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SPATIAL DISTRIBUTION OF POLYCHAETA IN A SOFT-BOTTOM COMMUNITY AT SACO DO CÉU, ILHA GRANDE, RIO DE JANEIRO, BRAZIL

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ABSTRACT

Polychaete worms represent an important group in soft bottom communities and their spatial structure is always closely related to grain size and other factors such as organic content. The main purpose of this study was to determine the spatial distribution of polychaetes in the bottom of a small and shallow bay (Saco do Céu), at Ilha Grande Island, Rio de Janeiro, Brazil. Thirty-nine stations were sampled over the bay at two different times of the year (January and July 1992). The Mantel test was used to compare sediment and biological matrices for January and July. The bottom of the studied area formed a mosaic which varied from fine to very coarse sand. The most abundant species were: *Glycinde multidens*, *Sigambra grubii*, *Paraprionospio pinnata*, *Mediomastus californiensis*, *Armandia agilis* in fine sand and *Magelona papillicornis*, *Goniadides carolinae*, *Eunice vittata* in coarse sand. The cluster analysis and the Canonical Correspondence Analysis (CCA) indicated the existence of different groups associated to the two types of sediment. Community composition did not vary between the two periods of the year sampled (summer and winter), thus suggests that the spatial distribution of polychaetes at Saco do Céu may be determined by grain-size characteristics and by organic matter conntent.

The structure of soft-bottom faunal communities can be closely related to the type of sediment (McLusky and McIntyre, 1988). The different characteristics of the sediment usually reflect circulation patterns of the covering water mass and these sediment differences are strongly influential in regulating faunal composition (Gray, 1974; Rhoads, 1974; Jumars, 1975; Gambi and Giangrande, 1986; McLusky and McIntyre, 1988; Capaccioni-Azzati et al., 1991).

Polychaetes represent the most characteristic group present in soft-bottom communities (Woodin, 1974; Knox, 1977; Bilyard and Carey, 1979; Whitlach, 1981; Gambi and Giangrande, 1986), and many reports have shown a relation between spatial distribution of polychaetes and sediment granulometry (Jumars, 1975; Bilyard and Carey, 1979; Maurer and Leathem,1980; Flint and Rabalais, 1980; Paiva, 1993). Some authors support the importance of this factor, and place it in a category of 'high parameter' (Jansson, 1967; Junoy and Vieitez, 1989; Fresi et al., 1983). This relationship between animal and sediment, led to the polychaetes being known as markers of some environmental conditions (Gambi and Giangrande, 1986).

Besides basic granulometric differences, other direct and indirect factors can affect the faunistic associations in soft-bottom communities. Colonization of sediment by some species may bring about changes that could be advantageous or disadvantageous to other species. For example, in sediments with high organic matter and low dissolved oxygen content, the presence of organisms that produce galleries allows the circulation of water through the sediment. This process, known as bioturbation, modifies the sediment in significant ways (Rhoads, 1974; McLusky and McIntyre, 1988; Dittmann, 1996). Rhoads (1974) showed that the sediment deposition by bioturbators can create many microhabitats with the construction of positive (conveyor-belt species) or negative reliefs. Jumars et al. (1982) related the role of such depositions in the process of bioturbation.

The aims of this investigation are to identify the spatial distribution of polychaetes in a Brazilian soft-bottom community and attested the correlation between the type of sediment and its organic matter content as the factor that determine this distribution.

Materials and Methods

The Ilha Grande (Big Island) is located at southeast of Angra dos Reis (44°45′ to 44°00′W and 22°50′ to 23°20′S), and consists of an area of 193 km^2. The study was conducted in a small bay of Ilha Grande, called Saco do Céu, which has an area of 1.04 km^2, and the depth range was 4–12 m (Fig. 1). All the studies in this area have been restricted to particular taxonomic groups (Haas, 1953; Tommasi, 1970; Schaeffer, 1972; Tommasi and Abreu, 1974; Galvão and Tommasi, 1977; Neme, 1979; Nonato, 1981; Grillo, 1995) and polychaete community have never been investigated.

