DISTRIBUTION OF MACROBENTHIC FORAMINIFERA ON BRAZILIAN CONTINENTAL MARGIN BETWEEN 18^0S – 23^0S

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Resumo *DISTRIBUTION OF MACROBENTHIC FORAMINIFERA ON BRAZILIAN CONTINENTAL MARGIN BETWEEN 18^{0S} – 23^0S* Este trabalho objetivou caracterizar os padrões de distribuição dos foraminíferos macrobênticos da margem continental brasileira localizada entre o sul da Bahia e o norte do Rio de Janeiro, a partir de amostras obtidas durante o cruzeiro Jops II (*Joint Oceanographic Projects*), pernada 8, em abril de 1995. O delineamento amostral consistiu de 13 estações entre 22 e 1.285 metros de profundidade, utilizando-se uma draga tipo *Van-Veen* e um *box-core*. O sedimento conservado em formalina e corante rosa de Bengala, com a finalidade de se evidenciar os exemplares vivos, foi lavado em peneiras de 1.0-0.5 mm, a partir do qual os espécimens foram triados e identificados ao menor nível taxonômico. Os foraminíferos foram representados pelas ordens Rotaliida, Miliolida e Textulariida, sendo as duas primeiras mais abundantes e diversificadas em número de espécies. A ordem Rotaliida apresentou-se mais diversificada em número de famílias, enquanto Miliolida foi representada por apenas cinco famílias. Muitos espécimens apresentaram alterações nas testas como resultado de processos tafonômicos, tais como, tubos de poliquetos e espécimens de briozoários, bem como carapaças desgastadas, amareladas e corroídas. Em geral, os indivíduos de foraminíferos apresentavam grandes dimensões que talvez possam ser explicados pelos fenômenos de ressurgência que promovem a biodiversidade e aumentam a produtividade na região, em conjunto com as altas taxas de carbonato de cálcio, carbono e nitrogênio dos sedimentos.

Palavras-chave: Foraminíferos, distribuição, margem continental, Brasil.

Abstract This work aimed to characterize the macrobenthic foraminifera distributional pattern on Brazilian continental margin between Southern Bahia and Northern Rio de Janeiro states from samples obtained during Jops II cruise (*Joint Oceanographic* Projects), leg 8, in April 1995. Sampling was performed on 13 stations, with depths among 22 and 1285 m using either a box-core or a van-Veen grab sampler. After sampling, the sediment was washed through 1.0-0.5 mm mesh sieve, and the specimens picked and stained in 4% rose Bengal in order to differentiate living specimens. Macrobenthic foraminifera were represented by Rotaliida, Miliolida and Textulariida orders, being the first two more abundant and diversified in number of species. Rotaliida was a more diversified order in number of families, while Miliolida was represented by only five families. Several specimens showed alterations on their tests due to taphonomic process, such as Polychaeta tubes, and remains of other invertebrates, as well as corrosion, rusty colors and eroded tests. Foraminifera specimens were in general very large, a fact that could be hypothetically explained by the local upwelling phenomenon that raises biodiversity and increases the productivity into the region, as well as increasing the amounts of important elements such as calcium carbonate, carbon, and nitrogen of sediments.

Keywords: Foraminifera, distribution, continental margin, Brazil.

INTRODUCTION Benthic foraminifera are frequently focus of paleoecological studies since they are generally abundant, well preserved, and their geographical and depth distribution have great importance in paleoenvironmental, paleoceanographical, and paleobathymetrical interpretations as well as in temperature oscillations studies (Carvalho 1980, Hannah & Rogerson 1997). On the Quaternary they are an appropriate material for different studies in biological, geological, and oceanographic sciences (Boltovskoy 1965, Scott *et al*. 2001, Barbosa *et al*. 2005). Studies on living foraminiferal fauna still far less evident in literature have been done recently in order to understand ecological distributional and latitudinal patterns following a coast-ocean gradient (Sen Gupta 1999), once foraminifera have been shown to be important food items for macrobenthos (Hannah & Rogerson 1997, Capriulo 1990, Murray 1991, Berry 1994), and to interact symbiotically with algae (Lee & Anderson 1991, Hallock 2000, Hallock *et al*. 2004).

Some studies using foraminifera as framework have been done on the same geographic range of the present study, such as the papers on zoogeographical provinces of Boltovskoy (1959, 1962), the faunal studies of Tinoco on Cabo Frio (1955), those of Ribas (1971), Vicalvi & Milliman (1977) from shelf and banks of eastern coast, besides those of Barbosa (2002) working on slope assemblages. D'Agostino (1999) and Machado & Kikuchi (1999) did relevant contribution to the knowledge of foraminifera from southeastern and northeastern shelf, among others.

