BOLETIM DO MUSEU NACIONAL
NOVA SÉRIE
RIO DE JANEIRO - BRASIL

ISSN 0080-312X

ZOOLOGIA N° 494 07 DE NOVEMBRO DE 2002

POLYCHAETES TROPHIC STRUCTURE IN TODOS OS SANTOS BAY (BA-BRAZIL) (1)

(With 5 figures)

RÔMULO BARROSO (2)(3)
PAULO C. PAIVA(2)(4)
ORANE F. S. ALVES (5)

ABSTRACT: The trophic structure of polychaetes was studied between March 1997 and May 1997 in Todos os Santos Bay. Thirty two survey stations were sampled with a van-Veen grab. A total of 1802 individuals (39 families) was recorded and grouped into 5 trophic groups. Deposit-feeders (represented by surface deposit-feeders and subsurface deposit-feeders) were the dominant group, followed by carnivores. Suspension-feeders and omnivores were less frequent. The dependence of trophic groups on environmental variables was estimated by means of a stepwise multiple regression analysis. The trophic groups were related to sediment type and depth. Carnivores were positively correlated to coarse sediments, being more abundant in the southwestern region of the bay. Suspension-feeders were positively correlated to gravel and depth. This correlation seems to be associated to the fixation of these animals in such substract, since most suspension-feeders are tubiculous species, and to the lower hydrodinamism of greater depths that facilitates the feeding process of such species.

Key-words: Polychaeta, trophic groups, trophic structure, Todos os Santos Bay, Brazil.

RESUMO:Estrutura trófica dos anelídeos poliquetas da Baía de Todos os Santos (BA-Brasil).

A estrutura trófica dos anelídeos poliquetas da Baía de Todos os Santos foi estudada no período de março a maio de 1997. As coletas foram feitas com um busca fundo do tipo van-Veen em 32 estações oceanográficas. Um total de 1802 indivíduos pertencentes a 39 famílias foram identificados. Os grupos tróficos mais abundantes foram os depositívoros, representados pelos de superfície e pelos de subsuperfície, seguido pelos carnívoros. Os onívoros e suspensívoros foram pouco comuns. A relação de dependência entre os grupos tróficos e as variáveis ambientais foi avaliada através de uma análise de regressão múltipla passo a passo. Houve correlação significativa dos grupos tróficos com os tipos de sedimento e com a profundidade. Os carnívoros ocorreram preferencialmente em sedimentos grossos e foram mais abundantes na região sudoeste da baía e os suspensívoros foram relacionados positivamente com a porcentagem de cascalho e com a profundidade. A relação dos suspensívoros com a porcentagem de cascalho possivelmente se deve ao fato da maior parte desses animais serem tubícolas, necessitando deste substrato para a fixação, e a relação com a profundidade pode ser explicada pelo baixo hidrodinamismo de profundidades maiores, o qual quando muito intenso, inviabiliza a captura de alimento por esses organismos.

Palavras-chave: Polychaeta, grupos tróficos, estrutura trófica, Baía de Todos os Santos, Brasil.

---

[1] Received on April 15, 2002. Accepted on July 15, 2002.

[2] Universidade Federal do Rio de Janeiro, Departamento. de Zoologia, IB, CCS, Bl. A, Ilha do Fundão, 21941-590, Rio de Janeiro, RJ, Brasil.

[3] Research Fellow of Conselho Nacional de Desenvolvimento Científco e Tecnológico (CNPq).

[4] Programa de Pós-Graduação em Ciências Biológicas/Zoologia, Museu Nacional/UFRJ. Quinta da Boa Vista; São Cristóvão, 20940-040, Rio de Janeiro, RJ, Brasil.

[5] Research Fellow of PICDT, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

INTRODUCTION

Structural analysis of benthic community is an important tool to describe changes in space, with applications on point source pollution monitoring, and in time, including the descriptions of changes in system health. (HEIP, 1992). Moreover, such analysis is one of the most parsimonious ways to evaluate energy flow in marine ecosystems (PAIVA, 1994).

