scars undivided.

#### ZOOGEOGRAPHICAL AND STRATIGRAPHICAL DISTRIBUTIONS

The zoogeographical distribution of ostracods from the Brazilian Equatorial Continental Shelf is radically influenced by

the estuary of the Amazon/Pará rivers. The great influence of this estuary changes the physico-chemical characteristics of the adjacent oceanic area and this is reflected in the distribution of the fauna.

The discharge of the Amazon River is a huge mass of fluvial water of about  $350\,000\text{ m}^3\text{ s}^{-1}$  into the Atlantic Ocean and  $11\text{--}13 \times 10^8$  ton  $\text{a}^{-1}$  of sediments (Diégues, 1972; Meade, 1985). The inner shelf to the northeast of the estuary is the most affected area. In both the dry and rainy seasons, the flux of fluvial water is permanent and runs parallel to the coast from the NE to Cape Orange. The discharge of sediments from the coast to c. 40 m depth is mainly muddy (Martins & Coutinho, 1981) due to the influence of the Amazon River, and the salinity is lower, especially in the rainy season; this is probably the reason for the absence of ostracods from this area. Directly offshore, in water deeper than some 40 m depth, because of the lower density of the freshwater, marine conditions begin to return to normal and ostracods are more abundant. The area from the Parnaíba River Delta (Piauí State) to Cape São Roque (Rio Grande do Norte State) is characterized by low freshwater input, which only becomes significant during floods. This, together with the shallow water shelf depths and the warm and semi-arid climate, reduces terrigenous sedimentation and encourages carbonate production (Summerhayes *et al.*, 1975; Melo *et al.*, 1975; Milliman, 1977).

Coimbra *et al.* (1999a,b) defined two zoogeographical units based on the distribution of the ostracods in the studied area. The Northwestern Unit (NW), from 47°30'W to 51°W, embraces the area between the Cape Orange and the mouth of the Amazon/Para rivers and is represented by 12 species which are restricted to this area, whereas the Southeastern Unit (SE), between 34°30'W to 48°W, from the mouth of the Amazon/Para rivers to the Cape São Roque has 16 endemic species. The remaining 46 species are pandemic to the studied area and prefer shallow waters and biodetritic sands.

In the present study, the NW unit is represented by two rare trachyleberidid species: *Cletocythereis atlantica* and *Costa variabilicostata brasiliensis*, occurring between depths of 50 m and 100 m. The SE unit is represented by three species, which are more abundant in the epineritic zone (<40 m): *Puriana convoluta*, *P. variabilis* and *Australimoosella polypleuron* sp. nov. (Fig. 2).

Pandemic Trachyleberididae in the study are: *Costa variabilicostata* aff. *reticostata*, *Henryhowella tuberculoclaviforma*, *Cativalva paratranslucens*, *C. reticulocostata*, *Neocaudites subimpessus* and *N. triplistriatus*. All, except the latter which is very rare, are abundant species. *H. tuberculoclaviforma*, *C. reticulocostata* and *N. triplistriatus* occur on biodetrital sand at 75 m, while *C. variabilicostata* aff. *reticostata*, *C. paratranslucens* and *N. subimpessus* occur also on biodetritic sand but at depths between 50 m and 100 m (Fig. 2).

Most of the genera representing these assemblages originated in the Neogene. *Cletocythereis atlantica* is the first species, of this genus, to be formally described in the Atlantic Ocean. The only prior record of this genus in the Atlantic waters is by Witte (1993), *Cletocythereis?* sp., from the Senegalese coast.

*P. convoluta*, *N. triplistriatus* and *N. subimpessus* seem to have first appeared in the Pliocene of North Carolina and migrated to the Caribbean and South America. The

occurrence of *Neocaudites subimpressus* in Recent sediments from Clipperton Islands (Allison & Holden, 1971), in the Eastern Pacific, is probably due to migration through the Neogene Straits of Panama, prior to the formation of the modern isthmus.

## CONCLUSIONS

The study of the family Trachyleberididae in the Equatorial Brazilian Continental Shelf yielded five new species: *Cleocythereis atlantica*, *Cativella paratranslucens*, *C. reticulocostata*, *Henryhowella tuberculoclaviforma* and *Australimoosella polypleuron*. Two sub-species were attributed to the *Costa* 'variabilicostata' group: *Costa variabilicostata brasiliensis* subsp. nov. and *Costa variabilicostata* aff. *reticostata* Bold, 1970 and four others species were recognized: *Neocaudites subimpressus*, *N. triplistriatus* Edwards (1944), *Puriana convoluta* Teeter (1975) and *P. variabilis* Chukewisky & Purper (1985a).

On the basis of the geographical distribution of the studied species, two assemblages are recognized. The NW assemblage, represented by two rare species restricted to this area, is the region most affected by the Amazon River discharge, especially at the inner shelf (c. 40 m depth). The SE assemblage, represented by three rare species restricted to this area, is the least affected area and ostracods are more abundant in the epineritic zone (<40 m depth). Most of the trachyleberidid genera studied here have their origins in the Neogene and are well distributed in shallow marine waters.

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