DISTRIBUTION AND ECOLOGY OF SUB-RECENT ORIONININAE (OSTRACODA) IN THE BRAZILIAN CONTINENTAL SHELF

JOÃO CARLOS COIMBRA* e LÍLIA PINTO DE ORNELLAS**

ABSTRACT DISTRIBUTION AND ECOLOGY OF SUB-RECENT ORIONININAE (OSTRACODA) IN THE BRAZILIAN CONTINENTAL SHELF. This paper comprises the study of the geographical and bathymetrical distribution, and the analysis of complementary ecological data, of subrecent species belonging to the subfamily Orionininae Puri, 1973 from the Brazilian continental margin, specially in the continental shelf. The results obtained allowed the characterization of three different associations. Between the Northern/Eastern characteristic association and the Southern one it was possible to establish a transitional zone in the meridional portion of the Eastern shelf.

RESUMO DISTRIBUIÇÃO E ECOLOGIA DOS ORIONININAE (OSTRACODA) SUB-RECENTES NA PLATAFORMA CONTINENTAL BRASILEIRA. Foi estudada a distribuição e a ecologia das espécies sub-recentes da sub-família Orionininae Puri, 1973 encontradas na margem continental brasileira, principalmente na região da plataforma continental. Os resultados obtidos permitiram caracterizar três associações: uma localizada na região norte-nordeste, outra na sul e uma transicional, correspondente à porção meridional da plataforma leste.

INTRODUCTION The 720 samples used in the study of the taxonomy of the sub-family Orionininae Puri, 1973 and its distribution in the Brazilian coast were obtained through the Centro de Estudos de Geologia Costeira e Oceanográfica of the Universidade Federal do Rio Grande do Sul (Ceco). These samples belong to Project Remac-Cruzeiro Woods Hole, Águas Rasas, coordinated by Petróleo Brasileiro S.A. (Petrobrás), Geomar VI/III of the Diretoria de Hidrografia e Navegação da Marinha do Brasil (DHN), and collected by Noc. El Austral.

The sampled area comprises all the Brazilian continental shelf from latitude 5°N to latitude 35°S.

The research was divided in three stages. The two first stages presented the systematic of the species belonging to the genera *Orionina* Puri, 1953 and *Caudites* Coryell & Fields, 1937. The third stage, developed in this paper, studies the geographical and bathymetrical distributions and complementary ecological data of this subfamily in the Brazilian coast.

GEOLOGICAL AND OCEANOGRAPHICAL DATA

The area in study comprises the Brazilian continental margin, more specifically the continental shelf.

In order to facilitate the correlation between the abiotic data and the distribution of the Orionininae species, it was adopted the division of the Brazilian continental shelf by Chaves (1983). This author considered three major regions: north, east, and south. The first includes the area between the Oiapoque River and the north limit of the marginal plateau of Rio Grande do Norte State, and the submarine mountain chain of Fernando de Noronha. The east region, which is located between the other two, has its south limit on the coast of Espírito Santo State near Itapemirim City. The south region extends from Itapemirim to the Chuí City in the Rio Grande do Sul State (Fig. 1).

North Shelf Francisconi *et al.* (1974) studied the sedimentation in the Brazilian continental shelf. They concluded that the sediments are predominantly terrigenous on the mouth area of the Amazonas River. According to those

authors an extense band of rounding orthoquartzitic sands exists in the north shelf, limited by the calcareous constructions of the external shelf. There is also calcareous detritus uniformly distributed through out the shelf. Confirming the opinion of Francisconi *et al.* (*op. cit.*), Kowsmann & Costa (1979) concluded that the Quaternary sedimentation on the north shelf is characterized by the predominance of terrigenous deposits over carbonatic ones. These latter are found in a continuous belt over of the external shelf. The calcareous facies consist predominantly of algal reefs, sands and/or gravels of branching algae, benthonic foraminifera, and molluscs. In the internal shelf the main bioclasts are molluscs as isolated speckles within terrigenous sands.

East Shelf According to Kempf (1970), this part of the shelf has a short depth range (maximum depth around 60 m). It is possible that it is being reworked by waves and currents until today. The coast is biologically poor due to the presence of terrigenous sands, except in zones of greater energy, where incrusting algae migrate over these sands.