Polychaete worms play a critical role in the macrobenthic productivity of continental shelves (KNOX, 1977) and their multiple feeding types allow for an evaluation of the macrobenthic trophic structure using only this taxon (GAMBI, GIANGRANDE & FRESI, 1982; BIANCHI & MORRI, 1985). Distributional patterns of polychaetes trophic groups have been proved to be sensitive to several factors including environmental disturbances, food supply, sediment type, anthropogenic effects and hydrodynamic conditions (SANDERS, 1958; LEVINTON, 1972; PROBERT, 1984; GASTON, 1987; GASTON & NASCI, 1988; PAIVA, 1994; MUNIZ & PIRES-VANIN, 1999; RUTA, 2001).

This trophic group approach was improved for the polychaetes with the establishment of the "feeding guild" concept by FAUCHALD & JUMARS (1979). Afterwards, DAUER, MAYBURY & EWING (1981) and GASTON (1987) amended this classification for some families, however the general pattern was maintained.

The aim of this paper is to describe the spatial distribution patterns of polychaete trophic groups in Todos os Santos Bay, and their dependence to some environmental variables.

STUDY AREA

Todos os Santos Bay is a depositional marine system, with many estuarine areas close to the rivers mouths (SOUZA, 1996). This Bay is the largest in Brazil, located in the northeastern coast in the State of Bahia (12°35'30"-13°07'30"S and 38°29'00"-38°40'00"W). It has an area of ca. 1.100km^2 and is surrounded by a coastline of ca. 200km reaching 32km in width. In most parts of the bay, the bottom is relatively flat, with depths ranging from 2 to 10 meters. The deepest region of the bay reaching approximately 50 meters, is in the Itaparica-Salvador channel (MACEDO, 1977). Geomorphology, geology, climate, vegetation and hydrographical condition aspects have also been studied by MACEDO (op. cit). A detailed study about sedimentation on the bay has been conducted by BITTENCOURT, FERREIRA & NAPOLI (1976), the oceanography by WOLGEMUTH *et al.* (1981) and the effects of petroleum and its derivates in benthic communities by PESO-AGUIAR *et al.* (2000).

This important water body has been subjected to strong human actions such as, fishing activities, tourism, the use for navigation for commercial and industrial production transport (SILVA *et. al.* 1996), urban sewage disposal, portuarie activities, bottom mining and channel dredging. These activities can cause different impacts on marine communities (GERMEN/UFBA - NIMA, 1997).

MATERIAL AND METHODS

Samples were taken between March and May 1997 in 32 survey stations, with 3 replicates for faunistic analysis and 1 for sedimentary analysis. The study region was divided in 6 regions according to its geomorphological characteristics. The stations location were: 5 stations in northwestern region (N1, N2,...), 6 in central region (C1, C2, ...), 4 in northeastern region, between the Madre de Deus and Mare Islands (M1, M2,...), 5 in southwestern region, between Itaparica Island and western coast (I1,I2,...), 7 in southeastern region, between Itaparica Island and Salvador city (S1,S2,...) and 5 in the adjacent shelf (P1, P2,...) (Fig.1).

