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Biodiversity and spatial distribution of Polychaeta (Annelida) communities in coral-algal buildup sediment, Bahia, Brazil

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Abstract: Bottom sediment samples from depths between 10 and 60m were examined, comprising an area of about 200km^2 where coral-algal buildups along the northern coast of the State of Bahia, Brazil occur. The composition and distribution of the polychaete fauna classified as functional groups (feeding) to mixed sands, carbonate sands and gravels and carbonate muddy sediments were analyzed. The highest diversity of species was recorded on carbonate sands and gravels. Dice's similarity index revealed the highest identity among the species in the carbonate sands and gravels and in the carbonate muddy sediment. Detritivores were the most dominant group. Surface deposit-feeders were more abundant in carbonate muddy sediments, which had the highest percentages of organic carbon, whereas subsurface deposit-feeders and carnivorous polychaetes presented a higher relative abundance in the carbonate sands and gravels and mixed sands substrate. The suspension feeders were the least abundant group, except in the carbonate muddy sediment because of the high abundance of the opportunistic *Owenia fusiformis* Dalle Chiaje, 1844.

Key words: Biodiversity, polychaetes, benthos, trophic groups, coral reefs.

Many polychaete species occur abundantly in dead coral skeletal substrates, and in soft sediments in coral reefs (Hutchings 1981). According to (Whitlatch 1981) the inter-relationships of habitat, resource availability, and feeding mechanisms are fundamental aspects of the animal-sediment interactions. In this regard, trophic group analysis can play a significant role in the interpretation of distribution patterns and benthic community organization.

Advances in reef polychaete research, include recruitment models (Hutchings 1981,1985), others are on reproduction (Hutchings and Howitt 1988), and on diversity and abundance (Vittor and Johnson 1977). There are few studies on distribution and abundance of feeding groups of polychaetes from coral-algal buildups under environment stress.

This study was undertaken to evaluate the distribution of the polychaete fauna and to verify the abundance of feeding groups of these communities, in an area of coral-algal buildups under influence of two industrial outfalls: the first one spills organic chemical-industrial residues which has been partially treated using microorganisms action. The second spills sulphuric acid, ferrous sulphate and, others previously treated inorganic compounds.

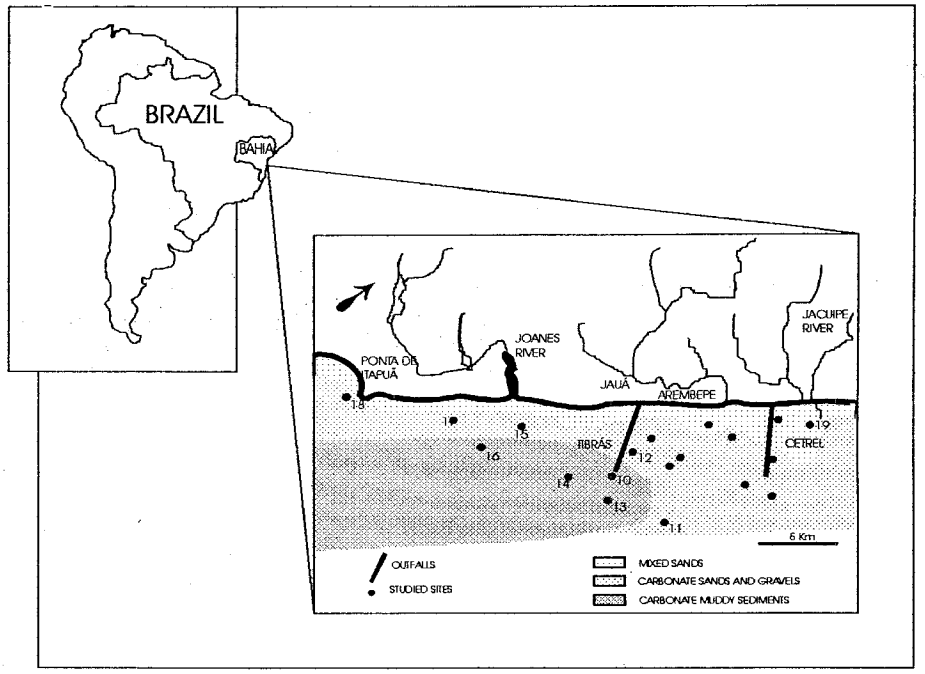

Fig. 1. Studied sites.