According to Francisconi *et al.* (1974), the sedimentation in the east shelf, between the Cape of São Roque and Contas River, includes orthoquartzitic bioterritic sands distributed through a narrow belt close to the littoral border. Carbonatic constructions occur near the coastline. Terrigenous muds appear over the shelf of the São Francisco River. They are an interruption of the sedimentary model of this region. According to the authors, towards south in the east shelf, from Contas River to Cabo Frio City, there is more terrigenous contribution due to the great number of fluvial channels. This caused remotion of the biogenic construction from the coast line. Near large rivers muddy and subarcosian sands occur.

Kowsmann & Costa (1979) observed the predominance of carbonatic facies in this area with concentrations of CaCO_3 usually higher than 75%. The terrigenous facies appeared with greater significance only along the coast of Ceará State and at the mouth of the largest rivers of the region, especially the São Francisco, Mucuri, São Mateus, and Doce rivers. The

* Petrobrás/Cenpes/DiveX/Sebipe. Ilha do Fundão, Quadra 7, Cidade Universitária, CEP 21910, Rio de Janeiro, RJ, Brazil

** Universidade Federal do Rio Grande do Sul, Inst. de Geociências, Depto. Paleontologia e Estratigrafia. Campus do Vale, Avenida Bento Gonçalves, 9500, bloco 1, Prédio C1, CEP 11500, Porto Alegre, RS, Brazil

Figure 1 – Index map of Brazilian continental shelf and geographical distribution maps of *C. nipeensis* (A), *C. ohmertii* (B), and *C. gnomus* (C) in the Brazilian continental shelf

Figura 1 – Mapa-índice da plataforma continental brasileira e mapas de distribuição geográfica de *C. nipeensis* (A), *C. ohmertii* (B) e *C. gnomus* (C)

carbonatic sediments, according to the authors, consist of a mixture of sand and gravel. The last type appears mainly in the external shelf. Between Fortaleza and Maceió cities facies of sands and gravels of branching algae and *Halimeda* sp. predominate.

In the reefs of Royal Charlotte and Abrolhos it is remarkable the presence of calcareous algae reefs, specially the incrusting ones. Bryozoan reefs and derived sands coexist

with algal reefs in the southern region of Caravelas. Benthonic foraminifers and molluscs occur sporadically in certain places. Still according to Kowsmann & Costa (1979), sediments of fluvial origin appear near the river mouths such as that of São Francisco River. The mapped muddy facies beginning in the south of Natal City are localized in topographic lows conditioned by algal reefs or by paleochannels existent within them.

South Shelf The south region, according to Franciscini *et al.* (1974), presents biogenic constructions from Cabo Frio City to Ilhabela Islands. The presence of these elements shows a continuation of those existing in the east region. Progressively these constructions produce biotritus and finally terrigenous, orthoquartzitic sands until their total disappearance near Paranaguá City. From Santa Maria Cape to Rio Grande City a band of biotritus associated with orthoquartzitic sands lays all over the external shelf. Subarcosian muds and muddy sands appear there and persist until the extreme south. The middle shelf has terrigenous muds and subarcosian sandy muds. In the internal shelf subarcosian and orthoquartzitic sands predominate.

According to Kowsmann & Costa (1979), there are two distinctive sedimentary dominions, much in the same way of the north shelf. The first is the terrigenous (inner and middle shelf) and the second is the carbonatic (outer shelf). The terrigenous sedimentation between Cabo Frio and Chuí cities is represented by very homogeneous facies and is practically continuous. The main carbonatic facies of the outer shelf from Cabo Frio to Santos cities are algal reefs, benthonic foraminifers, and mixtures of molluscs, bryozoans and benthonic foraminifers. They are richer in algal and bryozoan reefs, but they become scarce towards the farther parts to the south shelf. When present at all, the mixture of molluscs with cirripeds, benthonic foraminifers and locally with planktonic foraminifers is more frequent. Isolated facies rich in brachiopods rarely appear.

Currents The South Equatorial Atlantic Current originates the two main currents which extend through the Brazilian shelf. The first Brazil Current, shows large seasonal fluctuation both in speed and direction. It presents an average water temperature of 26°C and advances south-west. The second, Guiana Current, has an average water temperature of 27°C and moves north-west. The southern part of Brazil is subject to the influence of the subantarctic waters brought by the Malvinas Current. Its temperature may vary from 4°C near the Malvinas Islands up to 20°C at the latitude 32°S (Martins 1984).

Near Cabo Frio City (23°S), Rio de Janeiro State, upwellings of the last remains of the Malvin Current occur. Based on the differences shown by the fauna of foraminifers and molluscs, Boltovskoy (1976) considered this a limit zone between what he called Northern Brazilian subprovince and Southern Brazilian subprovince. The first comprises tropical and subtropical waters, and the second, temperate to cold waters.