Thirty-nine stations with three replicates each were sampled twice during 1992 (January and July) (Fig. 1). A Petersen grab with an area of 0.1 m^2 was used to collect bottom samples. Magnesium chloride diluted in 8% of sea water was added to the samples and faunal samples were sieved through 0.5 and 1.0 mm mesh sieves. The material was fixed in 10% formalin and preserved in 70% alcohol. The analysis used for evaluation of fine and coarse fractions is specified on the study of Suguio (1973) and Callisto (1994). Polychaetes were identified to the species using various guides to the polychaete fauna of South America such as Amaral and Nonato (1979, 1981), Lana (1984), Nonato et al. (1986), Bolivar and Lana (1986, 1987), Bolivar (1990) and Lana (1991).

Cluster analyses were performed using the Pearson's coefficient for the results of granulometry on the two seasons and WPGMA sorting strategy. The organic matter content was obtained by the calcination technique (Callisto, 1994). The classification of the biotic data was done by Bray-Curtis coefficient with ponderable means (WPGMA). Canonical Correspondence Analysis (CCA) (Ter Braak, 1988) was performed for winter and summer, to assess the hypothesis about the relations that structure the community. The abiotic parameters utilized were median grain size and organic matter content, the data were not transformed.

The correlation between the type of sediment and the abundance of polychaetes was tested with Mantel test. It was used to compare sediment and biological matrices (Paes and Blinder, 1995).

Results

Saco do Céu benthos consist of mainly sandy sediments in a mosaic which varies from fine to very coarse sand. This variable type of bottom was observed in the samples during both sampling periods. In summer, 52.7% of the bottom was composed of fine sand and 26.3% was coarse sand. Two defined groups of stations were observed in the sediment cluster analysis in this season. Sixty-six percent of the sampled had poorly sorted sediments. The data obtained during the winter were largely similar to those of summer. In this period there were similar percentages of fine and coarse sand (45.2%). In this season, two groups of sediment were observed and 87% of the samples contained poorly sorted sediments.

Thirty-three species in 19 families of polychaetes were identified (Table 1). In the cluster analysis of organisms of the summer samples, four distinct groups were found (Fig. 2). Species characteristic of Group I were the spionid *Prionospio cirrifera*, the paraonid *Cirrophorus branchiatus*, and in some cases, the pilargid *Sigambra grubii*. The stations for Group I was characteraized by fine and medium sand. The mean percentage of organic matter content for this group was value of 12.6%, (SD = 8.2%) .

