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Trophic relationships between polychaetes and brachyuran crabs on the southeastern Brazilian coast

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Introduction

Polychaete annelids constitute an important feeding resource for several species of the benthic and demersal marine fauna. Their role in the energetic flow of marine ecosystems has been made evidenced by their contribution to the diet of fishes (Amaral & Migotto, 1980; Ben-Elihau *et al.*, 1983; Ben-Elihau & Golani, 1990; Amaral *et al.*, 1994) and crabs (Schembri, 1981; Le Calvez, 1984; 1987; Hall *et al.*, 1990).

The main difficulty when studying the diet of crabs is the identification of stomach contents to specific level. Nevertheless, concerning the polychaetes, the presence of certain structures which are more resistant to digestion, such as setae, uncini, hooks, mouthpieces and opercula, allows the determination to family level. The analysis at this level is justified by the great within-family homogeneity regarding the trophic group, position in the sediment and feeding strategies, all of which are in agreement with the concept of feeding guilds by Fauchald & Jumars (1979). The feeding guild approach has been demonstrated to be rather useful in trophic ecology studies (Maurer & Leathem, 1981; Bianchi & Morri, 1985; Paiva, 1993).

Considering that brachyuran crabs are the main megabenthic group (Sartor, 1989; Pires, 1992) and polychaetes the main macrobenthic group in the studied area (Paiva, 1990; Pires-Vanin, 1993), the knowledge of their interrelations are fundamental in order to understand the local trophic web.

Study area

This work is a part of an integrated investigation of a tropical coastal ecosystem carried out by the Oceanographic Institute of São Paulo University (IOUSP) in Ubatuba.

The survey cruises were conducted on the continental shelf of São Paulo State, southeastern Brazil (23°31' to 23°45'S - 44°58' to 45°06'W), with the research trawler "Veliger II", at depths ranging from 15 to 45 m (Fig. 1). The sediment of the study area is constituted mainly by fine and very fine sand (Furtado & Mahiques, 1990). Mud component, with a mean grain size in the coarse silt range is greater close to the coast (20 m) and near the 50 m isobath.

The hydrographic conditions of the area were studied by Emilsson (1961), Matsuura (1986) and Castro Filho *et al.* (1987). The inner shelf has a marked annual variability, with a strong thermocline at mid-depths (20 m) in summer and almost no stratification during winter.

Material and methods

Seasonal sampling at three depths: 15, 30 and 45 m (Fig. 1) was carried out by means of an otter-trawl of 6 m mouth width (Fig. 1), starting in the spring of 1985. Two additional samples were taken at 30 m in the summer and winter of 1987.

For this study, 6 species of brachyuran crabs (Table 1), belonging to 4 families, were selected owing to their abundance, biomass and frequency of occurrence in the area.

After collection, the crabs were stored in ice boxes and the stomachs were removed and fixed in 10% buffered formalin. The stomach contents were later analyzed in the laboratory, the presumed polychaete material was sorted and preserved in 70% alcohol for further identification, based on the presence of structures as setae, uncini, hooks, mouthpieces and opercula.

The contribution of polychaetes to the stomach contents was estimated through their frequency of occurrence and their feeding guilds were defined as: carnivores, suspension-feeders, motile subsurface deposit-feeders, sessile subsurface deposit-feeders, motile surface deposit-feeders and sessile surface deposit-feeders, according to the classification of Fauchald & Jumars (1979).