GEOGRAPHICAL DISTRIBUTION, BATHYMETRY, AND COMPLEMENTARY ECOLOGICAL DATA *Caudites* Coryell & Fields, 1937. Moore (1961) considers *Caudites* as a typically American genus. However, according to obtained data, especially those related by Morkhoven (1963) and McKenzie (1967), it is verified that *Caudites* is a cosmopolitan genus, even though most of the species belonging to this genus had their origin in the Caribbean area.

Pinto *et al.* (1978) recorded the distribution of this genus all over the Brazilian continental shelf, within depth variation from 11 to 136 m. Nevertheless, according to the data obtained, this genus is found up to a depth of 164 m in the surroundings of São Francisco do Sul Island, State of Santa Catarina.

Reports of *Caudites* occurrences show that species of this genus, with few exceptions, have their widest bathymetrical distribution on the neritic zone, in tropical to temperate seas with normal saline waters.

Caudites nipeensis Van den Bold, 1946 (Fig. 1(A); Pl.3, Fig. 5-7) *C. nipeensis* is found in the Miocene on the Caribbean Province, near Cuba, Trinidad, and San Martin. It

was also reported in recent sediments in the North Atlantic along the coast of Trinidad, Venezuela, Hatteras Cape, Gulf of Paria and Gulf of Mexico. According to the data obtained, its geographic distribution spreads until inclosing the South Atlantic region including the Brazilian continental shelf between the latitudes 4°26'N and 21°02'S. Thus, it presents a large occurrence in a long and narrow zone of the Atlantic Ocean. This zone extends from Hatteras Cape (lat. 34°37'N) to the State of Espírito Santo (lat. 21°02'S).

According to the previous works (Key 1954, Van den Bold 1977, Hazel 1975), the depth variation in which this species occurs is between 10 and 66 m. The occurrence depths of *C. nipeensis* are situated between 11 and 113 m for the samples here studied. Therefore, this species occurs on the Brazilian coast in depths higher than the ones for the North Atlantic, maintaining its distribution inside the neritic zone.

It may be established a clear relation between the occurrence of *C. nipeensis* and sandy sediments in the Brazilian shelf. In the 58 samples in which this species is found, sand is predominant and in 58% of those it occurs with associated gravel. The carbonatic composition is the most frequent. This type of composition occurs in 67% of the samples above mentioned.

The only data found in the bibliography relating *C. nipeensis* to temperature were recorded by Hazel (1975). According to him, *C. nipeensis* supports a variation of about 11.25°C (from 13.75°C in the winter to 25°C in the summer) in Hatteras Cape. That region is considered by Ekman (1953) as the northern limit of the warm waters of the Atlantic Ocean and thus, it is considered a zone of significant fauna modification. On the other hand, considering the relationship between the geographic distribution of this species along several regions where it occurs and the general temperature data characteristic of these regions, it is clear that this species inhabits from equatorial to temperate waters.

In the Brazilian shelf *C. nipeensis* is directly related to the zones of warm currents influence and to the areas bearing carbonate and sandy sediments.

Caudites ohmertii Coimbra & Ornellas, 1987 (Fig. 1 (B); Pl.1, Fig. 1-6) This species was found between the latitudes of 19°32'S and 35°06'1"S, respectively the latitudes of Espírito Santo State (Brazil) and Uruguay.

Vicalvi *et al.* (1977) found *Caudites* sp. = *C. ohmertii* Coimbra & Ornellas, 1987 in waters of low depth and in sediments of sandy mud and biotritus. In the material studied its bathymetrical distribution remains between 13 and 148 m depth and its occurrence is conditioned in the majority of cases by the presence of sediments which are similar to the ones related by those authors.

Caudites ohmertii does not show lateral expansions of its carapace such as alar or spiniform processes. The absence of these structures which would prevent its submergence into the muddy sediment may signify that this species is an endobiont organism and thus belonging to the infauna.

Although this species endures some variation of temperature, it prefers temperate to cold waters of the Southern Brazilian subprovince.

Caudites gnomus Coimbra & Ornellas, 1987 (Fig. 1 (C); Pl. 3, Fig. 1-4) According to Bertels (1975), *Caudites* sp. = *C. gnomus* Coimbra & Ornellas, 1987 occurs in pleistocenian sediments of the Buenos Aires Province (Argentina) in marine ambients of low depth.