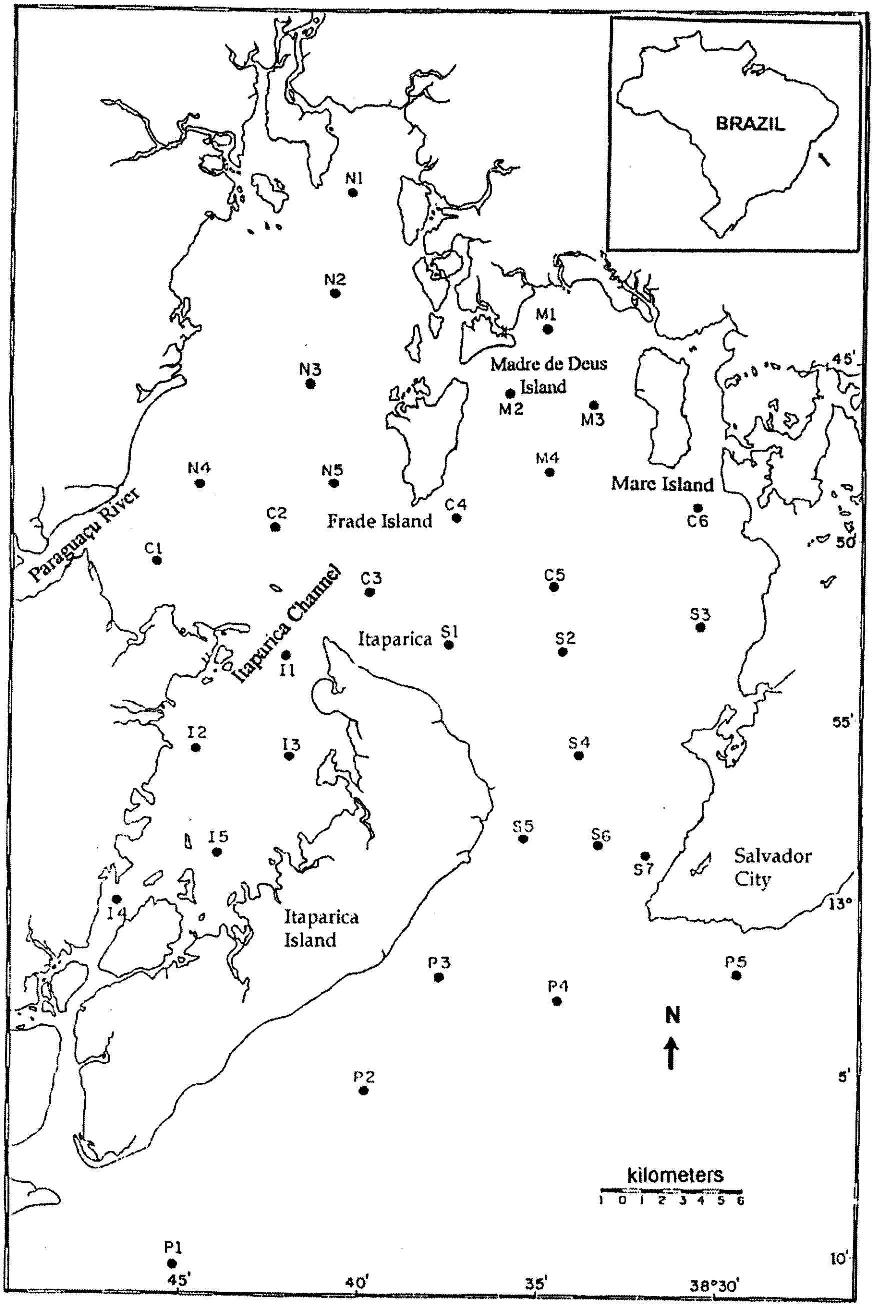

Fig. 1- Map of the study area with the 6 regions and 32 sampling stations.

All replicate samples were taken with a $0.1m^2$ van-Veen grab. The sediment collected was washed through a 1.0mm mesh sieve and the material retained was preserved in a 5% buffered formalin solution before sorting and identification, at family level, in the laboratory.

Hydrographic data were obtained using Nansen bottles with reversing thermometers. The salinity was measured using an refratometer and the dissolved oxygen content was determined by the Winkler titration method. The sediment was submitted to the standard dry-sieve pipette method described in SUGUIO (1973).

Families classification into feeding guilds was based on FAUCHALD & JUMARS (1979) and GASTON (1987). Five trophic groups were considered: carnivores, surface deposit-feeders, subsurface deposit-feeders, suspension-feeders and omnivores. Families classified into two trophic groups were included in both.

