COMPOSITION AND SEASONAL VARIATIONS OF THE BRACHYURAN CRABS (CRUSTACEA, DECAPODA) LIVING ON *Sargassum cymosum* IN THE UBATUBA REGION, SÃO PAULO, BRAZIL.

COMPOSIÇÃO E VARIAÇÃO SAZONAL DOS CARANGUEJOS BRAQUIUROS (CRUSTACEA, DECAPODA) HABITANTES DE *Sargassum cymosum* NA REGIÃO DE UBATUBA, SÃO PAULO, BRASIL.

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ABSTRACT

The aim of this study was to characterize the brachyuran crabs living on *Sargassum cymosum* C. AGARDH, 1820, with emphasis on seasonal variation of specimens collected on three different beaches in the Ubatuba region (23º 26' S and 45º 02' W). The algae were collected manually by snorkelling during low tide in four different seasons, from January to December 1995, bagged and stored frozen. In the laboratory, the samples were thawed at room temperature, transferred to a basin containing water and then carefully shaken branch by branch. The animals were sorted out under a camera lucida, counted and preserved in 70% alcohol. A total of 382 specimens were collected, belonging to three families, with seven genera and ten species. *Epialtus brasillensis* DANA, 1852 was the most abundant and constant species in all areas, followed by *Hexapanopeus schmitti* RATHBUN, 1930 and *Microphrys bicornutus* (LATREILLE, 1825). The occurrence of *Acantonyx dissimulatus* COELHO, 1991-1992 in São Paulo State is documented at first time. Species frequency varied over the year at the sites sampled. In general, Itaguá Beach presented a larger number of species. The highest and lowest densities occurred in the winter and summer, respectively.

RESUMO

O objetivo do presente estudo foi caracterizar os caranguejos braquiúros que habitam a alga *Sargassum cymosum* C. AGARDH, 1820, com ênfase na variação sazonal dos espécimens coletados em três diferentes praias da região de Ubatuba (23º 26' S e 45º 02' W). Amostras das algas foram coletadas manualmente através de mergulho livre por ocasião da maré baixa, nas quatros estações climáticas, de Janeiro a Dezembro/1995. Após as coletas, as amostras foram ensacadas e congeladas em freezer. No laboratório, foram descongeladas à temperatura ambiente e transferidas para uma vasilha contendo água, onde os ramos foram cuidadosamente agitados para que os animais se desprendessem. Os animais foram triados sob lupa, contados e conservados em álcool 70%. Um total de 382 espécimens foram coletados, abrangendo três familias, sete gêneros e dez espécies. *Epialtus brasiliensis* DANA, 1852 foi a espécie mais abundante e constante em todas as áreas, seguida por *Hexapanopeus schmitti* RATHBUN, 1930 e *Microphrys bicornutus* (LATREILLE, 1825). O registro da ocorrência de *Acantonyx dissimulatus* COELHO, 1991-1992 no estado de São Paulo é documentado pela primeira vez. A frequência de espécies variou ao longo do ano e das estações de coleta. De modo geral, a Praia do Itaguá apresentou o maior número de espécies. As maiores e menores densidades ocorreram no inverno e no verão, respectivamente.

KEY WORDS: Brachyura, composition, crabs, phytal, Sargassum

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INTRODUCTION

Decapod crustaceans comprise a notable component of seagrass and drift algae-associated macroinvertebrates, and form a community numerically important for tidal areas. Among them, the Brachyura frequently comprise an abundant group and form a discrete biotic community which is often endemic to the floating habitat.

Excellent reviews and discussions of phytal communities have been published by MASUNARI & FORNERIS (1981) and MASUNARI (1987).

In Brazil, investigations on the phytal fauna with emphasis on several groups were carried out in the Ubatuba region by LIMA (1969), LEITE (1976), MASUNARI (1976) and MONTOUCHET (1979). MOREIRA (1973), PIRES-VANIN (1977) and TARARAM & WAKABARA (1981) studied the biology of phytal species, and DOMMASNES (1968) and MOORE (1973) studied the phytal fauna from shores exposed to different wave actions.