In the Brazilian coast this species occurs between the latitudes 19°30'S and 31°06'S. It shows a bathymetrical variation from 29 to 164 m. Thus, it is a neritic species.

C. gnomus is always associated with sediments of predominant terrigenous sand (fine to coarse sand). This sediment usually carries biotritus within it.

Plate 1 – *Caudites ohmertii* Coimbra et Ornellas, 1987: 1. LV female holotype, n° MP-O-1013, lateral view. 2. RV female holotype, n° MP-O-1013, lateral view. 3. Carapace female paratype n° MP-O-1014, dorsal view. 4. LV male paratype n° MP-O-1016, lateral view. 5. RV male paratype n° MP-O-1016, lateral view. 6. Carapace male paratype n° MP-O-1017, dorsal view

Prancha 1 – *Caudites ohmertii* Coimbra & Ornellas, 1987

Plate 2 – *Caudites fluminensis* Coimbra et Ornellas, 1987: 1. LV male holotype, n° MP-O-1027, lateral view. 2. RV male holotype, n° MP-O-1027, lateral view. 3. Carapace male paratype n° MP-O-1028, dorsal view. *Caudites vandenboldi* Coimbra et Ornellas, 1987: 4. Carapace paratype n° MP-O-1032, dorsal view. 5. LV holotype n° MP-O-1031, lateral view. 6. LV holotype n° MP-O-1031, lateral view

Prancha 2 – *Caudites fluminensis* Coimbra & Ornellas, 1987

In the studied area the species occurs with a small number of specimens in each sample. The sample G-362 (latitude 31°06'S) where its farther south occurrence was related it is represented by 14 carapaces and one isolated valve. Such a number can be relatively considered as been large, once its gets close to the half *C. gnomus* valves and carapaces obtained from the samples used for this study. This sample is placed within a strong influence area of the Malvinas Current cold waters. According to Bertels (1975), *C. gnomus* occurs in the Pleistocene of Argentina in temperature waters environments. Since the marine pleistocenian fauna is very similar to the recent fauna, it is likely that its geographical distribution should be wider, stretching southwards to the Argentinean coast. The largest specimens number occurrence in areas showing more influence of a cold current can signify that the *C. gnomus* should be adapted to the temperature for cold regions. This agrees with the interpretation of Bertels (*op. cit.*).

Caudites fluminensis Coimbra & Ornellas, 1987 (Fig. 2(D); Pl. 2, Fig. 1-3) In spite of the greater number of examined samples, this species was found only in two samples placed in latitudes 22°01'S and 22°18'S. The first one was collected at a depth of 42 m and the second at 44 m, both near the limit between the epineritic and infraneritic zones. Both samples are located in the continental shelf of Rio de Janeiro State in terrigenous sand with biotritus. This region is near the resurgence area of the cold waters of Malvinas Current (Boltovskoy 1976).

The causes for the scarce occurrence of this species are unknown.

Caudites vandenboldi Coimbra & Ornellas, 1987 (Fig. 2(A); Pl. 2, Fig. 4-6) This species is found in the Brazilian continental shelf between the latitudes 15°01'S and 31°06'S. The area where the higher populational density of *C. vandenboldi* is recorded is located between Cabo Frio (Rio de Janeiro State) and Abrolhos Archipel (in the south of Bahia State). It is found in depths varying from 14 to 164 m. Thus, its occurrence is limited to the neritic zone.

C. vandenboldi occurs mainly associated to sandy sediments, frequently terrigenous sandy ones. About 85% of the samples containing representative examples of this species are located between the latitudes 15°01'S and 23°14'S and it encloses approximately 76% of the total specimens number. Therefore, the strongest concentration area is under the Brazil Current influence. Thus, this species prefers warm waters areas.

Concerning its habit, *C. vandenboldi* seems to be epibiont and therefore it belongs to the epifauna once its carapace shows conspicuous alar process that might preclude its submergence into the sediments.

Orionina Puri, 1953. Moore (1961) considers *Orionina* as a cosmopolitan genus. McKenzie (1967) agrees with Morkhoven (1963) about the exclusive american distribution for this genus. He still adds that its origin might be linked to Mexico Gulf region. Coimbra & Ornellas (1986) in a taxonomic study of this genus in the Brazilian coast affirm that the *Orionina* species related out of America do not belong to this genus. According to those authors, the *Orionina* species either as fossil or recent are mainly distributed in the Caribbean region.