This paper aims to study the macrobenthic foraminifera from continental margin between Southern Bahia and Northern Rio de Janeiro states emphasizing their ecology, taxonomy and systematic in order to contribute to paleoenvironmental applications and further ecological biogeographic studies.

MATERIAL AND METHODS **Study area** The study area comprises the continental shelf and slope between 18º00,00' to 23º12,5' S and 38º12,1' to 41º19,0'W, from east of Abrolhos bank to Macaé, near Paraíba do Sul river mouth. Based on previous knowledge of geomorphology the area was sub-divided in three sectors. The north one, including the south of the Abrolhos bank, the south section, which includes the area under the influence of

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the Paraíba do Sul delta; and the central section, from the city of Vitória on the coast, to the Royal Charllote bank and adjacent regions. The geomorphology of this area is described by Zembruscki *et al*. (1972), and Boyer (1969), among others.

Oceanographic conditions in this part of the Brazilian coast are complex, governed by the tropical waters of the Brazil current (BC) in oligotrophic areas, and mesotrophic areas generated by the seasonal upwelling of cold, nutrient-rich South Atlantic Central Water (SACW) southwards of the Doce river (20º) and near Cabo Frio (23º) (Ekau & Knoppers 1999). Primary productivity varies between 0.3 to 1.1 g C.m.d^{-1} (Gaeta *et al.* 1995) and the input of Doce and Paraíba do Sul rivers is in the order of 900 $m^3.s^{-1}$. Broad areas of the shelf are characterized by low organic matter deposition (Jennerjahn & Ittekkot 1996), sediments of the north-eastern, north-western and eastern shelves of Brazil, from Fortaleza to Cabo Frio, are dominated by carbonatic banks that are characterized by the occurrence of hermatypic coral, sea grass beds, vermetidae reefs in shallow areas, and mangrove forests, (Kempf & Laborel 1968, Mabessone & Coutinho 1970, Milliman *et al*. 1972). According to Soares-Gomes *et al*. (1999), the mean abundance of the soft- bottom macrobenthos in the area follows an inshore-offshore gradient; the abundance on the continental shelf is an order of magnitude higher than on slope.

Sampling design and analytical techniques The database of this work was obtained in April 1995 during the leg 8 of Joint Oceanographic Project (JOPS-II), in a cooperative agreement between Brazilian and German governments, on the board of R.V. Victor Hansen from Bremen University. The agreement had the objective of investigating the processes controlling the sedimentation and productivity of the eastern and northeastern continental shelves of Brazil, including Southern of the Abrolhos bank north-easterly offshore oceanic banks and islands.

Thirteen stations were sampled between 22 and 1,340 meters depth (Fig. 1), along six transects perpendicular to the coast. Standard 10 liters samples were collected using either a 60x60x30 cm box-core or a *van-Veen* grab, with a sampled surface area of 0.1 m^2 and 15 cm depth in the sediment column. After sampling,