However, it is only recently that consideration of this community has gone beyond simple species listings and annotated check lists, and despite the several papers, the biology, composition and seasonal variation of the brachyuran crab community associated with *Sargassum* algae remain little investigated. GOUVÊA & LEITE (1980) studied brachyuran species associated with *Halimeda opuntia* (LINNAEUS) LAMOUROUX in the State of Bahia, Brazil.

The present investigation is concerned with the qualitative and quantitative analysis of the brachyuran fauna of *Sargassum cymosum*, inhabiting three beaches, located in three different Bays in the Ubatuba region.

MATERIAL AND METHODS

Area of investigation

The material was collected at Ubatuba, northern coast of São Paulo State (23º30' S and 45º 06' W) from rocky parts of Domingas Dias Beach (DD), Lamberto Beach (LA) and Itaguá Beach (IT) (Fig.1). The first site is located in Fortaleza Bay, on a sheltered shore, with waves of moderate intensity and, according to NEGREIROS-FRANSOZO **et al.** (1991), with a high

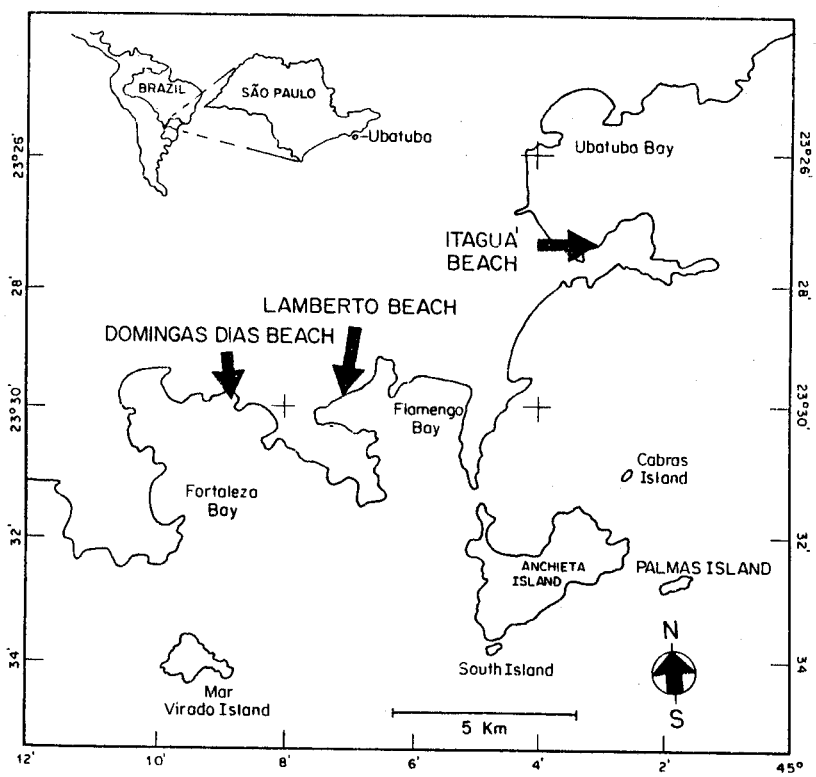

FIGURA 1 - Ubatuba region localization indicating the sample stations.

percentage of organic matter. The second area is located in Flamengo Bay, where the amount of detritus is not large, but during heavy rains the runoff of terrigenous material can be considerable (BOFFI, 1972). This is a considerably polluted site because of the presence of a marina. The third area is located in Ubatuba Bay, where the impact of waves on the rocks is greater than on the other beaches. According to MANTELATTO & FRANSOZO (in preparation), this Bay has currents of high intensity, with deposition of sediment and particles in the area located around Itaguá Beach.

METHODS

The salinity (measured with an optical refractometer) and temperature (measured with a common thermometer) of the sea water were monitored throughout the study period.

Sampling was carried out at 3-month intervals (summer, autumn, winter and spring) from January to December 1995, during low tide by snorkelling at the three sites mentioned. The algae, always submerged, were picked from the substratum, rapidly placed in a plastic bag, and stored frozen. In the laboratory the material was thawed at room temperature and all samples (5 per season, collected on the same day) were treated as follows under a binocular microscope: 1) the algae were transferred to an enclosure containing water; 2) they were then carefully shaken branch by branch; 3) the brachyuran crabs were screened, counted and preserved in 70.0 % alcohol.

