

Trophic structure of a shelf polychaete taxocoenosis in southern Brazil

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Abstract : The distribution patterns of polychaete trophic groups were examined throughout a seasonal cycle of the continental shelf of São Paulo State in southern Brazil. Detritivores (subsurface deposit-feeders, surface deposit-feeders and suspension feeders) were the most important trophic group in the whole area. Subsurface deposit-feeders did not show any temporal variability. Surface deposit-feeders and suspension-feeders underwent pronounced shifts in importance, with higher values in the shallow stations during summer. This variability was probably due to storm-induced disturbances. Other processes such as predation and anthropic action seemed to be spread along the inner shelf. Distribution of trophic groups was related to temperature, CaCO₃ content and environmental stability (this being reflected on depth variability). A trophic group importance index is proposed to solve partially problems regarding trophic structure analysis.

Résumé : Le schéma de distribution des groupes trophiques des annélides polychètes au cours d'un cycle saisonnier a été mis en évidence sur la plate-forme continentale au large de l'état de São Paulo, côte sud du Brésil. Les détritivores constituent le groupe trophique le plus important dans l'aire étudiée. Parmi ceux-ci les déposivores de sous-surface ne montrent pas de variations liées à la saison. Par contre, les déposivores de surface et les suspensivores présentent des variations significatives ; les valeurs les plus élevées se mesurent dans les eaux les moins profondes lors des échantillonnages d'été. Cette variabilité semble se retrouver dans l'ensemble de la plate-forme interne. La distribution des groupes trophiques montre une relation avec la température, le taux de calcaire et les caractéristiques de l'environnement. Il est proposé un nouvel index d'importance pour les groupes trophiques afin de rendre plus aisée l'analyse de la structure trophique du macrobenthos.

INTRODUCTION

At the ecosystem level, studies that assess the main energy flows without requiring a more detailed analysis at the specific taxonomic level are desirable. This is specially so for marine tropical ecosystems, where the high biological diversity obscures the recognition of specific food webs responsible for the main part of the energy flow. Analysis of trophic structure of the benthos is one of the most parsimonious ways to evaluate the energy flow in marine ecosystems. The distribution patterns of trophic groups have been proved to be sensitive to several factors including environmental disturbances, food supply, sediment types and hydrodynamic conditions (Sanders, 1958 ; Levinton, 1972 ; Maurer & Leathem, 1981 ; Probert, 1984 ; Gaston, 1987 ; Gaston & Nasci, 1988).

Polychaete worms play a key role in the macrobenthic productivity of continental shelves (Knox, 1977) and their multiple feeding forms allow an evaluation of the macrobenthic trophic structure using only this taxon ; such studies are common in soft-bottom environments (Maurer & Leathem, 1981 ; Gambi *et al.*, 1982 ; Dauer, 1984 ; Bianchi & Morri, 1985).

The trophic group approach was improved for the polychaetes with the "feeding guild" concept established by Fauchald & Jumars (1979). This concept is more comprehensive than the previous classifications, since it also includes the motility and feeding strategies of the worm in the guild determination. Afterwards, Dauer *et al.* (1981) and Gaston (1987) amended this classification for some families, but maintained the general pattern. The feeding guild approach allows grouping different species with similar roles in the food webs, which work as "ecological units", and may replace species in functional studies.

In this paper, the feeding guild approach is applied to analyze the seasonal and spatial distribution pattern of polychaete worms in the Ubatuba region.

RESEARCH AREA AND STATIONS

The survey cruises were conducted on the continental shelf of São Paulo State, southern Brazil (23°25' to 24°22'S - 44°33' to 45°16'W) at a depth from 15 to 117 m. The whole area covers 3 800 km², and is characterized by an inbayed shoreline and by the presence of several islands in the inner shelf. On the southwestern part there is the large Sao Sebastião Island, isolated from the continent by a deep channel (50 m). According to Furtado & Mahiques (1990), the shelf bottom sediment of the survey area is made mainly of fine and very fine sand. Mud content is higher (> 40 %) close to the coast (20 m), near the 50 meters isobath and in the outer shelf below 100 m. The sand fraction prevails in the northern section comprising 80 to 90 % of the sediment. Deposition and resuspension account for the spatial heterogeneity of the sediment on the inner shelf and homogeneity on the outer.