Following Pinto *et al.* (1978), the distribution of the genus *Orionina* in the Brazilian continental shelf is limited by the latitudes 1°20'N and 25°32'S, where the water temperature is about 28°C in the summer and 17°C in the winter. However, in the present study the species of this genus were only found between the latitudes 2°02'N and 18°49'S. In this area, according with the maps those authors displayed in their paper, the water temperature varies from 28°C in the summer to

21°C in the winter. Thus, its occurrence was restricted to the warm waters of the Northern Brazilian Subprovince. On the other hand, the maximum depth where Pinto *et al.* (*op. cit.*) found *Orionina* species was about 40 m, less inferior than the one found in this study (55 m).

The data supplied by the bibliography covering the ecology of this genus are scarce and limited specially to *O. bradyi* Van den Bold, 1963. Having this in mind, the only data recorded here are the ones obtained without establishing the ecological characteristics of the *Orionina* in order to avoid the mistakes this kind of generalizations could cause.

Orionina bradyi Van den Bold, 1963 (Fig. 2(B); Pl. 3, Fig. 8-9) This species is widely distributed in the recent sediments of several Caribbean areas: Florida Bay, Florida Reefs, Bahamas, Haiti, Dry Tortugas, Tobago, Guadeloupe, Santa Lucia, Cayos Miskitos, and on the reefs along the coast of Vera Cruz and Anton Lizardo (Gulf of Mexico). It also appears in the Bermudas Islands and in Cape Hatteras, east U.S.A. coast. Rodríguez (1969) found it as a fossil in Playa Grande Formation (Pliocene) of central north Venezuela. In the Brazilian continental shelf, *O. bradyi* occurs from Maranhão to Alagoas states. It has as northern limit the latitude 2°19'S and as southern limit the latitude 9°41'5"S. Thus, the actual geographical distribution of *O. bradyi* extends from Cape Hatteras (latitude 34°37'N) to Alagoas State (latitude 9°41'5"S).

Concerning the bathymetrical distribution of this species the following data are recorded: Brady (1880) found a significant number of *Cythere bermudae* (= *O. bradyi*) samples in the Bermudas region at a depth about 795 m; Hazel (1975) recorded *O. bradyi* specimens in Cape Hatteras about 41 m deep; Teeter (1975) found this species in Belize at a depth less than 9.1 m; Van den Bold (1977) recorded its presence at Alacran Reefs, a very shallow zone, less than 30 cm deep; and Krutak (1982) recorded *O. bradyi* at Vera Cruz and Anton Lizardo Reefs, 0.25 to 30 m deep. In the Brazilian continental shelf, *O. bradyi* is found in depths of 16 through 37 m. Its occurrence at a 795 m depth in the type locality should probably be caused by transportation. It is preferably an epineritic species.

Teeter (1975) recorded *O. bradyi* in a biofacies of carbonatic shelf rich in coral reefs. In the Brazilian coast this species always occurs associated with sediments having sand and gravel as the predominant grain sizes. Besides, in the majority of the samples it is found associated with carbonatic sediments. Thus, it shows the same relationship recorded by Teeter (*op. cit.*) for the mineralogical composition of the sediments.

Following Hazel (1975), *O. bradyi* supports temperature variation between 15°C and 26.25°C. Krutak (1982) records a lower thermal variation between 27°C and 32.1°C for this species. The geographical distribution of *O. bradyi* in the Brazilian continental shelf (latitude 2°19'S to 9°41'5"S) coincides with the warm water region because its occurrence is restricted to the equatorial zones. This region is subject to the influence of warm water currents (Brazil and Guianas).

Orionina similis Van den Bold, 1963 (Fig. 2(C); Pl. 3, Fig. 10-11) Van den Bold (1957, 1963) recorded the occurrence of this species in the Miocene and Pliocene of Trinidad without presenting any bathymetrical inferences. In the Brazilian continental shelf it occurs between the latitudes 2°02'N and 18°49'S (coastal Pará and Espírito Santo states respectively). Its bathymetrical range is between 16 and 55 m. However, in most samples it appears at depths of less than 40 m, so revealing a predominantly epineritic tendency.

Its relationship with sediment types is not constant. However, it seems to occur mainly in sandy sediments.