After treatment, the algae were dried for 24 h at 70°C in order to obtain dry weight for the calculation of density (nº ind./g algae).

The specimens were identifed according to WILLIAMS (1984) and with the help of Dr. Gustavo A. S . de Melo (Zoology Museum of the University of São Paulo).

Quantitative analysis was carried out by determining the following parameters: 1) Percentage of Occurrence (Po) by the method of MOORE (1971); 2) Constancy (C): where Constant species (Cs) = presence > 50 % of samples; Accessory species (As) = presence 25 to 50 % of samples, and Accidental species (Ac) = presence < 25 % of samples, according to SILVEIRA NETO **et al.** (1976); 3) Sorensen's Quotient of Similarity (QS) = 2j/a + b, where a = number of species at site x; b = number of species at site y; j = number of species at both sites, according to SORENSEN (1948). The possible effects of *Sargassum clump* weight on number of individuals and number of species were tested using least squares linear regression. The abundance of the most numerically important species between beach samples were tested separately by Student's t-test.

RESULTS

The average values of seawater salinity and temperature are given in Table I, because not significant difference was detected between the areas.

In 6750, 51 g *Sargassum* dry weight, a total of 382 specimens of brachyuran crabs were recorded during the four seasons of year at the three sites, belonging to 3 families, 7 genera, 10 species and 2 unidentified specimens (Table II). Three species contributed 86.40 % of all individuals, the majid crab *Epialtus brasiliensis* (69.64%; n = 266), the xanthid crab *Hexapanopeus schmztti* (11.0 %; n = 42) and the majid crab *Microphrys bicornutus* (5.76 %; n = 22). The other group (rare species) of which none totalled more than 5 individuals were: *Acanthonyx dissImulatus* COELHO, 1991-1992; *Hexapanopeus paulensis* RATHBUN, 1930; *Pilumnus reticulatus* STIMPSON, 1860; *Pilumnus diomediae*

Tabela I - The average values of seawater salinity and temperature at the Ubatuba region during the period of the study (x ± s). The values corresponds of average at three areas of study.

	summer	autumn	winter	spring
Temperature (°C)	26.6 ± 1.45	25.4 ± 2.38	21.7 ± 0.50	23.3± 1.77
salinity (‰)	35.0 ± 0.50	34.0 ± 0.00	33.5 ± 0.00	31.0 ± 0.82

Table II - Distribution of number of individuals by seasons and species in Ubatuba region. DD = Domingas Dias Beach; LA = Lamberto Beach and IT = Itaguá Beach. (M = Majidae; X = Xanthidae; P = Portunidae) (number of ovigerous females)

	Species	Summer			Autumn			Winter			Spring		
		DD	LA	IT	DD	LA	IT	DD	LA	IT	DD	LA	IT
M	*Epialtus brasiliensis*	6 (4)	1	8(5)	75(3)	21(2)	29(3)	70(2)	4	9(2)	24(11)	2(1)	17(6)
M	*Microphrys bicornutus*	-	-	1	-	3	5(1)	-	3	7	-	3	-
M	*Acanthonyx dissimulatus*	-	-	-	-	-	4(1)	1	-	-	-	-	-
X	*Hexapanopeus schmitti*	-	5	8	5(2)	5(2)	5	1	-	12	1(1)	-	-
X	*Hexapanopeus paulensis*	-	-	-	-	2	-	-	-	5	-	-	-
X	*Pilumnus reticulatus*	-	-	-	-	-	-	-	-	1	-	-	-
X	*Pilumnus diomediae*	-	-	-	-	-	-	-	-	2	-	-	-
X	*Pilumnus sp.*	-	-	-	-	-	-	-	-	1	-	-	-
X	*Panopeus sp.*	-	1	-	2	-	-	-	-	2	-	-	-
X	*Xanthidae sp.*	-	-	-	-	-	-	-	1	26	-	-	-
P	*Cronius ruber*	1	-	-	-	-	-	-	-	1	-	-	-
	not identified	-	1	-	-	-	1	-	-	-	-	-	-
	Total	7(4)	8	17	82(5)	31(4)	44(5)	72(2)	8	66(2)	25(12)	5(1)	17(6)
	Total/season	32(4)			157(14)			146(4)			47(19)		

RATHBUN, 1894; *Pilumnus* sp.; *Panopeus* sp. and *Cronius ruber* (LAMARCK, 1818). Unidentifed Xanthidae species made up a total of 7.07% (n = 27). The number of *E. brasiliensis* individuals was significantly higher than the number of all other species ($P < 0.005$).