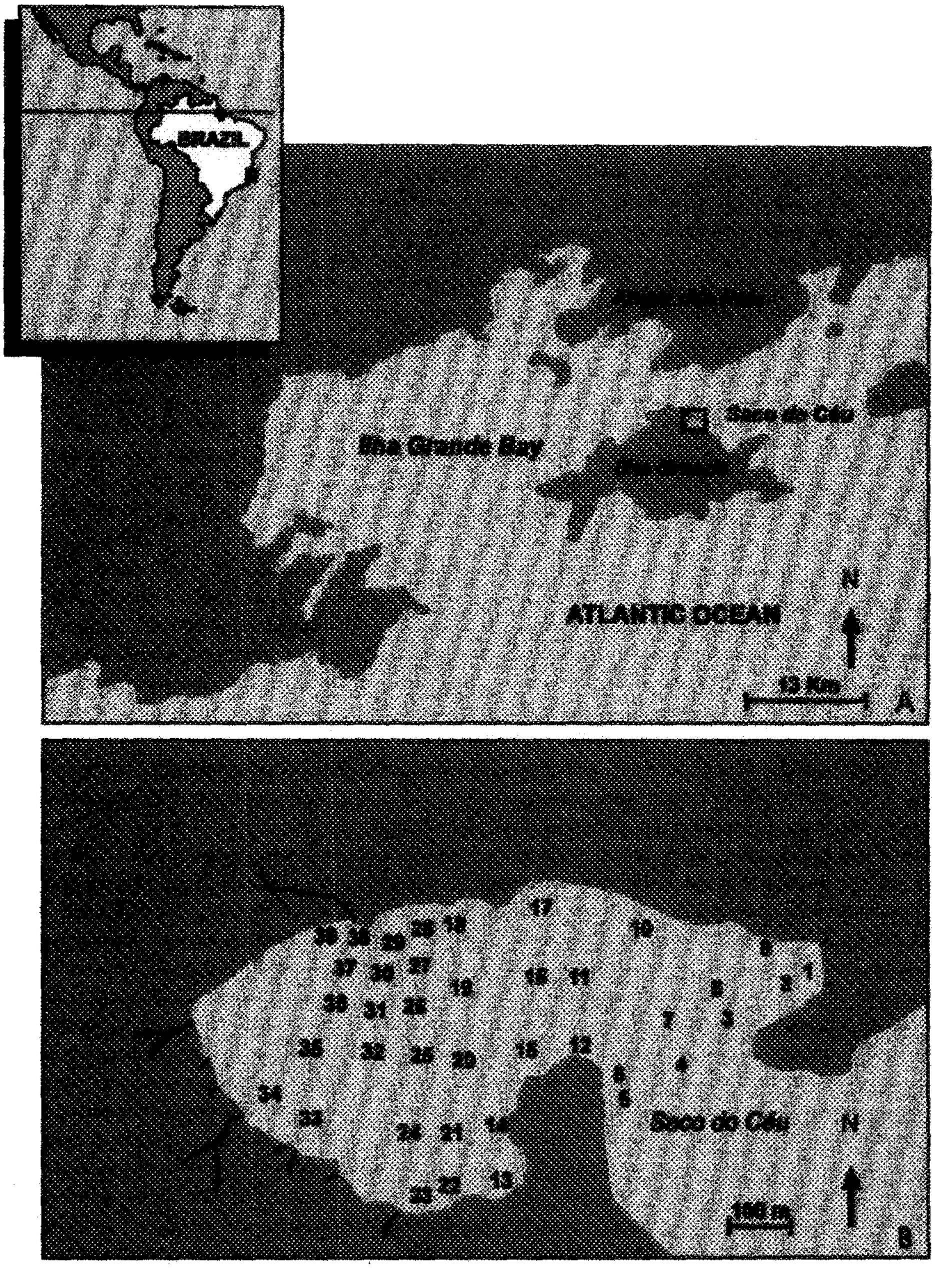

Figure 1. (A) Location of Ilha Grande Bay and (B) sampling stations (Saco do Céu).

Group II was characterized by stations with very fine sediments and the presence of the goniadid *Glycinde multidens, S. grubii* and the opheliid *Armandia agilis.* These stations showed the highest mean percentages of organic matter content (mean 17.8%, SD = 6.4%).

Group III was characterized by coarse sediments with a low percentage of organic matter (mean 3.9%, SD = 3.2%) and was represented by the magelonid *Magelona papillicornis,* the goniadid *Goniadides carolinae* and the eunicid *Eunice vittata.* Two sta-

Table 1. List of polychaete species recorded at Saco do Céu, Rio de Janeiro, Brazil (summer and winter 1992).