The ecological importance of each trophic group in the sampling stations was evaluated using a Trophic Importance Index, adapted from PAIVA (1994).

$$TII = \sum_{i=1}^{s} \ln ni + 1 \quad \text{where,}$$

s = number of families of the trophic group in the sample.
ni = number of individuals of the 1^{th} family in the sample.
ln = natural logarithm.

The dependence of trophic groups on environmental variables was estimated by means of a stepwise multiple regression analysis (LEGENDRE & LEGENDRE, 1983), with a significance level of 0.05.

Differences of Importance Index of each trophic group (carnivores, surface deposit-feeders, subsurface deposit-feeders, suspension-feeders and omnivores) among regions in the bay were assessed by means of an Analysis of Variance (ANOVA) with unequal replication and a post-hoc Tukey test (ZAR, 1996).

RESULTS AND DISCUSSION

Classification of families in trophic groups is presented in table 1, as well as their density in each sampling station. The most abundant trophic groups at Todos os Santos Bay were the deposit-feeders, represented by surface and subsurface deposit-feeders. For the surface-deposit feeders, Spionidae was the most abundant family. Some authors consider this family as an interface-feeder, owing to its capability of changing its feeding behavior according to hydrodynamic conditions (DAUER, MAYBURY & EWING, 1981). For the subsurface-deposit feeders group, the most abundant species were *Notomastus lobatus* Hartman, 1947 (Capitellidae) and *Sternaspis capillata* Nonato, 1966 (Sternaspidae). The second most abundant trophic group was the carnivores, represented mainly by Syllidae and Polynoidae species. The omnivores and suspension feeders were not abundant in the samples. The fact that the deposit feeders were the most important group was also found by PAIVA, (1994); MUNIZ, SUMIDA & PIRES-VANIN (1998) and RUTA (2001), thus, this seems to be a common pattern in studies of polychaetes trophic structure in the southern Brazilian continental shelf.

TABLE 1

Density (ind./ 0.3 m²) of polychaete families in each station and their trophic groups

Families/station	N1	N2	N3	N4	N5	M1	M2	M3	M4	C1	C2	C3	C4	C5	C6	I1	I2	I3	I4	I5	S1	S2	S3	S4	S5	S6	S7	P1	P2	P3	P4	P5	T.G.
Polynoidae		2	1		2	2	20	3	2	1	2	2	4			3	7		7	4	2	1	1						3				C
Polyodontidae																1	2								1								C
Pholoididae																						1	2										C
Sigalionidae	1	1					3	2				2	4		1			1		1		2		1	1							1	C
Chrysopetalidae																													1				C
Eulepethidae																1															3	2	C
Amphinomidae																								1									C
Phyllodocidae	1									1			2			4		3					1					1			1		C/B
Hesionidae																				2													C
Pilargidae							1		1		2					1					1							3					C
Syllidae	1							3						2		26	13			34				43	1	33			126	5			C
Nereididae							4	5			1		2			1	3		5	4	1							1	14	5		6	O
Nephtyidae																1					1			2		1					1	1	C/B
Goniadidae								2				2							1					2	4	4		1		4	4		C
Glyceridae																								1	5	1	9			5		1	C/B
Onuphidae							1	1				1				27				2		3								13		9	C/S
Eunicidae							1								1	2	4			5									8			1	C
Lumbrineridae							3					1				37	1		1										4	4	3	3	C/B
Lysaretidae								3									2		1	3				7						1		C/S
Dorvilleidae																	8									1					1		C/S