At the Domingas Dias Beach the seasonal contribution of the number of individuals attained a total of 186 pooled all seasons, with a maximum in autumn (n = 82) and a minimum in summer (n = 7); at Lamberto Beach a total of 52, with a maximum in autumn (n = 31) and a minimum in spring (n = 5), and at Itaguá Beach a total of 144, with a maximum in winter (n = 66) and a minimum in summer and spring (n = 17).

The patterns of seasonal fluctuations in number of individuals on the beaches were quite heterogeneous through the seasons, although the number of individuals collected did not differ significantly between seasons ($P<0.05$). Species diversity was greater on Itaguá Beach.

The percentage of occurrence (Po) of brachyuran species is listed in Table III. In terms of total number of individuals, the Domingas Dias beach presented the highest Po (48.69). However, the Itaguá beach presented the highest individual Po values for most species, except for *E. brasiliensis* on the Domingas Dias Beach. We emphasize the absence of several species on the Domingas Dias and Lamberto beaches. In general, *E. brasiliensis* was the predominant species, with the highest Po (69.64), followed by *H. schmitti* (11.0).

Tabela III - Percentage of occurrence (Po) and Constance (C) of brachyuran species at DD = Domingas Dias Beach; LA = Lamberto Beach and IT = Itaguá Beach (Cs = Constant; As = Assessory; Ac = Acidental)

Species	Po				C		
	DD	LA	IT	Total	DD	LA	IT
E. brasiliensis	65,79	10,53	23,69	69,64	Cs	Cs	Cs
M. bicornutus	-	40,90	59,10	5,76	-	Cs	Cs
A. dissimulatus	20,00	-	80,00	1,31	Ac	-	Ac
H. schmitti	16,67	23,82	59,52	11,00	Cs	As	Cs
H. paulensis	-	28,57	71,43	1,83	-	Ac	Ac
P. reticulatus	-	-	100,00	0,26	-	-	Ac
P. diomediae	-	-	100,00	0,52	-	-	Ac
Pilumnus sp.	-	-	100,00	0,26	-	-	Ac
Panopeus sp.	40,00	20,00	40,00	1,31	Ac	Ac	Ac
Xanthidae sp.	-	3,70	96,30	7,07	-	Ac	Ac
C. ruber	50,00	-	50,00	0,52	Ac	-	Ac
not identified	-	50,00	50,00	0,52	-	Ac	Ac
Total	48,69	13,61	37,70				

Total dry weight ranged from 385.56 (Lamberto and Itaguá winter) to 871.17 g (Domingas Dias/ summer). An inverse relation tended to occur between the fluctuation in number of crabs and *Sargassum* dry weight during the seasons of the year, i.e., an increase in number of animals corresponded to a decline in alga dry weight and vice-versa. (Table IV).

Total density on the three beaches ranged from 0.027 (Domingas Dias) to 0.075 ind./g **Sargassum** (Itaguá). Along the seasons of the year, the highest densities were recorded in winter (0.108) and the lowest in summer (0.171 indlg**Sargassum**). Over the study period, density ranged from 0.008 (Domingas Dias - summer) to 0.171 ind./g **Sargassum** (Itaguá - winter) (Table IV).

Tabela IV - Dry weight of *Sargassum* (g), number of individuals and density (between parentesis) shows at three sites of collecting during seasons (DD = Domingas Dias Beach; LA = Lamberto beach; IT = Itaguá Beach).