Family	Species
Paraonidae	*Cirrophorus branchiatus* Ehlers, 1908
Cossuridae	*Cussora* sp.
Spionidae	*Laonice branchiata* Nonato, Bolivar and Lana, 1986
	Paraprionospio pinnata (Ehlers, 1901)
	Prionospio (Minuspio) cirrifera Ligth, 1978
	Spiophanes sp.
	Polydora socialis (Schmarda, 1861)
	Polydora sp.
Magelonidae	*Magelona papillicornis* Müller, 1858
Capitellidae	*Mediomastus californiensis* Hartman, 1944
Opheliidae	*Armandia agilis* (Andrews, 1891)
Polynoidae	*Eunoe* spp.
Sigalionidae	*Ehlersileanira* cf. *incisa* (Grube, 1878)
Hesionidae	*Hesione* sp.
	Gyptis capensis Day, 1967
Pilargidae	*Sigambra grubii* Müller, 1858
Syllidae	*Exogone arenosa* Perkins, 1980
	Pionosyllis pectinata Temperini, 1981
	Typosyllis hyalina (Grube, 1863)
Nereididae	*Platynereis* sp.
Glyceridae	*Glycera americana* Leidy, 1855
Goniadidae	*Hemipodus* sp.
	Glycinde multidens Müller, 1858
	Goniada littorea Hartman, 1950
	Goniadides carolinae Day, 1973
	Goniadides sp.
Amphinomidae	*Linopherus ambigua* (Monro, 1933)
	Paramphinome besnardii Temperini, 1981
Onuphidae	*Diopatra* sp.
Eunicidae	*Eunice vittata* (delle Chiaje, 1828)
	Nematonereis sp.
Lumbrineridae	*Lumbrineris* sp.
Owenidae	*Owenia fusiformis* (delle Chiaje, 1844)

tions of fine sand were observed near stations with coarse sand and had the same faunal composition without explanation (G IV).The last group (V) formed by two stations, was also characterized by coarse sand and by only the goniadid *G. carolinae*.

The winter samples showed less defined characteristics compared with the summer samples. No particularly characteristic groupings of fauna were found (Fig. 3). The most evident group in the cluster analysis was with stations of fine and very fine sand, high organic content, and the species *G. multidens, Paraprionospio pinnata, P. cirrifera, S. grubii* and *Mediomastus californiensis* (GI). The remaining stations formed less distinct groups. The high presence of *M. papillicornis* grouped stations with coarse sand (Group II). *M. californiensis, Exogone arenosa* and *G. carolinea* formed the group IV with coarse

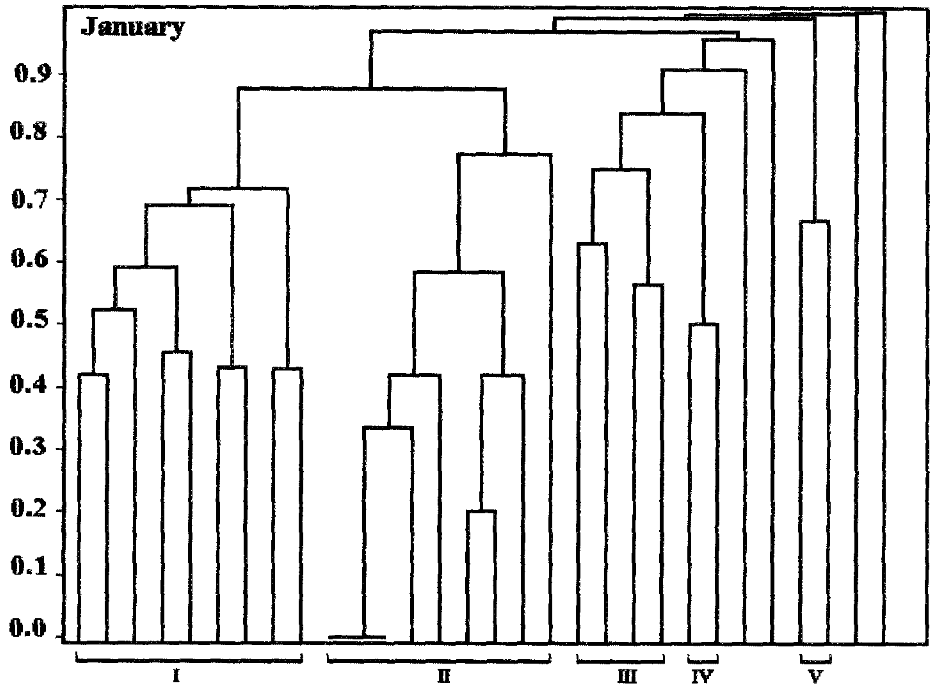

Figure 2. Dendrogram showing WPGM clustering of Bray-Curtis dissimilarity for polychaete community in summer, 1992.