continued

conclusion

Families/station:	N1	N2	N3	N4	N5	M1	M2	M3	M4	C1	C2	C3	C4	C5	C6	I1	I2	I3	I4	I5	S1	S2	S3	S4	S5	S6	S7	P1	P2	P3	P4	P5	T.G.
Orbiniidae	1						1	5	1			1	2			4	7		7	4	3	3					1			3		7	B
Paraonidae							2	1								1	4		1		1											1	S
Spionidae	14	2					8		1		4	2	10			9	37		5	18	2	13	5	6		4	1		2	6		28	S/F
Magelonidae	2						2	1		1	1	1				2	7			1	2					1	2	5		2	1	9	S
Poecilochaetidae					1			6	2						2					1	2		1							1		1	S
Cirratulidae					1		16	1		1		5	1			4			1	18	15	1								6		4	S
Flabelligeridae																2						4	3									1	S
Cossuridae																					1	1											B
Opheliidae							3	7			7	2				3	41			2	1	1			1	1	1					5	B
Sternaspidae	65	3					2			49	1	2				1	59			23		1										2	B
Capitellidae	5	6	5	6	12	1	2	25	4	16	15		2	8	2	6	3	5	3	5	7	7	4		4				1			6	B
Arenicolidae																						1											F/S
Maldanidae								9								11	44													12		12	B
Oweniidae																														3			S/F
Pectinariidae								1				1	1			3	1					2								1			B
Ampharetidae								1									3									1					7	4	S
Terebellidae								4								16	2			1		2				4	10		4	3		2	S
Trichobranchida							1						1		1	2	7			1		2										2	S
Sabellidae												1				1			1					3		1						1	F
Serpulidae																				1									2	1	1		F

(C) carnivores, (S) surface deposit-feeders, (B) subsurface deposit-feeders, (F) suspension-feeders and (O) omnivores.

The spatial distribution of trophic groups at different regions of the bay is presented in figure 2. Table 2 shows the differences thophic groups importance among regions assessed by the ANOVA and Tukey Test post-hoc. The omnivores were significantly more abundant in the shelf adjacent to the bay (region P) in relation to northwestern and southeastern regions (stations N and S), and the carnivores were significantly more abundant in southwestern region (region I) in relation to the bay's northwestern region (region N). The positive correlation between carnivores importance and coarse sediments is the probable explanation for the greatest abundance of this group in region I. The low abundance of carnivores in region N was probably due to the fact that the muddy sediments dominated this depositional region (mainly clay), and the carnivores showed a preference by coarse sediments as will be seen below.

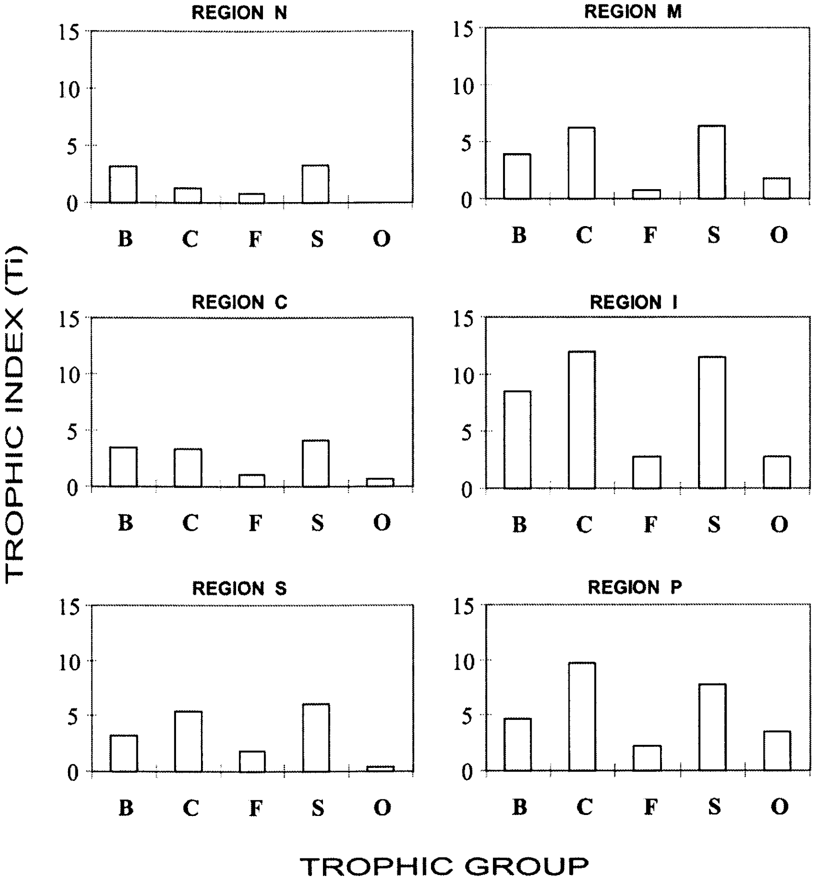

Fig.2- Trophic Importance Index of each trophic group for regions at Todos os Santos Bay. (C) carnivores, (S) surface deposit-feeders, (B) subsurface deposit-feeders, (F) suspension-feeders, (O) omnivores.