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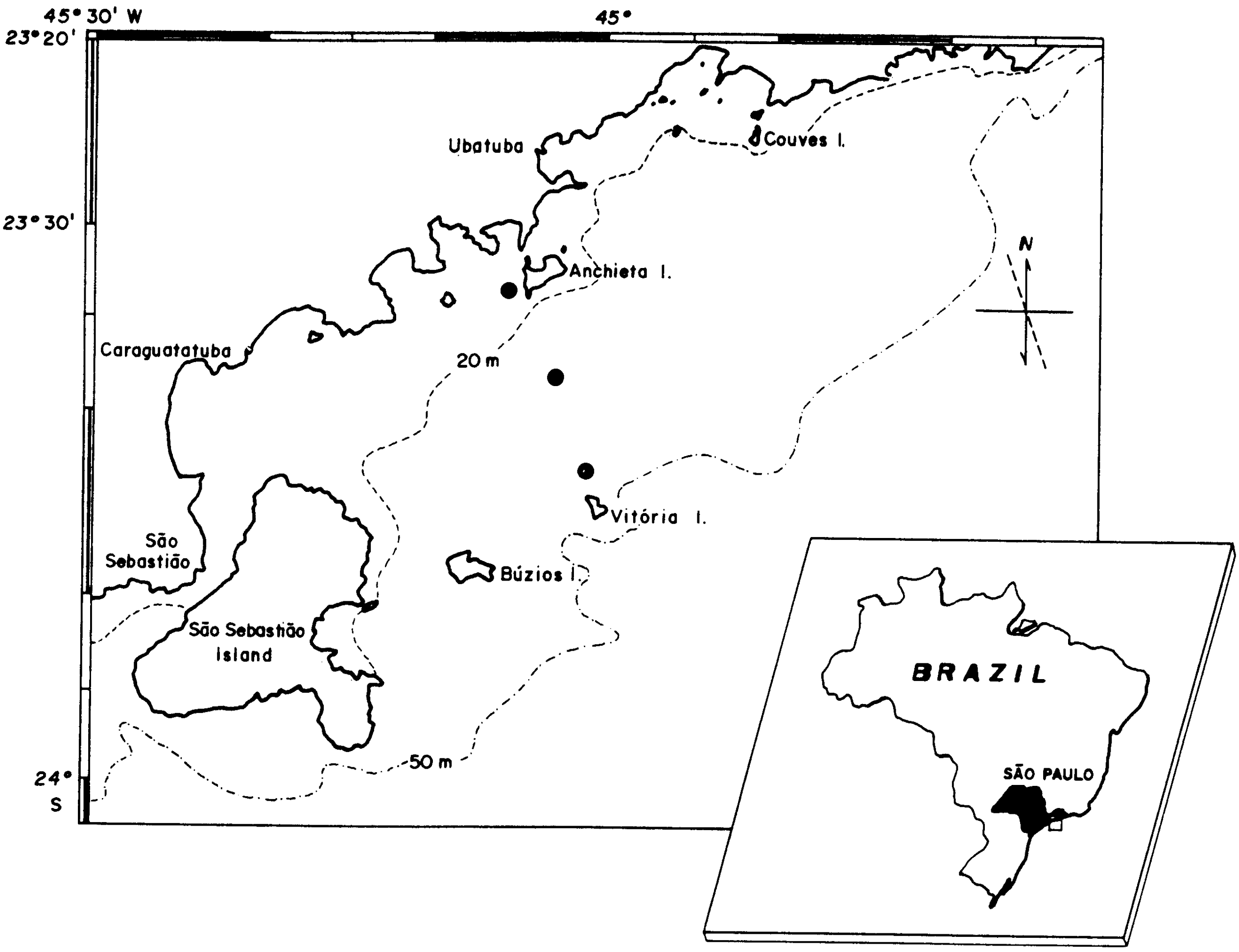

Fig. 1. Studied area and sampling stations (●).

Table 1. Number of stomachs of crabs with identifiable contents (1), number of stomachs with polychaetes (2) and their frequency of occurrence (3)

	(1)	(2)	(3)
Persephona mediterranea (Herbst, 1794)	142	114	80.3%
Libinia spinosa H. M. Edwards, 1834	409	128	31.3%
Portunus spinimanus (Latreille, 1819)	172	59	34.3%
Portunus spinicarpus (Stimpson, 1871)	90	17	18.9%
Callinectes ornatus Ordway, 1863	423	107	25.3%
Hepatus pudibundus (Herbst, 1785)	579	88	15.2%
Total	1815	513	28.3%

Results

The stomach contents of 2715 specimens from the 6 referred species were examined and only the stomachs with identifiable food items were considered. Table 1 shows the number of stomachs with identifiable preys for each species, the number of stomachs with polychaetes and their frequency of occurrence. In some cases, more than one polychaete family was found in a single stomach.

The frequency of occurrence of the polychaete families found in the brachyuran stomach contents and their feeding guilds are shown in Table 2. It was possible to determine 31 polychaete families. The most frequent families were Terebellidae, Capitellidae, Maldanidae, Onuphidae and other Eunicida, which could not be identified.