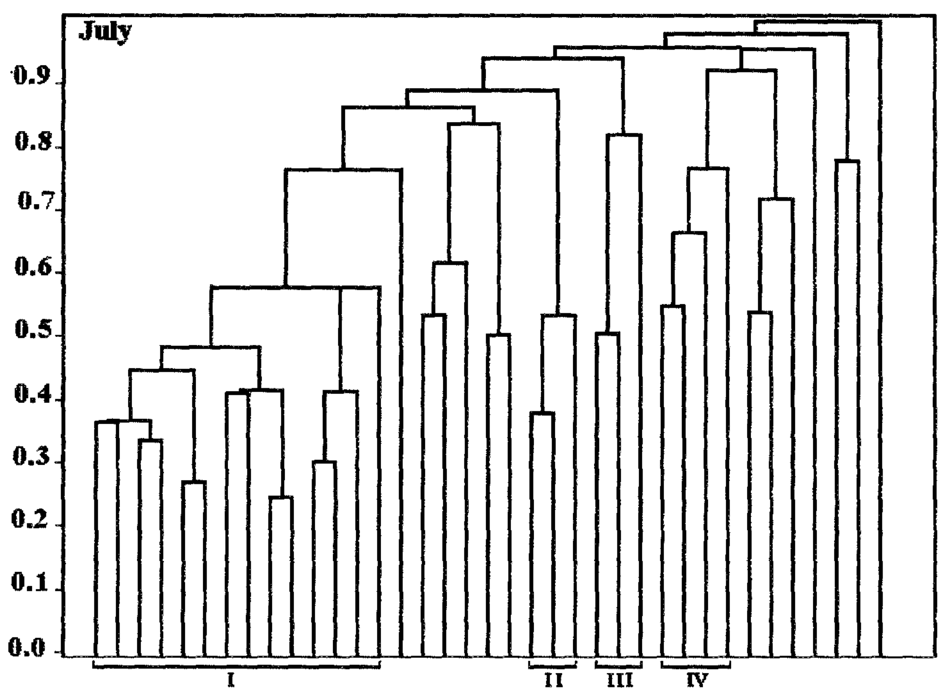

Figure 3. Dendrogram showing WPGM clustering of Bray-Curtis dissimilarity for polychaete community in winter, 1992.

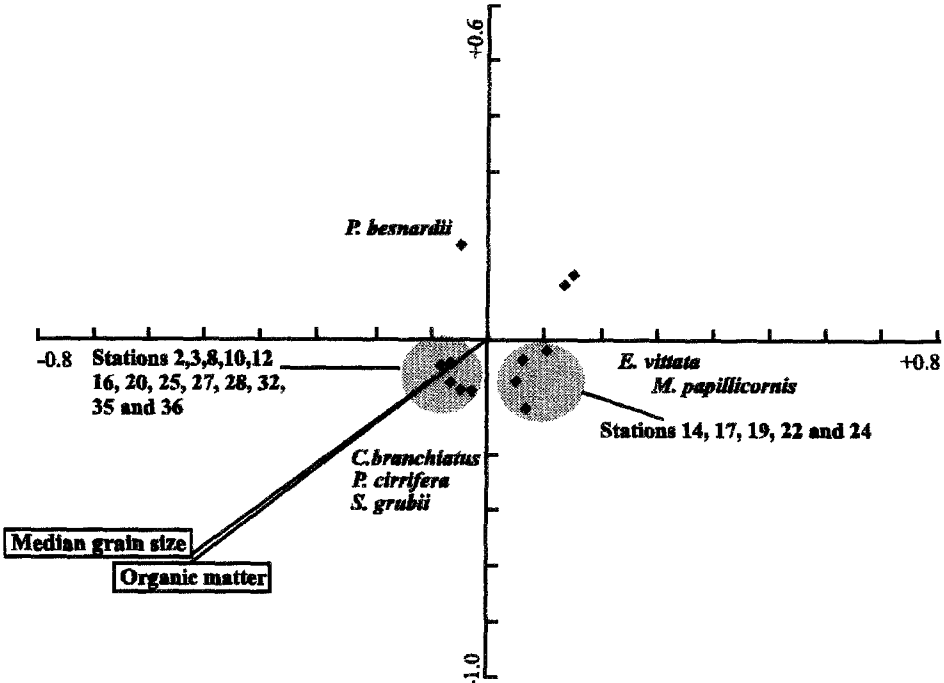

Figure 4. Canonical Correspondence Analysis (CCA) in summer season using abiotic parameters median grain size and organic matter content.