MATERIAL AND METHODS

This study took place along the northern coast of the State of Bahia, comprising an oligotrophic area of about 200km^2, between Açu da Torre (12^{0}32'.80"S, 37^{0}57'.60"W) and Ponta de Itapuã (12^{0}58'.20"S, 38^{0}21'.70"W). In this area 19 sampling stations were marked between the 10m and 60m. Among the sampling stations, 17 were located in an area under the influence of two industrial outfalls, the others (1 and 18) were considered as control stations (Fig. 1).

Trimestral samplings were made from May 1993 to February 1994. For quantitative samples ten replicates of non consolidated substrate were collected by means of a Petersen dredge. Total sampled area was 1.02 m^2 per station and for quantitative samples two Holme's dredge hoistings were performed for 30 seconds each. The sediment was sieved through a series of 5.0, 2.0, and 1.0 mm sieves. Sediment samples were subjected to granulometric and organic material contents analyses.

The organisms were anesthetized in 7.8% $MgCl_2$, fixed in 4% formalin and stored in 70% ethanol. All polychetes present were classified according to the trophic categories proposed by Fauchald and Jumars (1979). Each species was allocated to one of these classes on the basis of their gut contents. The detritivores were subdivided into surface and subsurface deposit feeders. Some species were assigned to more than one trophic group because they have alternative feeding mechanisms. Voucher specimens are at the scientific collection of the Zoology Departament of the Federal University of Bahia, Brazil.

Dice's Index (Rohlf 1994) was used to verify the similarity of polychaete fauna on the different substrata. The relative abundance analysis was made according to the progressive scale proposed by Peixinho and Peso-Aguiar (1989).

RESULTS

A total number of 865 polychaetes were found to belong to 82 species. They were distributed among three types of substrate: mixed sands, carbonate sands and gravels and carbon-

TABLE 1

Polychaete species occurrence, total number of individuals and functional trophic groups, at different types of substrate

SPECIES	MS	CSG	CMS	Total	FTG
Species	MS	CSG	CMS	TOTAL	FTG
Chloeia viridis Schmarda, 1861	2	3	1	6	C
Epidiopatra sp.	4	15	2	21	CS
Arabella sp.	1			1	CS
Hyalinoecia sp.	2	2		4	CS
Dasybranchus sp.1		4		4	B
Nothria sp.		1	4	5	CS
Dasybranchus sp.2			3	3	B
Onuphis sp.	7	34	9	50	CS
Cossura coasta Kitamori, 1960			3	3	B
Armandia agilis (Andrews, 1891)	3	33		36	B
Protodorvillea biarticulata Day, 1963	1			1	CS
Ophelia capensis Kirkegaard, 1959	1			1	B
Grubeulepis fimbriata (Treadwell, 1875)		1	3	4	C
O.denticulata Verrill, 1875		1		1	B
Pareulepis sp.		2	3	5	C
Ophelina sp.			1	1	B
Eunice sp.1		3		3	CB
Pholyophthalmus pictus (Dujardin, 1839)			1	1	B
Eunice sp.2	6	113	5	124	CB
Scoloplos sp.	2	1		3	B
E.rubra Grube, 1856		9		9	CB
S. agrestis Nonato and Luna, 1970	1		9	10	B
Lysidice ninetta Audouin and Milne Edwards,1833[a]		23		23	CB
Owenia fusiformis Delle Chiaje, 1844	4	7	222	233	FS
Marphysa kimbergi Mc Intosh, 1910		8		8	CB
Pectinaria sp.			1	1	B
Nematonereis sp.		1		1	CB
Pectinaria ragalis Verrill, 1901	1	1		2	B
Paramarphysa sp.		1		1	CB
Eteone sp.		1		1	CB
Pherusa sp.		1		1	S
Eulalia bilineata (Johnston,1840)		1	2	3	C
Glycera sp.	1	19	1	21	CB
Phyllodoce sp.	1			1	C
G.benguellana Augener, 1931	1			1	CB
Eunoe sp.		1		1	C
G. convoluta Kejerstein, 1862		1		1	CB
Harmothoe sp.		1		1	C
G.subaenea Grube, 1878		1		1	CB
Eupanthalis sp.	1	1	5	7	C
G.tesselata Grube, 1863	4	13	2	19	CB
Sabellaria floridensis Hartman, 1944		1		1	F
Goniada teres Treadwell, 1931		3		3	C
Sabellastarte sp.		1		1	F
Lumbrinerides sp.	5			5	CB
Pholoe sp.		1		1	C
Lumbrineriopis mucronata Ehlers, 1908	1	1		2	CB
Ehlersileanira sp.	1	4	5	10	C
Lumbrineris sp. 1	3	6		9	CB
Psammolyce arenosa Delle Chiaje, 1841		1		1	C
Lumbrineris sp. 2	1	3	1	5	CB
Sigalion sp.	2			2	C
L. januarii (Grube, 1878[a])	1	4		5	CB
Sthenolepis grubei (Treadwell, 1901)		1	2	3	C