Ecological data about this species have not been recorded

Figure 2 – Geographical distribution of *C. vandenboldi* (A), *O. similis* (B); *O. bradyi* (C), and *C. fluminensis* (D) in the Brazilian continental shelf

Figura 2 – Distribuição geográfica de *C. vandenboldi* (A), *O. bradyi* (C); *O. similis* (B), and *C. fluminensis* (D) na plataforma continental brasileira

in other areas. This made impossible any comparison with the data obtained from the Brazilian coast. Its occurrence coincides with warm waters regions.

ASSOCIATIONS (Fig. 3) The geographical distribution of the species shows the typical association of *Caudites nipeensis*, *Orionina bradyi* and *Orinina similis* for the northern/eastern regions of the Brazilian continental shelf, while the association of *Caudites ohmert*, *Caudites gnomus* and *Caudites*

vandenboldi represents a characteristic association of the southern region. *Caudites fluminensis* apparently belongs to the southern fauna, although it has been found only in two samples from near the meridional part of the east shelf. However, its ultimate position in the several associations will be possible to define only after new data are provided by additional sampling. A transition zone intermediate between the two groups mentioned above is recognizable between the latitudes 15°01'S and 21°02'S, in a zone extending from the

Plate 3 – *Caudites gnomus* Coimbra et Ornellas, 1987: 1. Carapace male paratype n° MP-O-1025, dorsal view. 2. Carapace female paratype n° MP-O-1023, dorsal view. 3. LV female holotype n° MP-O-1022, lateral view. 4. RV female holotype n° MP-O-1022, lateral view. *Caudites nipeensis* Bold, 1946: 5. LV plesiotype n° MP-O-1007, lateral view. 6. RV plesiotype n° MP-O-1007, lateral view. 7. Carapace plesiotype n° MP-O-1008, dorsal view. *Orionina bradyi* Bold, 1963: 8. LV plesiotype n° MP-O-1036, lateral view. 9. RV plesiotype n° MP-O-1036, lateral view. *Orionina similis* Bold, 1963: 10. LV plesiotype n° MP-O-1039, lateral view. 11. RV plesiotype n° MP-O-1039, lateral view.

Prancha 3 – *Caudites gnomus* Coimbra et Ornellas, 1987

extreme south of Bahia State to the south of Espírito Santo State (fig.3). Members of almost all the species studied here are found in this region, except *O. bradyi* and *C. fluminensis*. The predominant species are *C. vandenboldi* and *C. nipeensis*. The first shows a homogeneous distribution all over this area where one third of the total valves were found. Farther to the north its occurrence (latitude 15°01'S) is considered to demarcate the northern limit of the transition zone. *C. nipeensis* displays its main distribution and more significative abundance since the northern through the eastern portions (latitude 18°53'S) of the shelf. Beyond this latitude it becomes scarce, and it was only found in two samples containing a small number of carapaces (sample 3922 - latitude 20°42'S and sample 3935 - latitude 21°02'S). Its occurrence in this last sample was considered as indicative of the southern limit of the transition zone.

Figure 3 – Geographical distribution of the associations and transitional zone

Figura 3 – Distribuição geográfica das associações e zona de transição

CONCLUSIONS Boltovskoy (1976) and Forti-Esteves (1984) in their studies of foraminifers and molluscs, respectively, have considered the resurgence zone of the cold Malvinas Current (latitude 23°S) as the limit between a

northern and southern fauna. However, it was verified that the Orionininae fauna, besides being responsive to the temperature, are also subject of sedimentary influence, in its distribution along the Brazilian continental shelf.

The transitional zone of these ostracodes (latitude 15°01'S – 21°02'S) corresponds to great deposits of both terrigenous sediments, as well as to transitional area from the carbonatic sandy sediments of the eastern shelf to terrigenous ones in the inner and middle parts of the southern shelf. The building of biogenic limestones takes place far from the coast and are restricted to the external shelf.

The southern fauna, constituted of *C. ohmertii*, *C. gnomus* and *C. vandenboldi*, prefers terrigenous sediments and is subject to strong influence of Malvinas Current cold waters. *C. vandenboldi*, although best represented between latitudes 15°01'S and 23°14'S, seems to be an stenothermic species.

The northern/eastern fauna of *C. nipeensis*, *O. bradyi* and *O. similis* prefers carbonatic sediments and is subject to the influence of the warm currents of Brazil and Guianas. Thus, although the sedimentary dominion of the south shelf external part is carbonatic, this region is deeper and colder than the northern and eastern shelves. This hinders the southerly migration of species belonging to the northern/eastern associations.