sand and low organic content. The presence of *E. vittata* grouped stations 18, 21 and 10 (G III)

The Canonical Correspondence Analysis (CCA) for summer showed an axis with the influence of the organic matter content and median grain size, relating the species *C. branchiatus*, *P. cirrifera* and *S. grubii* with fine sediment stations. Another evident group is formed by the species *E. vittata* and *M. papillicornis* in coarse sediment stations (Fig. 4). These results indicate the importance of median grain size and organic matter in fine sediment communities. These factors do not influence for the spatial distribution of polychaetes in coarse sand communities.

The winter analysis also showed that fine sediment stations were related to the median grain size and organic matter content. The species associated with these stations group were *P. pinnata* and *S. grubii.* Some coarse sand stations were associated with the species *Exogone arenosa* and *G. carolinae* (Fig. 5).

The Mantel showed low correlations, the species of polychaetes were distributed in accordance with the granulometric type of the bottom. In summer, $r = -0.1988$ with $P = 0.003$ were obtained, whereas in winter $r = 0.365$ with $P = 0.001$.

Discussion

The principle polychaete species observed in the present study have also been observed by other authors and noted as occurring on the same type of bottom. However, compared with other similar regions of the South American east coast, in which polychaetes repre-

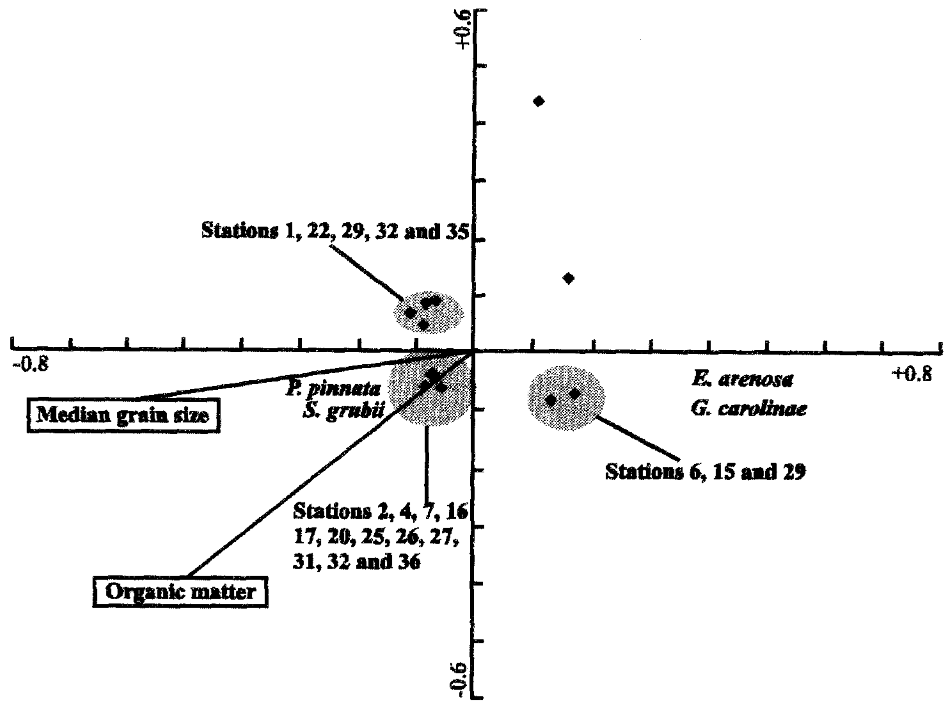

Figure 5. Canonical Correspondence Analysis (CCA) in winter season using abiotic parameters median grain size and organic matter content.

sent the richest group (Orensanz and Gianuca, 1974; Lana, 1981; Paiva, 1993), there were fewer species of polychaetes at Saco do Céu. *C. branchiatus* occurred in bottoms of fine sand with high organic content which was also observed by Paiva (1991). Fauchald and Jumars (1979) classified the other species of this family as non-selective deposit-feeders justifying its occurrence in bottoms with high organic content.