Ninoe brasiliensis Kinberg, 1865		1	2	3	CB
Sphaerodoridium sp.		1		1	B
Notocirrus sp.	1			1	CB
Sternaspis capillata Nonato, 1966		5	2	7	B
Magelona sp.	1			1	S
Branchiosyllis oculata Ehlers, 1887	1	1		2	C
Euclymene sp.		2	1	3	B
Exogone clavator Ehlers, 1913	1			1	C
Asychis sp.	1	4	4	9	B
Geminosyllis sp.	6	14	2	22	C
Nephtys sp.			3	3	CB
Odontosyllis polycera Schmarda, 1861		1		1	C
N.squamosa Ehlers, 1887	16	3		19	CB
Spermosyllis capensis Day, 1953		1		1	C
Ceratonereis excisa Grube, 1874			1	1	CS
Sphaerosyllis sp.	1			1	C
Neanthes sp.		2	3	5	CS
Syllis (Syllis) gracilis Grube, 1840		2		2	C
N.bruaca Lana, 1987	1	27	12	40	CS
S.(Syllis) spongicola Grube, 1855		1		1	C
Nereis sp.1		20		20	CS
Loimia medusa (Savigny 1818)		1		1	S
Nereis sp.2		25		25	CS
Terebellides anguicomus (F. Muller, 1858)		1		1	S
Platynereis sp.		4		4	CS
Diopatra sp.		2	17	19	C
Total of individuals	**86**	**447**	**332**	**865**	
Species number / Sediment types	**34**	**63**	**31**	**82**	

FTD=Functional trophic groups, MS=Mixed sands, CSG=Carbonate sands and gravels, CMS=Carbonate muddy sediments, C=Carnivorous, S=Surface deposit-feeders, B=Subsurface deposit-feeders, F=Suspension feeders.

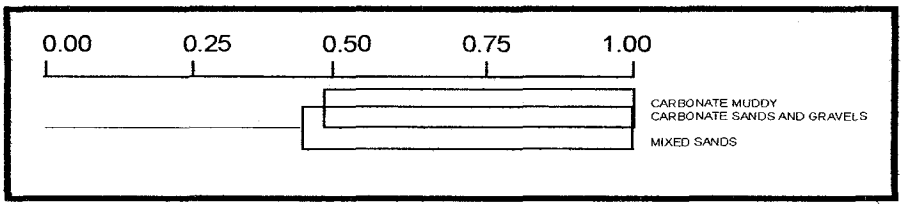

Fig. 2. Graphic representation of the polychaete fauna similarity at the marine substrates.

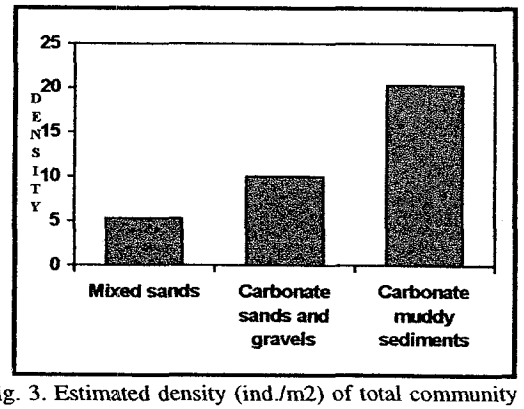

Fig. 3. Estimated density (ind./m2) of total community of polychaetes on the different types of substrata.

ate muddy sediments (Table 1).