The hydrographic conditions were studied by Emilsson (1961), Matsuura (1986) and Castro Filho *et al.* (1987). Three main water masses have been recognized : the Coastal Water (CW), the Tropical Water (TW) and the South Atlantic Central Water (SACW). The CW is restricted to shallow water (< 20 m) in summer, interacting with the TW in winter when they cover all the inner shelf. The SACW covers the outer shelf all year round, inflowing to the inner shelf during summer. Thus, the inner shelf has a large annual variability, with a strong thermocline at mid-depths (20 m) in summer and almost no stratification during winter.

The grid (Fig. 1) was composed of 9 stations on the inner shelf and 3 stations on the outer shelf, (northern, central and southern). The inner stations at approximately 20, 35 and 45 m depth, were sampled seasonally, whereas the outer stations, at approximately 50, 75 and 100 m depth, were sampled only in summer and winter. A total of 54 stations (36 in the inner and 18 in the outer shelf) were sampled from October 1985 to July 1986.

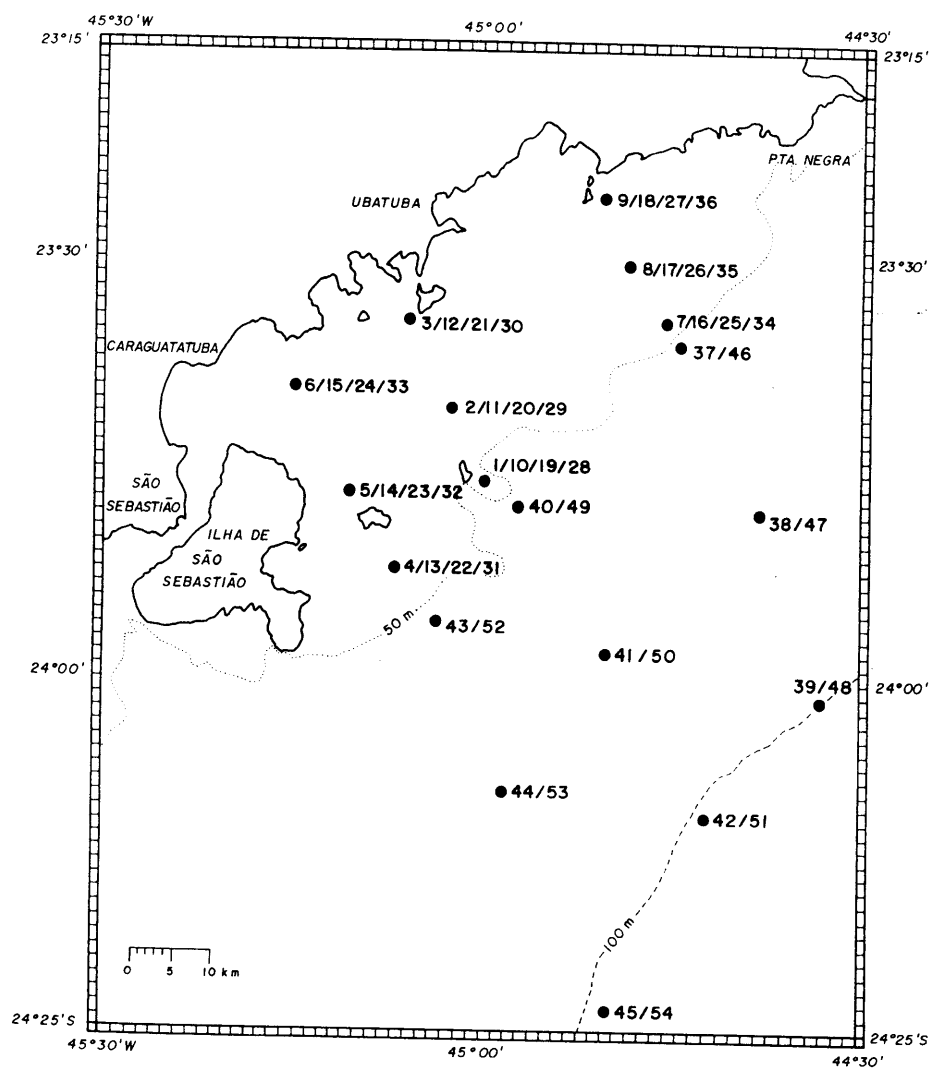


Fig. 1 : Studied area and Sampling stations.