Table 2. Frequency of occurrence of the polychaete families found in the brachyuran stomach contents and their feeding guild

POLYCHAETA	BRACHYURAN SPECIES						TOTAL	FEEDING GUILD
	PEME	POSP	POSC	CAOR	LISP	HEPU		
Family Aphroditidae		2	2	3	4	1	12	CARNIVORE
Family Polynoidae	1		1	4	4	6	16	CARNIVORE
Family Polyodontidae					2	1	3	CARNIVORE
Family Sigalionidae		1	4	6		2	13	CARNIVORE
Family Phyllodocidae	1		1	1			3	CARNIVORE
Family Pilargidae			1	1	2	2	6	CARNIVORE
Family Syllidae			1				1	CARNIVORE
Family Nereididae		1		4	3	4	12	CARNIVORE
Family Nephtyidae	1					1	2	CARNIVORE
Family Glyceridae	2	4	1	2	4	1	14	CARNIVORE
* Family Onuphidae	11	3		6	2		22	CARNIVORE
* Family Eunicidae	1						1	CARNIVORE
* Family Lumbrineridae				2	1		3	CARNIVORE
* Family Arabellidae						1	1	CARNIVORE
* Family Dorvilleidae				1			1	CARNIVORE
Eunicida unidentified	17	3	2	12	10	9	53	CARNIVORE
Family Orbinidae		3		1	3		7	MOT. SUBSURF. DEP. FEEDER
Family Paraonidae	1						1	MOT. SURF. DEP. FEEDER
Family Poecilochaetidae	1				4		5	MOT. SURF. DEP. FEEDER
Family Chaetopteridae	3			1	5		9	SUSPENSION FEEDER
Family Flabelligeridae	1	2	1	2	1	5	12	MOT. SURF. DEP. FEEDER
Family Sternaspidae						1	1	MOT. SUBSURF. DEP. FEEDER
Family Capitellidae	32	1		5	2	10	50	MOT. SUBSURF. DEP. FEEDER
Family Maldanidae	18	1	2	7	11	5	44	SES. SUBSURF. DEP. FEEDER
Family Oweniidae	2						2	SUSPENSION FEEDER
Family Sabellariidae		7		1	4		12	SUSPENSION FEEDER
Family Pectinariidae		2		10	1	2	15	MOT. SUBSURF. DEP. FEEDER
Family Ampharetidae				1	1	1	3	SES. SURF. DEP. FEEDER
Family Terebellidae	5	22	2	5	18	6	58	SES. SURF. DEP. FEEDER
Family Trichobranchidae			1	1			2	SES. SURF. DEP. FEEDER
Family Sabellidae	2			1	4	1	8	SUSPENSION FEEDER
Family Serpulidae	1	9		2			12	SUSPENSION FEEDER
Unidentified	31	9	3	37	52	36	168	
TOTAL	131	70	22	116	138	95	572	

PEME - *Persephona mediterranea*
POSP - *Portunus spinimanus*
POSC - *Portunus spinicarpus*
CAOR - *Callinectes ornatus*
LISP - *Libinia spinosa*
HEPU - *Hepatus pudibundus*

* Eunicida families

As expected for soft sediments, there was a prevalence of deposit-feeding polychaetes, even though the proportion varied amongst species of Brachyura (Fig. 2).

In *P. mediterranea*, the subsurface deposit-feeders were responsible for 38% of the diet (Fig. 2) and the main families found were Capitellidae and Maldanidae (Table 2).

In *P. spinimanus*, the surface deposit-feeders (Terebellidae) and the suspension-feeders (Serpulidae) (Table 2) made up more than 50 % of the polychaetes found (Fig. 2).

In *P. spinicarpus*, the carnivores were responsible for 59% of the diet. Suspension-feeders were absent (Fig. 2; Table 2).

C. ornatus fed on carnivores (Eunicida) and subsurface deposit- feeders, mainly on the Pectinariidae (Fig. 2; Table 2).

L. spinosa fed on deposit-feeders, carnivores and suspension- feeders (Fig. 2). Amongst the deposit-feeders, a large part was represented by the surface sessile forms, mainly by the family Terebellidae (Table 2).

H. pudibundus fed on carnivores and deposit-feeders, both from surface and subsurface (Fig. 2).

There was a high occurrence of unidentified polychaetes (29 % of the total). This proportion varied from 13 to 38 %, amongst the brachyuran species (Fig. 2).