DICE'S Index (qualitative analysis) revealed a 49% similarity between the communities from carbonate muddy substrate and carbonate sands and gravels, and among these and communities from mixed sands revealed a 45% similarity (Fig.2).

The density of the polychaete communities by type of substrate revealed the highest value in the carbonate muddy sediments with 20.3 ind./m^2. This value was followed by carbonate sands and gravel sediments with 10.0 ind./m=, and the lowest value was in mixed sands, 5.3

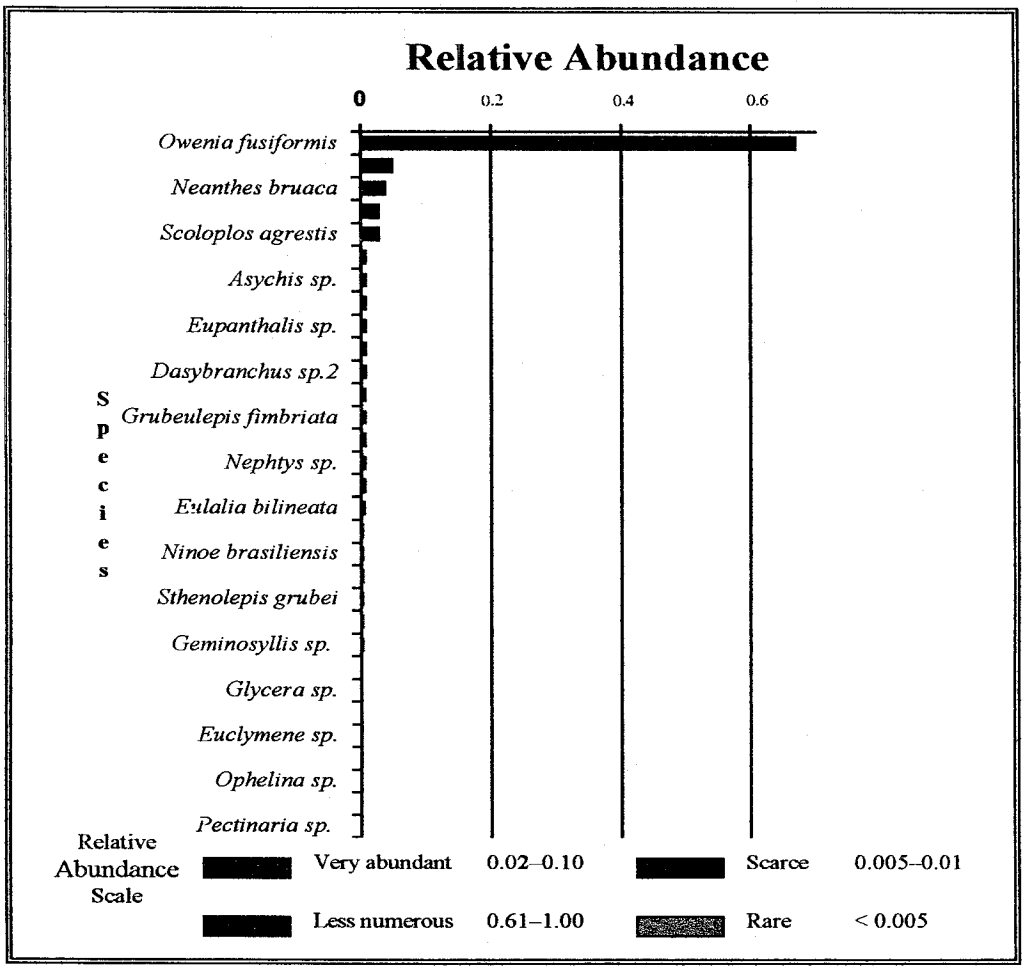

Fig. 4. Relative abundance of polychaete communities on carbonate muddy substrate.

TABLE 2

Sediment average physico-chemical parameters at different types of substrate

Types of substrate	Mixed sands	Carbonate sands and gravels	Carbonate muddy sediments
Granulometric analysis (%)			
gravel	1.00 – 30.00	14.00 – 68.50	0.00 – 2.75
sand	70.00 – 98.67	30.25 – 86.00	10.70 – 56.75
clay	0.00 – 0.50	0.00 – 3.00	43.00 – 89.33
Organic carbon (%)	0.69 – 0.86	1.11 – 2.98	2.48 – 6.38

ind./m≈ (Fig.3).