MATERIAL AND METHODS

Samples were taken with a 0,1 m² Van-Veen grab. The sediment collected was washed through a 0,5 mm mesh sieve and the material retained was preserved in a 4 % buffered formalin solution before sorting and identification in the laboratory.

Hydrographic data were obtained using Nansen bottles with reversing thermometers. The salinity was measured using an inductive salinometer and the dissolved oxygen content

was determined by the Winkler titration method. The sediment was submitted to the standard dry-sieve and pipette method described in Suguio (1973). Four size classes were used in this study : mud, fine sand (from 0,0625 to 0,25 mm), medium sand (0,25 to 0,5 mm) and coarse sand (> 0,5 mm). the CaCO_3 content was obtained by HCl 10 % attack and the organic matter content by means of H_2O_2 oxidation.

The species 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. The species classified into two trophic groups were included in both.

To evaluate the degree of ecological importance of each trophic group in the sampling stations, a trophic group importance index (Ti) is proposed herein, expressed as :

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

s = number of species of the trophic group in the sample.

ni = number of individuals of the ith species in the sample.

ln = natural logarithm.

In this case the sampled area was 0,1 m² and no extrapolation was made, as the index will overestimate the density or the richness depending on the relation between sampling area and patch sizes.

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.

RESULTS

The importance of each trophic group in the stations is shown in figures 2 to 7 and the variables selected in the regression model are presented in table 1.

Detritivores, represented by surface deposit-feeders and subsurface deposit-feeders, were the dominant group, being followed by suspension-feeders and carnivores.

The surface deposit-feeders were represented by : *Spiophanes missionensis*, *Cirratulus filiformis*, *Paraprionospio pinnata*, *Owenia fusiformis*, *Amphicteis latibranchiata*, *Amphicteis gunneri* and *Polydora socialis*. Surface deposit-feeders were very common in the area, in spite of the low values in the spring sampling (10/85). During summer (12/85 and 01/86) they reached their greatest importance at depositional environments such as the 20 m stations and the southern transect on the inner shelf ; on the outer shelf they presented lower values, except for the high values of station 37 (50 m). In autumn samplings (04/86) the values decreased, only the southern transect stations having values higher than 10. The winter samples were similar to autumn ones in the inner shelf, maintaining higher values on the southern transect ; in the outer shelf, the values were similar to that observed in the

inner and also to those observed in the outer shelf during summer. The importance of surface deposit-feeders was inversely dependent on depth ($t = -2.07$).

TABLE I
Variables selected (0.05 significance level) in the regression model for each trophic group.

	Carnivores	Subsurface dep. feeders		Surface dep. feeders	Suspension feeders	Omnivores
Variables selected	—	Temp.	CaCO ₃	Depth	CaCO ₃	—
Coefficient	—	1,84	- 4,57	- 0,78	4,55	—
STD error	—	0,76	2,29	0,38	2,25	—
T - value	—	2,42	- 2,00	- 2,07	0,02	—
Sig. level	—	0,01	0,05	0,04	0,04	—

The carnivorous species were : *Harmothoe lunulata*, *Pionosyllis pectinata*, *Sigambra grubii*, *Parandalia americana*, *Kinbergonuphis orensanzi*, *K. difficilis*, *Lumbrineris cingulata*, *Goniada maculata*, *Glycinde multidentis* and *Glycera americana*. In spring, carnivores had low importance values, similar to the surface deposit-feeders, but during summer they were uniformly distributed on the inner shelf, while presenting lower values on the outer (except for station 37). In autumn and winter the index values were lower on the inner shelf, although this was the dominant trophic group in the winter. On the outer shelf the winter values were not different from the inner values and were higher than summer ones. Carnivores were not significantly dependent on any environmental variables.

The main subsurface deposit-feeding species were : *Euclymene dalesi*, *Cirrophorus americanus*, *Sternaspis capillata*, *Notomastus lobatus*, *Axiothella brasiliensis*, *Asychis brasiliensis*, *Aricidea (Acesta) simplex*, *Lumbriclymene noemia*, *Cirrophorus branchiatus* and *Levinsenia gracilis*. Subsurface deposit-feeders did not present importance values higher than 10. They were evenly distributed throughout the whole area with no seasonal variability such as shown by the other trophic groups. They presented dependence on temperature and inversely on CaCO₃ content.