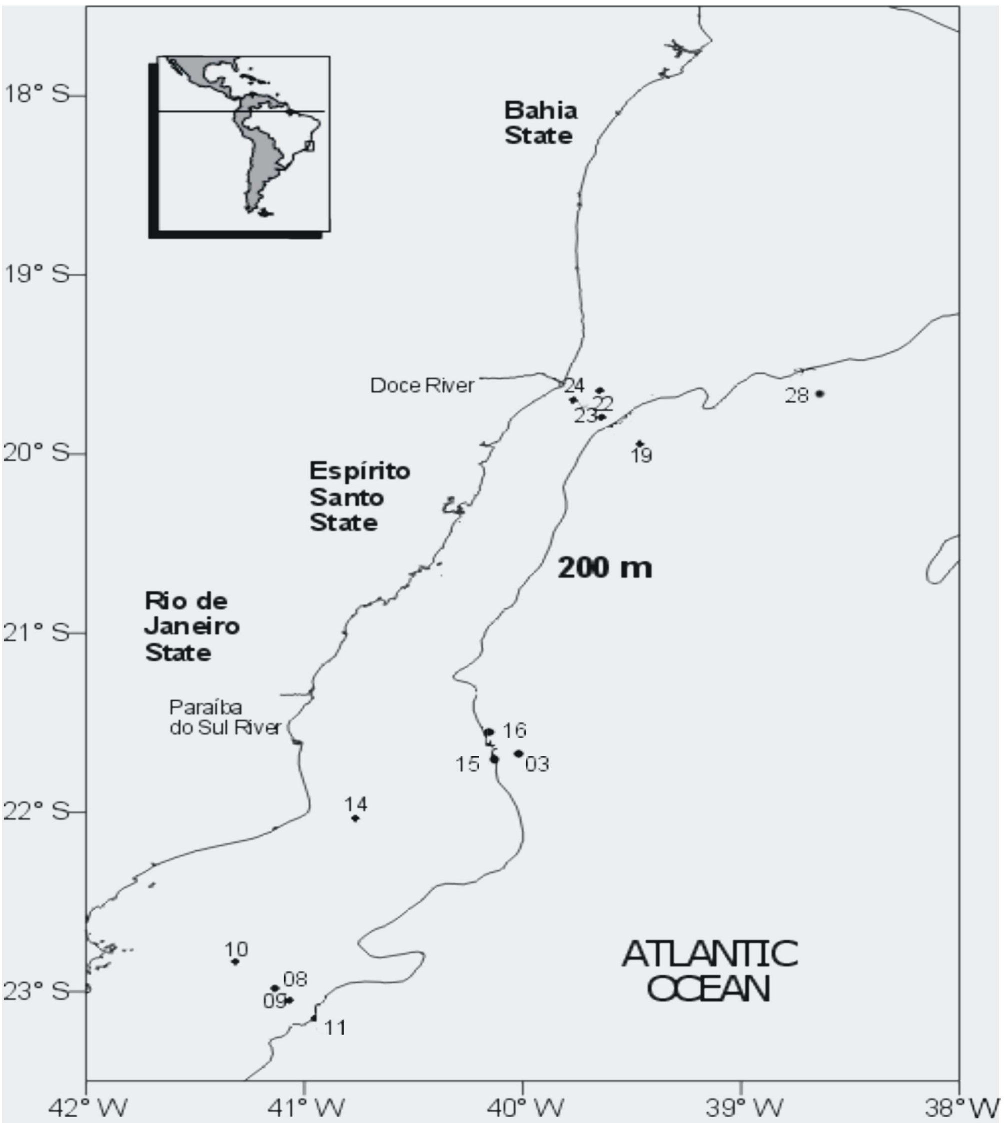

Figure 1 - Study area, and samples stations.

Table 1 - Depth (in meters), calcium carbonate, percentages of sandy fractions, C/N ratio and Wentworth classification of samples. ($CaCO_3$ = calcium carbonate; VCS= very coarse sandy; CS= coarse sand; MS= medium sand; FS= fine sand; VFS= very fine sand).

Station	Depth	$CaCO_3$	VCS	CS	MS	FS	VFS	C/N	Wentworth Classification
3	650	0	0.14	0.14	0.21	0.34	7.16	6.62	silt
8	98	97	7.93	13.86	26.99	18.78	6.14	5.86	fine sand
9	95	91	12.72	26.00	24.02	14.86	8.21	7.01	coarse sand
10	60	22	3.49	4.00	4.74	22.38	62.63	8.16	fine sand
11	705	0	0.00	0.00	0.11	0.24	2.48	7.22	silt
14	25	0	0.40	3.93	8.02	17.04	32.53	9.55	silt
15	75	89	19.30	21.40	13.18	12.99	2.62	7.29	very coarse sand
16	300	0	0.00	0.00	0.44	0.67	13.72	6.34	silt
19	1285	0	0.00	0.23	0.66	1.32	8.99	7.41	silt
22	45	5	1.02	2.16	22.13	68.46	5.93	21.62	fine sand
23	32	4	1.22	16.02	48.77	33.18	0.81	10.60	medium sand
24	22	0	0.00	0.00	0.60	1.65	15.82	7.72	silt
28	1100	0	0	0.49	1.91	2.62	5.83	5.70	silt

sediment was washed through 1.0 and 0.5 mm mesh sieves, stained in 4% rose Bengal, and foraminifera specimens were sorted and identified under a stereomicroscope using Sen Gupta (1999) morphological key. The specimens are deposited at the Laboratório de Microscopia of Universidade Federal Fluminense waiting the transfer to the Micropaleontological Museum from the same University where they will receive a number at the collection.