In terms of relative abundance, O. *fusiformis* was the only species classified as "very abundant" in carbonate muddy substrate, while among the remaining resting species, only *Eunice sp.2*, from carbonate sands and gravels and *Nephtys squamosa* from mixed sand sediments were recorded as "numerous". The rest were recorded as "less-numerous" and "rare". (Figs.4, 5 and 6).

The polychaetes from the study sites belong to three trophic groups: Detritivorous with 50%

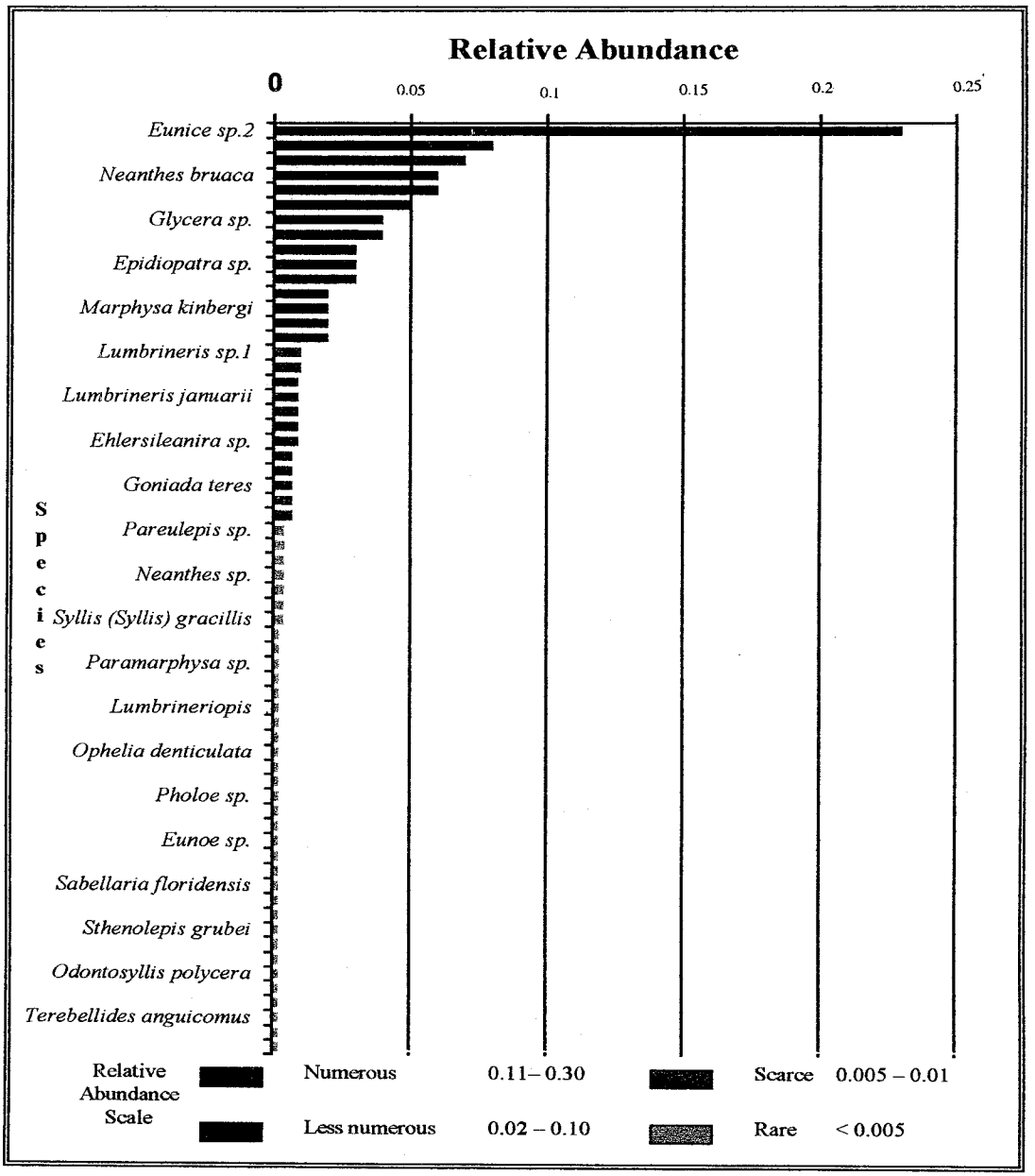

Fig. 5. Relative abundance of polychaete communities on carbonate sands and gravels substrate.