The most important suspension-feeders in the area were *Chone insularis*, *Hydroides plateni* and *Owenia fusiformis* (also a surface deposit-feeder). The group was not very common in the area, except for some patches in coastal stations. They seldom presented importance values higher than 3. The group was almost absent during spring. In summer they reached their highest values at low depths (20 m) with some occurrences on the outer shelf (75 to 100 m). They were scarce in autumn and nearly absent during winter on the whole shelf. Their winter outer shelf values were similar to the summer ones.

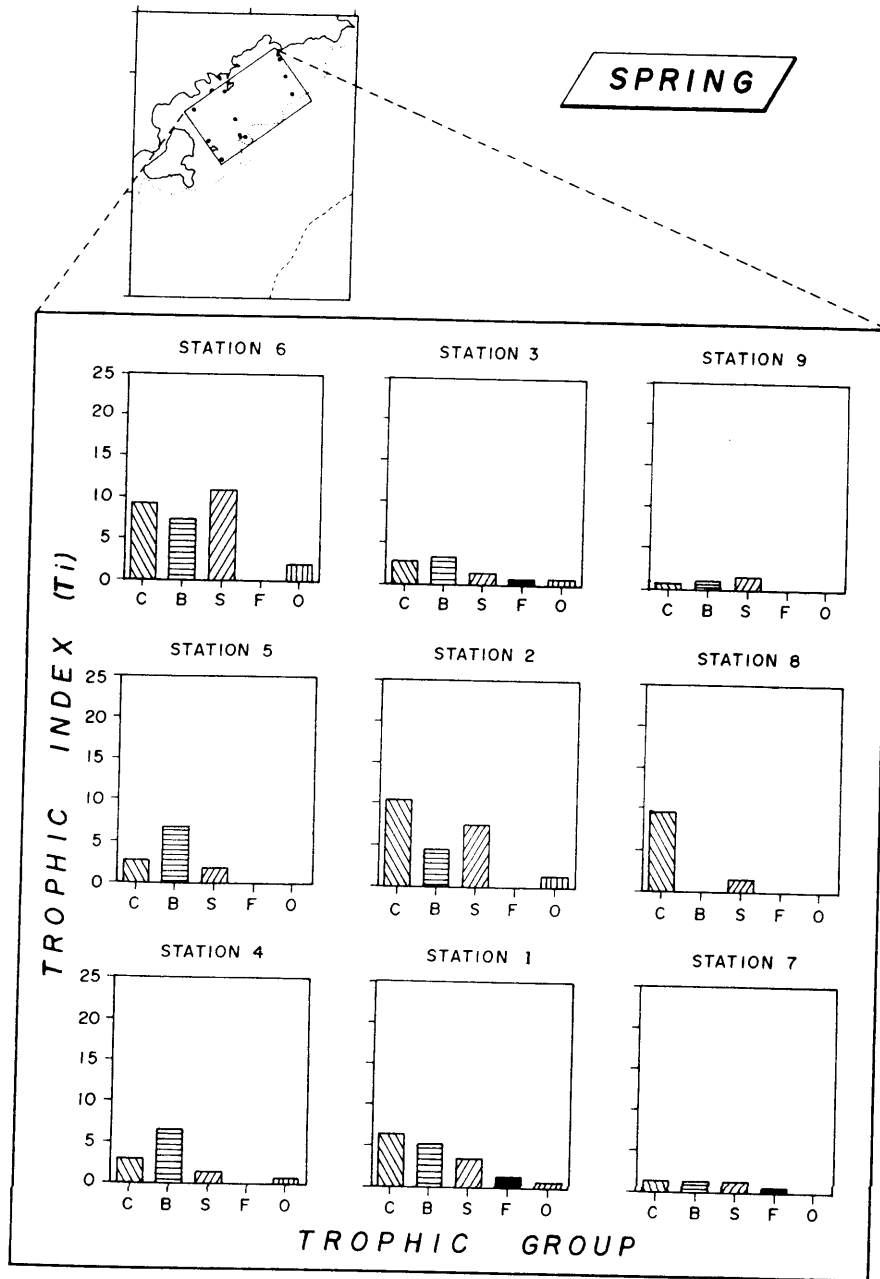


Fig. 2: Trophic Importance Index of each trophic group for sampling stations during Spring. (C = carnivores ; B = subsurface deposit-feeders ; S = surface deposit-feeders ; F = suspension-feeders ; O = omnivores).