Acknowledgments The authors are indebted to the following institutions and organizations for the financial support: Coordenadoria de Aperfeiçoamento de Pessoal para o Ensino Superior (Capes); Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul (FAPERGS); Câmara Especial de Pesquisa e Pós-Graduação da Universidade Federal do Rio Grande do Sul; and Conselho Nacional do Desenvolvimento Científico e Tecnológico (CNPq) (Proc. nº 30.5503/78). The Centro de Estudos de Geologia Costeira e Oceanográfica of the Universidade Federal do Rio Grande do Sul (Ceco), which provided the samples from the Brazilian continental shelf. Sincere thanks are due to Dr. Ieda R. Forti-Esteves (Universidade Federal do Rio Grande do Sul) and Dr. Martini Tolderer-Farmer (Pau, France), for helpful comments on the manuscript. José H. Melo (Petrobrás/Cenpes) improved the English. Verônica Lavradas and Gidair Messias typed the manuscript.

REFERENCES

- BERTELS, A. 1975. Ostracode ecology during the Upper Cretaceous and Cenozoic in Argentina. *Bul. Amer. Paleont.*, 65(282):317-351.
- BOLD, W.A. van den. 1946. *Contribution to the study of Ostracoda with special reference to the Tertiary and Cretaceous Microfauna of the Caribbean Region*. Amsterdam, J.H. Bussy, 173 p.
- BOLD, W.A. van den. 1957. Oligo-Miocene Ostracoda from Southern Trinidad. *Micropaleontology*, 3(3):231-254.
- BOLD, W.A. van den. 1963. The ostracode genus *Orionina* and its species. *J. Paleont.*, 37(1):33-50.
- BOLD, W.A. van den. 1977. Distribution of Marine Podocopid Ostracoda in the Gulf of Mexico and Caribbean. In: LOFFLER, H. & DANIELOPOL, D. ed. *Aspects of ecology and zoogeography of recent and fossil ostracoda*. The Hague, Dr. W. Junk p. 175-186.
- BOLTVOVKOY, E. 1976. Distribution of Recent Foraminifera of the South America Region. *Foraminifera*, 2:171-235.
- BRADY, G.S. 1880. Report on the Ostracoda dredged by H.M.S. Challenger during the years 1873-1876. *Zoology*, 1(3):1-184.
- CHAVES, H.A.F. 1983. Processos e métodos – Introdução geral. In: PETROBRÁS *Processos e Métodos*. Rio de Janeiro, Cenpes/Dintep, p. 7-31 (Série Projeto REMAC 6).
- CHUKIEWSKI, K. & PURPER, I. 1985. Occurrence of *Purina* (Ostracoda) in the Brazilian Continental Shelf. Its ecology, geographical and stratigraphic distribution. In: SIMP. GEOL. AMAZÔNIA, 2, Belém, 1985. *Anais...* Belém, SBG/Núcleo Norte. v. 1, p. 327-339.
- COIMBRA, J.C. & ORNELLAS, L.P. 1986. The subfamily Orionininae Puri, 1973 (Ostracoda; Hemicytheridae) in the Brazilian Continental Shelf. Part I. General data and systematic of the genus *Orionina* Puri, 1953. In: CONGR. BRAS. GEOL., 34, Goiânia, 1986. *Anais...* Goiânia, SBG. v. 1, p. 539-555.
- COIMBRA, J.C. & ORNELLAS, L.P. 1987. The subfamily Orionininae Puri 1973 (Ostracoda; Hemicytheridae) in the Brazilian Continental Shelf. Part II. Systematic of the genus *Caudites* Coryell & Fields, 1937. *Pesquisas*, 19:55-80.
- CORYELL, H.N. & FIELDS, S.A. 1937. A Gatum Ostracode Fauna from Cativa Panamá. *American Museum Novitates*, 956:1-18.
- EKMANN, S. 1953. *Zoogeography of the sea*. Londres, Sidgwick & Jackson Ltd. 417 p.
- FRANCISCONI, O.; COSTA, M.P.A.; COUTINHO, M.G.N.; VICALVI, M.A. 1974. Geologia costeira e sedimentos da Plataforma Continental Brasileira. In: CONGR. BRAS. GEOL., 28, Porto Alegre, 1974. *Anais...* Porto Alegre, SBG. v.3, p. 305-321.
- FORTI-ESTEVES, I.R. 1984. Recent bivalves (Palaeotaxodonta and Pteriomorpha) from the Brazilian Continental Shelf. *Pesquisas*, 16:190-226.
- HAZEL, J.E. 1975. Ostracodes biofacies in the Cape Hatteras, North Carolina. *Bul. Amer. Paleont.*, 65(282):463-480.
- KEMPF, M. 1970. Notes on the benthic bionomy of the N-NE Brazilian Shelf. *Marine Biology*, 5(3):213-24.
- KEY, A.J. 1954. Ostracoda. Identification and description of species. In: ANDEL, T. VAN & POSTMA, H. ed. *Recent sediments of the Gulf of Paria. Reports of the Orinoco Shelf Expedition*. Amsterdam, North-Holland Publishing Company, p. 218-231.
- KOWSMANN, R.O. & COSTA, M.P. de A. 1979. Sedimentação quaternária da margem continental brasileira e das áreas oceânicas adjacentes. In: PETROBRÁS. *Sedimentação quaternária da margem continental brasileira e das áreas oceânicas adjacentes*. Rio de Janeiro, Cenpes, Dintep, p. 1-55 (Série Projeto REMAC 8).
- KRUTAK, P. 1982. Modern ostracods of the Veracruz-Anton Lizardo