(27% surface deposit feeders and 23% subsurface deposit feeders); carnivorous 35%; and suspension feeders 15% (Fig.7). The surface deposit feeders dominated in the muddy sediments, which had the highest concentration of organic carbon (Table 2), with 43% of the individuals (Fig. 8). Subsurface deposit feeders had comparable percentage values in the mixed sands (34%) and in carbonate sands and gravel sediments (33%). The percent of species belonging to the carnivorous trophic level was 49% in the mixed sands, and 48% in carbonate sands and gravel substrates. Among the carnivorous species, 82% of the individuals were able

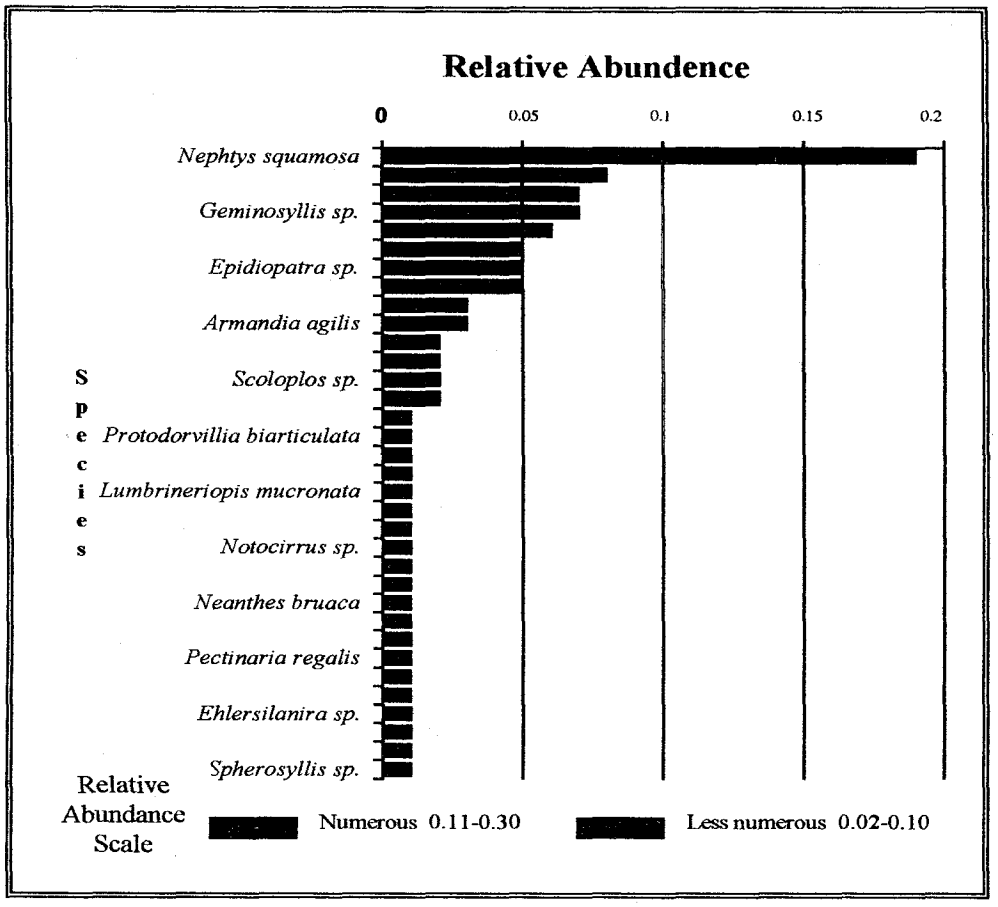

Fig. 6. Relative abundance of polychaete species communities on mixed sands substrate.