Beach	summer	autumn	winter	spring	Total
		DryWeight /nº indiv.			
DD	871,17/7	666,67/82	578,07/72	773,12/25	2889,03/186
	(0,008)	(0,123)	(0,125)	(0,032)	(0,064)
LA	569,50/8	419,99/31	385,56/8	567,58/5	1942,62/52
	(0,014)	(0,074)	(0,021)	(0,009)	(0,027)
IT	537,59/17	567,51/44	385,56/66	428,19/17	1918,85/144
	(0,032)	(0,078)	(0,171)	(0,040)	(0,075)
Total	1978,26/32	1654,17/157	1349,19/146	1768,89/47	6750,51/382
	(0,016)	(0,095)	(0,108)	(0,027)	(0,057)

The Sorensen's Quotient of Similarity ranged from 0.50 to 0.74%, showing the best proximity between Lamberto/Itaguá (0.74), Domingas Dias/Itaguá (0.59) and Domingas Dias/Lamberto (0.50).

Because of poor fit of points to simple linear regression equations for all beaches, except Domingas Dias for number of species (r = 0.9l), samples could not be differentiated, demonstrating the low relation between number of species and number of individuals versus dry weight of *Sargassum* (Table V).

Tabela V - Summary statistics for linear regressions of number of individuals and numbers of species versus *Sargassum* dry weight.

Beache	r	n	F	P
	Number of individuals			
DD	0,27	20	1,35	0,001
LA	0,30	20	1,78	0,001
IT	0,18	20	0,58	0,001
	Number of species			
DD	0,91	4	9,14	0,020
LA	0,23	4	0,11	0,140
IT	0,38	4	0,33	0,030

DISCUSSION

Associations between fauna and pelagic *Sargassum* whether obligatory or facultative, provide numerous advantages to the animals. Although according to HANSEN (1977), few species directly consume the relatively unpalatable brown algae, pelagic *Sargassum* species have been shown to release large amounts of dissolved organic material which is utilized by heterotrophic bacteria.

The *Sargassum* habitat also provides a source of attachment sites for sessile and motile organisms in an otherwise open water environment, and the substratum probably protects its associates from pelagic predators

and mechanical disturbance by waves. WIESER (1952) studied the vertical distribution of phytal in the intertidal zone and found that the specific vertical levels for various animals and, therefore, which the distribution varied with algal species. This parameter suggest a close relationship between abundance of animals and construction of the algae (surface areas affect the number of individuals inhabiting them).

According to MASUNARI (1982), the dominance of crustaceans in phytal composition is a common characteristic. In this respect, brachyurans form a small group when compared to the remaining crustacean groups inhabiting the *Sargassum*, such as Gammaridae and Caprellidae, among others, (MONTOUCHET, 1972; DUTRA, 1988; ALBUQUERQUE & GUERON, 1989). The low diversity of brachyuran species in phytals is probably related to the morphophysiological adaptations (morphology of pereopods, reproduction cycle, larval development, etc.) necessary for survival in habitat, although some species utilize this ecosystem as a reproductive site for the development and growth of larval phases (MONTOUCHET, 1972).

There was a marked increase in the density and number of individuals in fall and winter, accompanied by a decrease in temperature, salinity and alga weight. This pattern was also observed for other phytal crustaceans by MUKAI (1971), coinciding with the growth of *Sargassum*, a fact that was not observed in the present investigation since algal biomass was not analyzed during the study period.

Specifically for some Brachyura species, few reports have mentioned a tendency to reduced abundance during the winter: GOUVEA & LEITE (1980) detected alternate densities of crabs studied over 2 consecutive years on the alga *Halimeda opuntia*; MONTOUCHET (1972) and MASUNARI (1982) detected this same decrease in frequency in *Epialtus brasilzensis* for *Sargassum cymosum* and *Amphiroa beauvoisü* LAMOUROUX, 1816, respectively.

According to DAHL (1948), the volume of detritus on the thallus affects the density of the animals living there. This volume is affected by factors such as running water conditions, secretion of mucous matter by the thallus and presence of plankton organisms. Along this same line of reasoning, personal observations previously made in this region during frequent diving episodes in other studies showed a considerably large quantity of sediment in suspension from June to September (fall-winter). This fact was also observed by CASTRO-FILHO **et al.** (1987) in the Ubatuba region, which is penetrated by various currents, among them Tropical water (TW) in the direction of the coast on the surface layer, and a recession of the South Atlantic Continental Water (SACW) current in the direction of the slope, together with the cooling of surface waters in the fall-winter which, added to the intensification of processes of vertical mixing caused by an increased frequency of strong winds, is suficient to destroy the seasonal thermocline and consequently to turn the waters close to the coast almost homogeneous, with large amounts of particles in suspension.