TABLE 2

Tukey Test - Trophic groups and regions

Trophic Groups	Tukey Test
C	I > N
S	---
O	P > N = S
F	---
B	---

C) carnivores, (S) surface deposit-feeders, (B) subsurface deposit-feeders, (F) suspension-feeders and (O) omnivores.

Table 3 shows the relation of dependence trophic groups and environmental variables. The carnivores depended positively on the percentage of gravel and coarse sand, and negatively on the dissolved oxygen content. The positive correlation between the carnivores and coarse sediments has already been described in other studies (MAUER & LEATHEM, 1981; GASTON, 1987; MORGADO, 1988; MUNIZ, SUMIDA & PIRES-VANIN, 1998) and it might be due to the fact that the carnivorous species are motile with well-developed parapodia and locomotory bristles. In coarse sediments, and especially in gravel, syllids can move more easily through the sediment interstice, searching for preys. Other important carnivores, such as the polynoids can move easier on the sediment surface due to the stability of coarser sand grains (personal observation).

TABLE 3

Variables selected (0,05 significance level) in the regression model for each trophic group. Significant positive correlation (+), Significant negative correlation (-)

Independent variables	C	S	B	F	O
Gravel (%)	+			+	+
Mud (%)			–	–	
Fine Sand (%)				–	+
Very Fine Sand (%)				–	
Coarse Sand (%)	+	+			
Very Coarse Sand (%)					
Sorting Coeficient (phi)			+	–	
Oxygen Content (mg/l)	–				
Depth (m)				+	

(C) carnivores, (S) surface deposit-feeders, (B) subsurface deposit-feeders, (F) suspension-feeders and (O) omnivores.

Surface deposit-feeders were positively related to the percentage of coarse sand, as also found by MUNIZ & PIRES (1999). Conversely, FAUCHALD & JUMARS (1979) pointed out that this trophic group has been associated with fine-grained sediment in the literature. Such results are probably due to the fact that owenids and spionids were considered in this work as surface deposit-feeders and also as suspension-feeders, which were usually associated with coarser sediments. Subsurface deposit-feeders were positively related to the sorting coefficient (*i.e.*, they prefer more heterogeneous sediments) and negatively related to the percentage of mud, the opposite of what was expected for deposit-feeders in general (SANDERS, 1958; GRAY, 1981; GAMBI & GIANGRANDE, 1985). Such pattern is difficult to explain, mainly without a more detailed analysis of the pattern of vertical distribution of the sediments, since in the sediment analysis, different horizons of sediment could be mixed, not reflecting the actual position of sediment grains and animals.

Suspension feeders were positively related to the percentage of pebble and negatively related to the percentage of fine sand, very fine sand and mud, and positively related to depth. The relationship of this group to percentage of pebble and their negative correlation with fine sediments (fine sand, very fine sand and mud), instead of found by MUNIZ, SUMIDA & PIRES-VANIN, (1998), could have happened due to the fact that sabellids and serpulids needs hard substratum for their tubes fixation.

The positive correlation with depth, also found by MUNIZ & PIRES-VANIN (1999), can be explained by the low hydrodynamism of greater depths that when very intense, it disables food capture by these organisms, causing obstruction in their filter-feeding structures (SANDERS, 1958), therefore sessility is generally associated with less dynamic, more stable sedimentary conditions encountered in deeper water. (MAUER & LEATHEM, 1981). The suspension-feeders showed a homogeneous distribution pattern all around the bay, except for region N in the northwestern part of the bay, where they were less frequently found, since it is composed of shallow stations covered mainly by clay.