The comparison between the polychaetes present in the stomach contents of the studied crabs and those collected from the survey area is shown in Figure 3. Some families were only found in the area (Opheliidae, Magelonidae, Goniadidae, Cirratulidae and Spionidae) and others only found in the stomach contents (Aphroditidae, Polyodontidae, Chaetopteridae, Sabellariidae, Pectinariidae, Serpulidae and Ampharetidae).

Discussion

Polychaete annelids are very abundant in the inner shelf of Ubatuba coast, being represented by more than 150 species and reaching densities up to 250 individuals/m^2 (Morgado, 1988; Paiva, 1990).

They are an important item in the diet of brachyuran crabs, occurring approximately in 30% of the stomachs with identifiable contents. Using a feeding index, which is based on the frequency of occurrence of food items and on the percentage of each item in the total volume, Petti (1990) observed that for *P. mediterranea* and *P. spinimanus*, the polychaetes were one of the most important food items. *H. pudibundus*, *L. spinosa* and *C. ornatus*, however, showed ontogenetic changes in feeding habits, with the predominance of polychaetes only in the younger specimens.

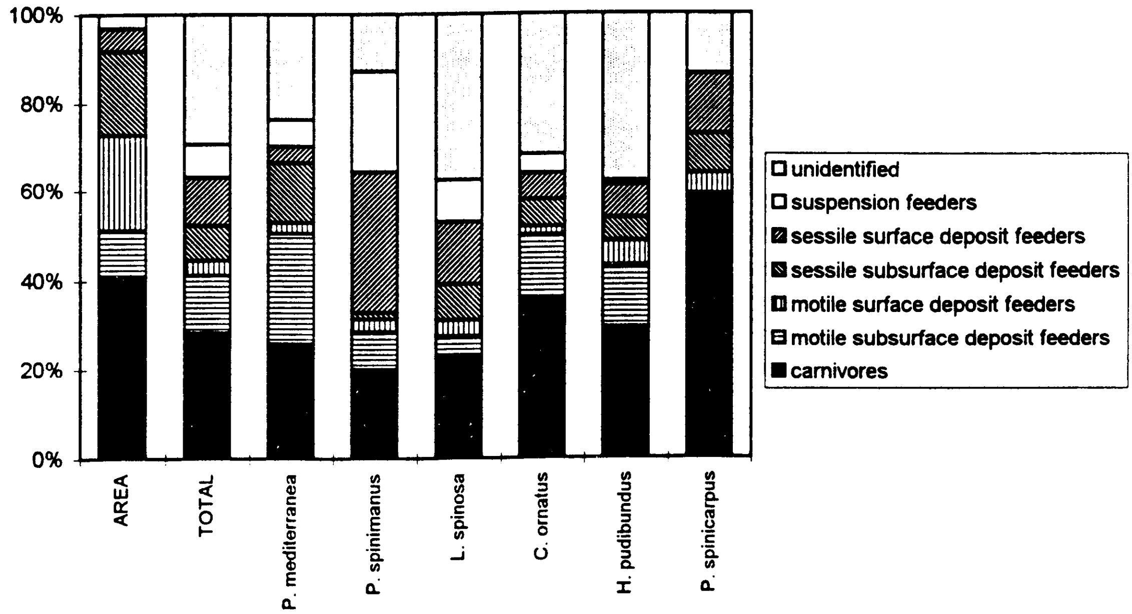

Fig. 2. Frequency of occurrence of polychaete groups in the diet of crabs and the percentage of density of each polychaete group in the area, according to Paiva (1990).