We believed that this circulation pattern may probably affect the seasonality of brachyurans observed on the three beaches, especially Itaguá, whose geomorphological characteristics lead to a greater influx of particles resulting in an increase in number and density of individuals. Other studies specifically conducted on the composition of Brachyura living in the non-consolidate substratum of the three bays studied here, i.e., Fortaleza studied by FRANSOZO **et al.** (1992); Flamengo studied by NEGREIROS-FRANSOZO **et al.** (1992) and Ubatuba studied by MANTELATTO & FRANSOZO (in preparation) have conformed the existence of conditions favorable to the settling and development of a greater diversity of species demonstrated by the difference in number of species found in Ubatuba Bay (44), and on the Flamengo (12) and Fortaleza (24) beaches.

A similar pattern was observed by GOUVEA & LEITE (1980), who reported that the density of brachyurans was markedly reduced during periods of decreased sedimentation near the alga *Halimeda opuntia*.

The number, kind, and wealth of associated brachyuran crab species, however, appears to be highly variable. Although a weak correlation was found between number of species and individuals and the weight of Sargassum, this relation was expected and has been documented before for several phytal species (FINE, 1970; MUKAI, 1971; GORE **et al.**, 1981). However, BROOK (1978) and HIGHSMITH (1985) found no relationship between number of alga blades and relative faunal abundances or species composition.

Species composition was relatively stable over varying *Sargassum* weight and the increasing wealth of species was most likely a simple stochastic function of increasing numbers of individuals, as pointed out by STONER & GREENING (1984).

CONNOR & McCOY (1979) critically reviewed the general species-area relationship and concluded that: (1) at least three mechanisms could contribute to correlations between species number and area (increased habitat diversity; increased area sustaining larger, more stable populations; and passive sampling

from a species pool); (2) there is no single "best fit" model, i.e., the best equation to describe the data can only be determined empirically for each case; and (3) parameters for best fit models, such as slope and intercept, are best viewed as ftted constants lacking specifc biological signifcance.

Epialtus brasiliensis was present on all beaches during all months with heterogeneous abundance, representing the most abundant species and supporting the idea that the phytal is a specific habitat. This pattern agrees with the results reported by NEGREIROS-FRANSOZO **et al.** (1994) about the population biology of this species whose occurrence was recorded annually with a high incidence of reproduction (demonstrated by the number of ovigerous females) in fall and winter. The presence of this species was noted on *Amphiroa beauvoisii*, with high frequencies in winter (MASUNARI,1982) and on *Sargassum cymosum* (MONTOUCHET, 1972), being the most characteristic Decapoda species for the latter and for *Pterocladia capillacea* (GMELIN) BARNET & THURET, as reported by DUTRA (1988).

According MELO (pers. comm.), the occurrence of *A. dissimulatus* in São Paulo State is documented at first time. The recent paper (MELO, 1996) mencioned the distribution from Piauí to Bahia State.

GORE **et al.** (1981) inferred that the drift algae habitat is very nearly, if not completely, species-saturated at all times of the year. The stability in species composition and species saturation of this habitat is directly related to habitat complexity, and therefore some degree of resilience in response to changing environmental parameters must also occur in the community.

Alternatively, the presence of rare species might be a result of interaction with the characteristic species. The latter, with a relatively large number of individuals, could partition the resource of living space to such a degree that immigration of rare species would only occur with increases in drift algal abundance.

The reasons for the difference in the number of individuals collected on the different beaches are difficult to explain. A number of factors may have acted differentially on beaches, such as the rate of sediment deposition on the algae and variation in plant biomass.

In view of the reduced number of studies available in the literature about the aspects studied in this region, little can be inferred about the number of species since the parameters for comparison are limited. However, personal observations made over the last ten years have revealed a growing expansion of the tourist industry in the Ubatuba region, with the consequent introduction of undesirable products such as domestic sewage, oil spills and industrial residues into the ecosystem, with an effect on populations inhabiting intertidal areas. In this respect, there is an urgent need for studies on the monitoring and population structure of the species inhabiting that location in order to obtain the data for future comparisons involving the region.

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