- reefs, México. *Micropaleontology*, **28**(3):258-288.
- MARTINS, I.R. 1984. Aspectos da oceanografia física do Atlântico Sul. *Pesquisas*, **16**:76-90.
- McKENZIE, K.G. 1967. The distribution of Cenozoic Marine Ostracoda from the Gulf of México to Austrália. In: ADAMS, C.G. & AGER, D. V. ed. *Aspects of Tethyan biogeography*. s.l. Systematics Association. p. 219-238. (Publ. 7).
- MOORE, R.C. 1961. *Treatise on invertebrate paleontology. Part. Q. Arthropoda 3 Crustacea - Ostracoda*. New York, Geological Society of America and University of Kansas Press. 442 p.
- MORKOVEN, F.P.C.M. van. 1962. *Post-Palaeozoic ostracoda; their morphology, taxonomy and economic use; general*. Amsterdam, Elsevier. v. 1, 204 p.
- MORKOVEN, F.P.C.M. van. 1963. *Post-Palaeozoic ostracoda; their morphology, taxonomy and economic use; generic descriptions*. Amsterdam, Elsevier, v. 2, 478 p.
- PINTO, I.D.; ORNELLAS, L.P.; PURPER, I.; KOTZIAN, S.B.; SANGUINETTI, Y.T. 1978. Recent ostracodes along 7,408 km of the Brazilian Coast (33°45'S to 4°25'N) *Pesquisas*, **9**:109-120.
- PURI, H.S. 1953. Contribution to the study of the Miocene of the Florida Panhandle, Part 3, Ostracoda. *Bul. Florida State Geol. Surv.*, **36**:216-345.
- RODRÍGUEZ, L.R. 1969. Pliocene marine ostracodes from the Playa Grande Formation, North Central Venezuela, South America. *Bol. Inf. Asoc. Venezolana de Geología, Minería y Petróleo*, **12**(6):155-215.
- TEETER, J.W. 1975. Distribution of Holocene Marine Ostracoda from Belize. In: WANTLAND, K. F. & PUSEY, W.C. ed. *Belize shelf-carbonate sediments, clastic sediments and ecology*. Amer. Assoc. Petrol. Geol., v. 2, p. 400-499.
- VICALVI, M.A.; KOTZIAN, S.C.B.; FORTI-ESTEVEZ, I.R. 1977. A ocorrência de microfauna estaurina no Quaternário da plataforma continental de São Paulo. In: PETROBRÁS *Evolução sedimentar holocênica da plataforma continental e do talude do sul do Brasil*. Rio de Janeiro, Cenpes, Dintep, p. 77-96 (Série Projeto REMAC 2).

MANUSCRITO 580

Recebido em 29 de novembro de 1988

Revisão do autor em 07 de março de 1989

Revisão aceita em 08 de março de 1989

...Têm-me atribuído até excessivos méritos, porém até mesmo esse excesso entra em minha meditação, porque significa o desejo de aproveitar um esforço sincero feito em benefício daquilo que é de maior importância para o desenvolvimento deste país: a educação. Nisso concordam educadores e economistas, pelo menos os economistas que vêem a economia em função dos fatores sociais e procuram raciocinar em termos de uma nação que busca o desenvolvimento, e não de um país já farto, se assim se pode dizer, de desenvolvimento.

José Reis