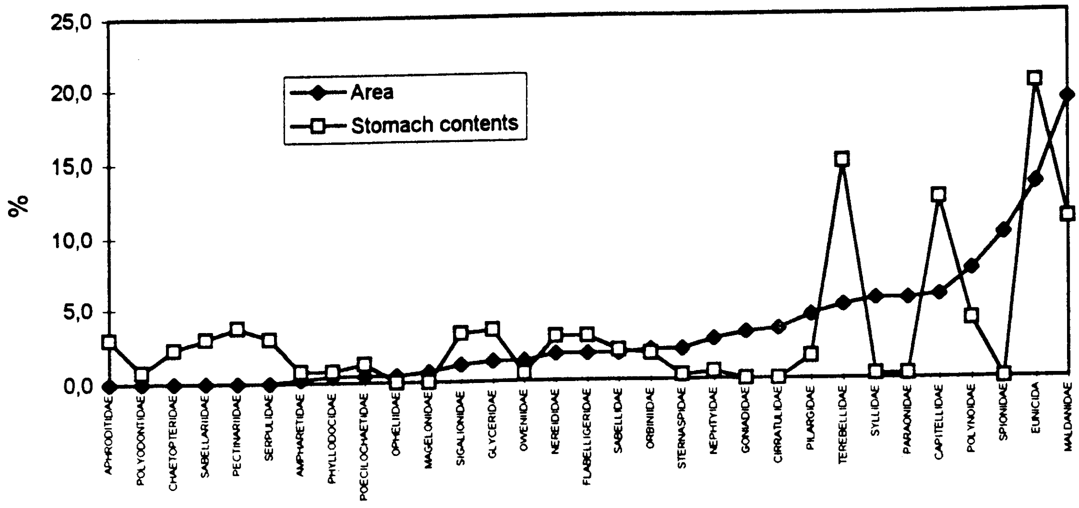

Fig. 3. Comparison between the density of the polychaete families found in the area (Paiva, 1990) and the frequency of occurrence of those found in the stomach contents of crabs.

Two main groups can be recognized regarding crab predation on polychaetes. *P. spinimanus* and *L. spinosa* feed mostly on surface animals such as sessile and motile deposit-feeders and suspension feeders, and do not appear to forage into the sediment. The other group encompasses those species which capture mainly carnivores or dig in search of subsurface species. They are active species such as *C. ornatus, P. mediterranea* and *H. pudibundus*, although the latter does not have polychaetes as an important component in its diet (Petti, 1990).

Observation in laboratory concerning the behavior of each brachyuran species when searching and catching the different preys could provide valuable information, allowing a better understanding of their feeding habits.

P. spinicarpus was unfortunately undersampled and, as a consequence, the results obtained for this species are unreliable. Owing to the great importance of this species in the area, mainly at depths greater than 50 m (Sartor, 1989; Pires, 1992), additional studies are required in order to establish its actual position in the local trophic web.

Emphasis must be placed on the great number of unidentified polychaetes which probably belong to some families also common in the area, such as Paraonidae, Magelonidae, Spionidae and Cirratulidae (Morgado, 1988; Paiva, 1990). Since these families have few structures resistant to digestion, which are reduced to simple setae and tiny uncini of difficult identification, the importance of their trophic group (deposit-feeders) in the diet of crabs is likely to be underestimated. The occurrence of these families in the diet of fishes studied in the same area (Amaral *et al.*, 1994) corroborates this observation. The identification of fish stomach content is normally based on entire animals and not on fragments or hard parts like those found on crabs.

The comparison between the polychaetes found in the stomach of the studied crabs and the actual polychaete fauna (Paiva, 1990) shows a feeding partitioning of the crab community through predation upon different polychaete families by different crabs. Their ability to feed on surface and subsurface polychaetes of different trophic groups was also observed by Le Calvez (1987) in the Rance estuary (France).

P. spinimanus, whose diet is based mainly on brachyuran and polychaetes (Petti, 1990), had the most selective diet concerning the polychaetes. This fact suggests a preference for some families rather than to others more available in the benthic community. All the other species, but *L. spinosa* showed higher affinities between the benthos and overall stomach contents of the crabs. They are less selective, eating the most abundant families in the area, such as Polynoidae, Maldanidae, Capitellidae and the Eunicida families.

The comparison between the contribution of polychaetes to the diet of crabs and fishes in the area showed differences concerning the feeding guilds. Some carnivores, such as Amphinomidae, Euphrosinidae and

Hesionidae were found only in fishes (Amaral *et al.*, 1994). Conversely, tubicolous suspension-feeder families as Serpulidae and Sabellariidae were common in crabs but absent in fishes. This indicates the greater capacity of crabs to feed on polychaetes of rather different habits.

In view of the information given hitherto and considering the importance of the detritic web in the survey area (Paiva, 1990; Pires-Vanin *et al.*, 1993), brachyuran crabs certainly have a key role in the energy transfer, linking the sediment communities to the higher trophic levels.

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