The spionids *Laonice branchiata*, *P. pinnata*, and *P. cirrifera* were distributed in fine sand sediments with a wide range of percentages of organic matter content. Paiva (1991) observed *P. pinnata* in sand-mud bottoms, classifying the species as a surface deposit-feeder. Most spionids are considered surface deposit feeders, but some species may feed other ways (see Fauchald and Jumars, 1979), matching the presence of these species in places with fine sediments and high organic matter content. Another spionid, *Spiophanes* sp., also occurred in fine sand sediments with high percentages of organic matter content. Other authors have related the same genus with fine sand and silt sediments (Lana,1981; Morgado, 1988).

The magelonid *M. papillicornis* did not show any association with a particular granulometric type, and its distribution varied between medium and coarse sand. Lana (1986) found other species of the same genus occurring in sediments of silt /clay to sand. Fauchald and Jumars (1979) classified this species as deposit-feeders and as an inhabitant in sand bottoms. The occurrence of the pilargid *S. grubii* in fine sand sediments with high percentages of organic matter content, while being a carnivorous species, could be explained by the fact of this species feeds on other organisms distributed by sediment characterists. Paiva (1991) also found the same species related to sand-mud sediments, whereas Fauchald and Jumars (1979) stated it prefers mixed sediments with sand or mud-sand.

The goniadid *G. carolinae*, the eunicid *E. vittata* and the syllid *E. arenosa*, all related to coarse sediments on Saco do Céu, were also found in this type of sediment by Paiva (1991). The goniadid *G. multidens* was widely distributed on Saco do Céu, occurring mainly in fine sand sediments. This was also observed by Lana (1986). Fauchald and Jumars (1979) demonstrated that this species is carnivorous, and showed a wide distribution related to the type of the bottom. Paiva (1991) found this species related to carbonate rich bottoms. The groups formed in the cluster analysis allow some assessment regarding the distribution of polychaetes according to sediment type. Group II, (summer sample), which showed *G. multidens* as the most representative species, is also present in stations with the highest percentages of organic matter content, and suggests that this species is a carnivore and probably feeds on organisms distributed in areas with high percentage of organic matter content.

Group I, which links some stations by deposit-feeding species (*P. cirrifera* and *C. branchiatus*) and the carnivore *S. grubii*, also showed high percentages of organic matter content. For the deposit-feeders their presence in this type of bottom is understandable. The presence of *S. grubii*, as discussed above, could be explained by the presence in these sediments of prey utilized by this species. Interestingly, Netto and Lana (1994) observed a decrease of *S. grubii* in sediments which show modifications on the surface, suggesting that this species preys on organisms that are affected by local disturbance. Such factors could not be assessed in this study.

Group III in summer samples was formed by species seemingly with a preference for coarse sand stations. The low similarity levels found in this case could possibly be related to the low density of these organisms. In the winter, a group of stations was formed by the presence of *P. cirrifera, P. pinnata, G. multidens, S. grubii* and *M. californiensis*, represents fine sand stations and high organic matter content, as observed in the summer. However, the cluster analysis of the winter samples did not show well defined groups. The reason is that the stations occurred more in coarse sand where low densities of the representative species were found.

The Canonical Correspondence Analysis (CCA) showed that during two periods of the year there was the same pattern of distribution of the subjected species to the two granulometric basic types (fine and coarse sand). The Mantel test demonstrated that there was a relationship between the spatial distribution of polychaetes and the granulometric type in the two periods of the year.

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