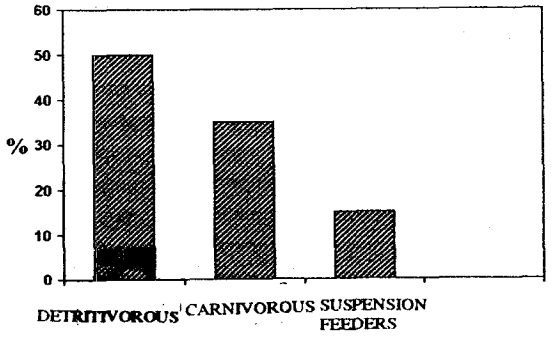

Fig. 7. Numerical distribution of the functional feeding groups in the studied site.

to use alternative strategies, either carnivorous or detritivorous, and only 18% were recorded as just carnivorous. The most abundant species in this group was *Eunice sp.2*. The suspension feeders were the least abundant group.

DISCUSSION

The low density recorded in this polychaete fauna is associated with the oligotrophic environmental characteristics (UFBA/CEPEMAR 1994, unpublished). Habitat differences of sediment structure related to local hydrological conditions determine the distribution of trophic groups and consequently of the community structure of the polychaetes (Morgado *et al.* 1994).

The degree of similarity was higher between the carbonate sands and gravels and carbonate muddy sediments.

The verification of the spatial variation of the polychaete communities on the different substrate types, corroborates with the differen-