The omnivores were positively related to pebbles and fine sand. Distributional patterns of this group are difficult to explain, as observed by PAIVA (1994), probably because of their great feeding plasticity and the difficult classification of the animals in this group without any observation of their stomach contents. The relationship of omnivores with environmental variables is a problem yet to be solved in further researches.

The present work showed how complex is the polychaete trophic structure of the ecosystem of Todos os Santos Bay. Such complex structure is likely to occur due to variability of the Bay environment concerning oceanography, geomorphology and human impacts.

ACKNOWLEDGMENTS

The senior author is grateful to Afonso Leal (UFRJ) and Carla Zilberberg (UFRJ), for helping with the English version. Many thanks to Joana Zanol (Smithsonian Institution) and Alejandro Echeverría (UFRJ), for suggestions on earlier drafts; Leila Pessoa (UFRJ) and Denise Nascimento (MNRJ), for valuable colaboration. Financial support was provided by World Wildlife Found (WWF-Brasil), Process: 085-97.

LITERATURE CITED

BIANCHI, C.N. & MORRI, C., 1985 – I policheti como descrittori della struttura trofica degli ecosistemi marini. **Oebalia**, Taranto, **11**:203-214.

BITTENCOURT, A.C.S.P.; FERREIRA, Y.A. & DI-NAPOLI, E., 1976 - Alguns aspectos da sedimentação na Baía de Todos os Santos, Bahia. **Revista Brasileira de Geociências**, São Paulo, **6**:246-263.

DAUER, D. M.; MAYBURY C.A. & EWING R.M., 1981 - Feeding behavior and general ecology of several spionid polychaetes from the Chesapeake Bay. **Journal of Experimental Marine Biology and Ecology**, Amsterdan, 54:21-38.

FAUCHALD, K. & JUMARS P.A., 1979 - The diet of worms: a study of polychaete feeding guilds. **Oceanography and Marine Biology Annual Review**, London, **1**:193-284.

GAMBI, M.C. & GIANGRANDE, A., 1985 - Caractterizzazione e distribuzione dele categorie trofiche dei policheti nei fondi mobili del golfo di Salerno. **Oebalia**, Taranto, **11**:223-240.

GAMBI, M.C.; GIANGRANDE, A. & FRESI E., 1982 - Gruppi trofici dei policheti di fondo mobili: um esempio alla fosse del Tevere. **Bolletino dei Musei e degli Istituti Biologici della Universita di Genova**, Genova, **50**(suppl):202-207.

GASTON, G.R., 1987 - Benthic polychaeta of the Middle Atlantic Bight: feeding and distribution. **Marine Ecology Progress Series**, Berlin, **36**:251-262.

GASTON, G.R. & NASCI J.C., 1988 - Estuarine macrobentos in Calcasieu Lake, Louisiana: community and trophic struture. **Estuaries**, Lawrence, **11**:201-211.

GERMEN/UFBA-NIMA, 1997 - **Baía de Todos os Santos: diagnóstico sócio-ambiental e subsísdios para a gestão**. Salvador: Edições Germen. 244p.

GRAY, J.S., 1981 - **The ecology of marine sediments**. London: Cambridge University Press. 185p.

HEIP, C., 1992 - Benthic Studies: Summary and conclusions. **Marine Ecology Progress Series**, Berlin, **91**:265-269.

KNOX, G.A., 1977 - The role of polychaetes in benthic soft-botton communities. In: REISH, D. & FAUCHALD, K. (Eds.) **Essays on Polychaetous Annelids in Memory of Dra. Olga Hartman**. Los Angeles: Allan Hancock Foundation. 547-604.

LEGENDRE, L. & LEGENDRE P., 1983 - **Numerical Ecology. Developments in Evironmental Modelling**. New York: Elsevier Sci. Publ. Company. v.3, 419p.