Sediment granulometric fraction was determined by standard dry-sieve and pipette methods (Suguio 1973). Granulometric statistics were calculated using Folk & Ward (1957) formulas and sediments were classified on Wentworth (1922) scale. Organic carbon (OC) and nitrogen (ON) content were determined with a LECO CNS 2000 analyzer.

RESULTS Grain-size distribution showed a predominance of clay and silt, both on shelf and slope stations. Higher values of silt and clay concentration occurred at deeper stations, except for ones under the influence of the Paraíba do Sul and Doce rivers mouths. The carbon-nitrogen (C/N) ratio was highest at the shallow stations of the central sector and the calcium carbonate concentration was highest on the south sector (See Table 1).

A total of 109 taxa belonging to 37 families of the Rotaliida, Miliolida and Textulariida orders were identified, the first two being more abundant and diversified in number of species. The Rotaliida was the most diversified order in number of families, while Miliolida was represented by five families only (Refer to Table 2).

The Rotaliida showed large abundances of *Laticarinina pauperata*, *Nodosaria subsoluta*, *N. filiformis* and several species of *Lenticulina* sp. (at stations 03 and 28), and *Lingulina seminuda*. *Amphistegina* aff. *A. lessonii* was the species with the highest number of individuals in the majority of stations. The greatest richness was found into Miliolida by the genus *Pyrgo*, represented by the species *P. phlegeri*, *P. oblonga,* and *Pyrgo* sp.A, mainly at station 28. *Quinqueloculina funafutiensis* is abundant at station 08. Textulariida species were well represented in all stations by *Haplophragmoides emaciatum*, *H. scitulum*, and *Cyclammina cancellata*, mainly at stations 03 and 28. *Trochamminoides proteus* was present only at station 28. *Cribrobigenerina* sp. and *Bigenerina cylindrica* appeared in high quantities only at stations 08, 15, 08, 14 and 22 respectively.

A large number of tests showed alteration, bioerosion and corrosion, or were altogether observed broken in all stations. Once all specimens were characteristically large their tests provided a surface for invertebrates to construct tubes upon. Polychaeta tubes were thus observed over *Cyclammina cancellata* tests at stations 03 and 28, while Bryozoa was found incrusting tests of *Bigenerina cylindrica*, and *Amphistegina* aff. *A. lessonii* mainly at station 09. Diatoms were observed above *Lenticulina antillea* at station 10. The Textulariida on general presented corroded and fragile tests, which broke easily when manipulated, while Miliolida and Rotaliida specimens were broken and showed rusty colors.

DISCUSSION River input on the central and south sectors is more important than on the north sector and grain-size distribution does not follow the theoretical pattern (coarser sediments occurring in shallow areas and fine sediments in deeper ones), exhibiting domain of fine sediments in almost all stations. The C/N ratio show relation to depth, with high ratios on the continental shelf mainly at stations 22 and 23, which are under influence of Doce river. Calcium carbonate concentrations do not agree with Knoppers *et al.* (1999) whom observed that sediments of shallow waters of Abrolhos bank present great contribution of carbonate shells, coral fragments, and needle – shaped biogenic opal which was not observed on the group of samples analyzed at north sector of the present study. Otherwise, stations located at south sector present high values of $CaCO_3$, what can be explained by the presence of carbonate banks 10-15km long and 5-10km width, reaching 10m high on the shelf edge of the Campos basin as seen by Viana & Faugères (1998). The high concentration of calcium carbonate in south and central samples was reflected by calcareous foraminifera, which tend to increase the thickness of their tests due to its addition.

Studies that use or have foraminifera as the main focus on shelf environments are still rare in Brazil. Nevertheless Soares-Gomes *et al.* (1999) studying the same area, concluded that mollusks and foraminifera were the most abundant and frequent taxa of macrobenthic community, occurring at all stations with a maximum of 760.000 ind.m^{-2}, followed by polychaeta, echinoderms and bryozoans.

The high diversity found on southern samples can be explained

Table 2 - Qualitative occurrence of species by samples (+ means presence, - means absence).