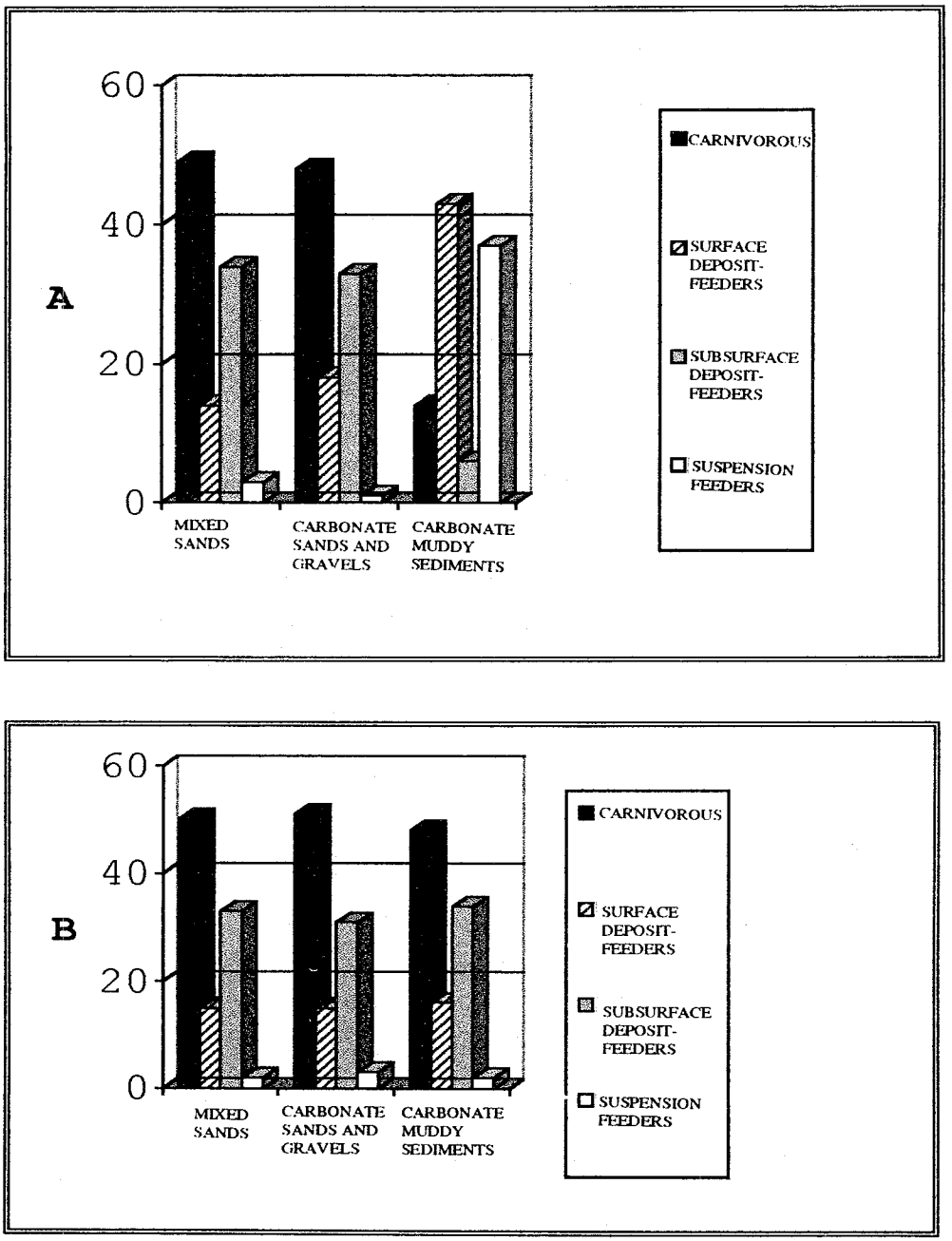

Fig. 8. Trophic groups distribution (A: % of individuals; B: % of species) along the different types of substrate.

tiated registration of the number of species. The maximun value was recorded in the carbonate muddy sediments, in which *O. fusiformis* had a significatively higher dominance than the other species. The sediments that occur to the south (down current) from one of the industrial outfalls, acumulate precipitated material as ferrosus sulphate (UFBA-CEPEMAR 1994, unpublished). The dominance of *O. fusiformis* over the other species may be associated with its capacity to enjoy the sediment at the water interface. According to Danuer (1983), species

that can use alternative strategies, like Oweniidae, as surface deposit feeders and suspension feeders, are able to live on sediments rich in organic material as well as on those with a high quantity of suspended material.

The density gradient, revealed by the relative abundance of the species recorded on the different substrate, is in accordance with the normal distribution of the abundances in the communities (Magurran 1989). The analysed carbonate sands and gravels and mixed sands are characterized by *Eunice* sp.2 and *N. squamosa,* as "numerous". The dominance of *O. fusiformis* in the mud sediments (Fig.4) corroborates with the interpretation of this species as opportunistic along the northern part of the coast of the State of Bahia.

Surface deposit feeders were dominant in carbonate muddy sediments because they can explore a wider resource spectrum in the sediment/water interface (Josefson 1986). Species which are able to use alternative strategies, such as *O. fusiformis* (either surface deposit feeding or suspension feeding), are able to use rich organic sediments as well as sediments with large amounts of suspended material.

According to Gaston (1987), subsurface deposit feeders are usually associated with very fine sediment particles rich in organic material. Nevertheless, in this study these polychaetes were less numerous in very fine sand and abundant in other types of sediments. Similar observations were reported by Morgado *et al.* (1994) along sandy beaches of São Sebastião Island (southern Brazil).

The greater relative abundance of carnivorous polychaetes in coarser sediments is related to substrate physical characteristics . Many of the intertidal carnivorous polychaetes are small, depending on size of the sediment interstices for easier locomotion and prey capture (Gaston 1987). But in this study the majority of carnivorous species probably were able to use alternative strategies, either carnivorous or detritivorous, revealing that these organisms also use the sediments for feeding. According to López and Levinton (1987) possible food sources include organic debris and microbes.

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RESUMEN

Fueron examinados muestras de sedimentos del fondo marino entre los 10 y 60 m de profundidad, en un área de 200 km^2 aproximadamente, de construcciones arrecifales coral-algal en la costa Norte del Estado da Bahía, Brasil. La composición y distribución de la fauna de poliquetos fue clasificada en niveles tróficos distintos para cada tipo de sedimento analizado: arenas mixtas, arenas carbonáticas y guijos y limo carbonado. Fue registrada una alta diversidad de especies en las arenas carbonáticas y guijos. El Índice de Similitud de Dice indicó una identidad más alta entre las especies de arenas y guijos y las de limo carbonado. Los gusanos detritívoros fue el grupo dominante. Los depositívoros de la superfície resultaron más abundantes en sedimentos limosos que contenían porcentajes más altos de carbono orgánico; en cuanto a los poliquetos depositívoros de la subsuperfície y carnívoros presentaron una abundancia relativa más alta en las arenas mixtas, carbonáticas y guijos. Los suspensívoros resultaron menos abundantes y su incidencia en substratos carbonáticos limosos estuvo asociada con la alta abundancia de *Owenia fusiformis.*

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