LEVINTON, J., 1972 - Stability and trophic struture in deposit-feeding and suspension-feeding communities. **American Naturalist**, Salem, **106**:472- 486.

MACEDO, M.H.F., 1977 - **Estudo Sedimentológico da Baía de Todos os Santos**. Salvador. 108p. Dissertação (Mestrado em Geologia), Instituto de Geociências, Universidade Federal da Bahia.

MAUER, D. & LEATHEM W., 1981 - Polychaete Feeding Guilds from Georges Banks, USA. **Mar. Biol.**, Berlin, **62**:161-171.

MORGADO, E.H., 1988 - **Anelídeos poliquetos do sublitoral da região de Ubatuba-SP, compreendida entre as ilhas Anchieta e Vitória**. Campinas, 181p. Tese (Doutorado em Zoologia). Universidade Estadual de Campinas, Instituto de Biologia, Campinas.

MUNIZ, P.M. & PIRES, A.M.S., 1999 - Trophic struture of polychaetes in São Sebastião Channel (southeastern Brazil). **Marine Biology**, Berlin, **134**:517-528

MUNIZ, P.M.; SUMIDA, P.Y.G. & PIRES-VANIN A.M.S., 1998 - Trophic struture of polychaetes in two bays of the Southeastern Brazilian Coast (Mar Virado and Fortaleza, Ubatuba, São Paulo). **Oebalia**, Taranto, **24**:39-53.

PAIVA, P.C., 1994 - Trophic struture of a shelf polychaete taxocoenosis in southern Brazil. **Cahiers de Biologie Marine**, Roscoff, **35**:497-512.

PESO-AGUIAR, M.C.; SMITH, D.H.; ASSIS, R.C.F.; SANTA-ISABEL, L.M.; PEIXINHO, S.; GOUVEIA, E.P.; ALMEIDA, T.C.A.; ANDRADE, W.S.; CARQUEIJA, C.R.G.; KELMO, F.; CARROZZO, G.; RODRIGUES, C.V.; CARVALHO, G.C. & JESUS, A.C.S., 2000 - Effects of petroleum and its derivatives in benthic communities at Baía de Todos os Santos/Todos os Santos Bay, Bahia, Brazil. **Aquatic Ecosystem Health and Management**, Burlington, **3**:459-470

PROBERT, P.K., 1984 - Disturbance, sediment stability, and trophic structure of soft-botton communities. **Journal of Marine Research**, New Haven, **42**:893-921.

RUTA, C., 2001 – **Distribuição espacial da estrutura trófica dos poliquetas em substrato não-consolidado ao laro da Praia Suja, Baía de Sepetiba, RJ**. Seropédica. 26p. Monografia (Bacharelado em Ciências Biológicas), Instituto de Biologia da Universidade Federal Rural do Rio de Janeiro.

SANDERS, H., 1958 – Benthic studies in Buzzards Bay: animal-sediment relationships. **Limnology and Oceanography**, Wako, **3**(3):245-258.

SILVA, E.M.; ACCIOLY, M.C.; NAVARRO, M.F.T. & CHASTINET, C., 1996 – Baía de Todos os Santos: situação atual e perspectivas futuras. **Revista de Economia do Nordeste**, Fortaleza, **27**(2):207-232.

SOUZA, F.B.C., 1996 – Briozoários como componentes das fácies sedimentares da Baía de Todos os Santos. CONGRESO BRASILEIRO DE GEOLOGIA, 39., Salvador. **Resumos...** p.263-265.

SUGUIO, K., 1973 – **Introdução à Sedimentologia**. São Paulo: Edgard Blücher, EDUSP. 318p.

ZAR, J.H. 1996 – **Biostatistical Analysis**. New Jersey: Prentice-Hall. 589p.

WOLGEMUTH, K.M.; BURNETT W.C. & MOURA P.L., 1981 – Oceanography and suspended material in Todos os Santos Bay. **Revista Brasileira de Geologia,** São Paulo, **11**(3):172-178.