	Stations													
Species	3	8	9	10	11	14	15	16	19	22	23	24	26	28
Adelosina sp.	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Ammodiscus incertus	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Ammoglobigerina globigeriniformis	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphistegina sp.	+	-	+	-	-	-	-	-	-	-	-	-	-	-
Amphistegina aff. *A. lessonii*	+	+	+	-	+	-	+	-	-	+	-	-	-	-
Bigenerina cylindrica	-	+	-	-	-	+	-	-	-	+	-	-	-	-
Bigenerina sp.	-	-	+	-	-	-	+	-	-	-	-	-	-	-
Botellina sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cibicidina sp.*1*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cibicidina sp.*2*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cibicidina sp. *3*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cibicidinella sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cibicidoides incrassatus	+	-	-	-	-	-	-	-	-	-	+	-	-	-
Cornuspira involvens	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Cribrobigenerina sp.	-	+	-	-	-	-	+	-	-	-	-	-	-	-
Cyclammina cancellata	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Cyclammina pauciloculata	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclammina sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Discorbinella sp. *1*	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Discorbinella sp. *2*	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Discorbis incrassatus	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Egerella propinqua	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Egerella sp. *A*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Egerella sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Epistominella exigua	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Epistominella cf. *E. exigua*	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Epistominella sp.	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Eponides sp.	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Eponides repandus	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Fissurina sp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Fontbotia cf. *F. wuellerstorfi*	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Gaudryiina flintii	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Gaudryina rugosa	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Glandulina laevigata	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Gordiospira sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Gyroidina soldanii d'orbigny var. *altiformis*	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Haplophragmoides emaciatum	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Haplophragmoides runianum	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Haplophragmoides scitulum	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Haplophragmoides sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Hoeglundina elegans	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Hoeglundina sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Lagena sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Laticarinina pauperata	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Lenticulina albatrossi	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Lenticulina antillea	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Lenticulina formosa	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Lenticulina iota	+	-	-	+	-	-	-	-	-	-	-	-	-	-
Lenticulina occidentalis var. glabrata	+	-	-	-	-	-	+	-	-	-	-	-	-	+
Lenticulina rotulatus	-	+	-	+	+	-	-	-	-	-	-	-	-	+
Lenticulina cf. L. septentrionalis	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Lenticulina submamilligera	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Lenticulina sp.	-	-	-	-	+	-	+	-	-	-	-	-	+	-
Lenticulina sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	+

Table 2 (cont.)

	Stations													
Species	3	8	9	10	11	14	15	16	19	22	23	24	26	28
Lingulina seminuda	+	-	-	-	-	-	-	-	-	-	-	+	-	-
Miliolinella sp. A	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Miliolinella sp. B	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Miliolinella sp. E	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Nodosaria advena	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Nodosaria farcimen	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Nodosaria filiformis	+	-	+	-	-	-	+	-	-	-	-	-	-	-
Nodosaria cf. N. hirsuta	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Nodosaria mucronata	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Nodosaria vertebralis var. albatrossi	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Nodosaria sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Nodosaria subsoluta	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Nutallides sp.	-	+	+	+	-	-	+	-	-	+	-	-	-	-
Planulina ariminensis	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Planulina sp. 1	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Peneroplis bradyi	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Poroeponides lateralis	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Psammatodendron arborescens	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudogaudryina sp. A	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Pyramidulina intercellularis	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Pyrgo murrhina	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Pyrgo oblonga	+	+	+	+	+	-	+	-	-	-	-	-	-	+
Pyrgo phlegeri	+	-	-	-	-	-	-	-	-	-	-	-	-	+
Pyrgo sp.	+	-	-	-	-	-	-	-	-	-	-	-	+	+
Pyrgo sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Pyrgo sp. B	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Pyrgo sp. C	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Pyrgo sp. D	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Quinqueloculina angulata	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Quinqueloculina artica	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Quinqueloculina cf. Q. barnardi	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Quinqueloculina bicornis	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Quinqueloculina disparilis	-	-	-	-	-	-	-	-	-	+	-	-	-	-
Quinqueloculina funafutiensis	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Quinqueloculina lamarckiana	-	-	+	+	-	-	-	-	-	+	-	-	-	-
Quinqueloculina cf. Q. rotunda	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Quinqueloculina sp.	-	-	-	-	+	-	-	-	-	-	-	-	+	-
Reophax distans Brady var. turbo Göes	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Reussella sp.	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Rhabdammina abyssorum	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhumblerella sepetibaensis	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Sahulia pseudotrochus	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Saracenaria italica	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Siphonaperta sp.	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Sphaeridia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Spiroloculina caduca	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Spiroloculina depressa	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Spiroloculina cf. S. pellucida	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Stomatorbina torrei	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Textularia foliacea foliacea	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Thalmannammina sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Textularia pseudotrochus	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Textularia sp.	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Trochamminoides cf. T. proteus	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Vaginulina advena	-	-	+	-	-	-	-	-	-	-	-	-	-	-

by the occurrence of upwelling in this region, which raises the biodiversity and increases the productivity, once it carries to the continental margin oxygen and food-rich cold waters, in agreement with Sen Gupta's (1999) observations of benthic foraminifera as indicators of productivity. This high productivity is related to SACW, which flows up on south of the Doce river and near Cabo Frio causing an upwelling and making this area seasonally mesotrophic. Under this upwelling influence area it was observed at stations 08 and 09 the presence of *Epistominella exigua,* which is known to be a species whose population density is dependent on phytodetritus fall (Gooday 1993). Perhaps the high diversity of macrobenthic foraminifera on south sector could be still explained by the great size of the specimens retained at the mesh sieves used, once sample washing was not performed using 0,062mm mesh sieve used in foraminiferal analysis, as the main objective of the cruise was not to sample foraminifera. If this mesh sieve was used, probably the other sectors could show the same diversity as the south.

A correlation between faunal and sediment characteristics, at south sector, was found for agglutinated foraminifera in relation to the number of individuals, due to high silt concentration loaded by Paraíba do Sul river, while Rotaliida dominated in numbers of species. This could also be related to the erosion of siliciclastic layers found intercalated with calcareous sediments in the carbonatic platform that occurs at the Campos basin shelf edge (Coimbra *et al.* 2000). High numbers of specimens of *Bigenerina cylindrica* were observed to have coarse grain agglutination, and even other macrobenthic organisms and shell-fragments attached to their tests.

The central sector presented low richness compared to southern and northern ones. This could be a result of the great influence of Doce river, which carries a high water volume into a narrow shelf as shown by Petri (1979). Calcareous species of *Quinqueloculina* and *Pyrgo* dominated in numbers in such samples, even in low concentration of calcium carbonate. However, these specimens show not only brownish and yellowish, but also eroded and broken tests suggesting that they may be relict due to paleosurface bottom facies, confirming what was observed by Moraes & Machado (2003) for the foraminifera fauna on the carbonate shelf of Bahia state. Besides that, Macario *et al.* (2004) dating foraminifera tests collected on the upper slope of Campos Basin, near the south sector analyzed in the present study, shows ^{14}C ages between 2560 + 80 years and 4540 + 80 years for the first 12 cm of sediment, which depth comprises the samples analyzed in agreement with the relict material proposed here.

Carbon to nitrogen (C/N) ratio of sediment was very high for central sector, mainly at stations 22 and 23, explaining the presence of living calcareous population. The Textulariida in these samples was represented by *Bigenerina cylindrica* in a high number of specimens, which is in accordance to Haq & Boersma (1999) who stated that the inner shelf presents few species of this order in high dominance; a fact also reflected in Textulariida macrobenthic foraminifera of the Brazilian shelf environment.

For the north sector (station 28), the high number of species can be explained by the proximity to Abrolhos bank, which is rich in coral reefs and calcareous sediments, thus promoting high variability of habitats and high ecological complexity. Station 28, located at 1100 m depth was marked by *Cyclammina cancellata* with Polychaeta tubes on their tests. The occurrence of this species at stations 03 and 28 is probably due to cold waters and silty sediment as mentioned by Akers (1954).

The occurrence of large size species, although imposed by the sorting method, also suggests a correlation with increasing water depth and decreasing water temperature. The *Amphistegina* aff. *A. lessonii* was found in several stations in large numbers and large diameters, being mainly characteristic of depths greater than 20 meters, extending beyond across the central and outer shelf zone once it is symbiotic with algae, which requires light to photosynthetic process (Bandy 1956, 1964, Chai & Lee 2000, Fujita 2004). So, the specimens of *Amphistegina* aff. *A. lessonii* found at deeper stations were clearly transported by currents as shown by taphonomic processes on their tests. The uncommonly large sizes for all specimens can be explained by high C/N ratio (from 5.70 up to 21.62) imposed by the upwelling, which provides an increase of nutrients to the continental margin, irrespective of sieve size used.

The macrobenthic foraminifera listed at the present study are under the influence of warm waters of the southward-flowing Brazil current, being assigned to the West Indian Province by Boltovskoy (1976). However it is important to highlight that more samples and quantification are necessary in order to assign this macrobenthic foraminiferal and limit them into a specific biogeographical sector on this province. This work showed that local variables such as low temperatures and C/N ratios besides reworking processes might influence the faunal occurrence of macrobenthic foraminifera in this shelf portion.

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