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BRACHYURAN COMMUNITY IN UBATUBA BAY, NORTHERN COAST OF SÃO PAULO STATE, BRAZIL

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ABSTRACT A brachyuran crab assemblage from eight transects at a non-consolidated sublittoral site in Ubatuba Bay was studied on a monthly basis from September 1995 to August 1996. Data about number of individuals of 50 species found and other information such as distribution of the dominant crabs are reported. The family Majidae was represented by 13 species, followed by Xanthidae (13), Portunidae (10), Leucosiidae (5), Calappidae (2), Dromiidae (2), Parthenopidae (2), Goneplacidae (1), Pinnotheridae (1), and Ocypodidae (1). The brachyuran taxocoenosis was dominated by *Callinectes ornatus* (60.4%), *Callinectes danae* (18.8%), and *Hepatus pudibundus* (7.7%), representing together 86.9% of the total number of collected brachyurans. The Shannon-Weaver diversity index ranged from 1.10 to 2.06 between transects, and from 1.34 to 2.22 between months, depending more on equitability than on richness.

KEY WORDS: Biodiversity, Brachyura, crabs, Crustacea, Ubatuba, Brazil

INTRODUCTION

With approximately 5,000 species described worldwide, the Brachyura is a highly significant group of marine crustaceans playing an important role in the marine trophic chain (Melo 1996). Recently our group listed 315 brachyuran species living along the Brazilian coast (Pohle et al. 1999) and this number continues to be modified both by new species descriptions and new records of exotic brachyurans.

The South Atlantic coastal zone can be functionally divided into two regions: the subtropical Brazilian coast (from 22°S to 33°S) of about 3,000 km, and the Patagonian region consisting of the temperate coasts of Southern Brazil, Uruguay and Northern Argentina (from 33°S to 42°S) extending over 2,900 km. Located along the northern coastline of the State of São Paulo, the Ubatuba region is an important area for crustacean investigations, particularly on Brachyura. This region comprises the coastal portion of the Biogeographic Province of the State of São Paulo, a zone of faunal transition (Palácio 1982). The area as a whole possesses a mixture of faunas of both tropical and Patagonian origin (Sumida and Pires-Vanin 1997). In addition, Ubatuba Bay is its fairly pristine and is used as a standard for comparison with other marine habitats strongly influenced by man (Mantelatto and Fransozo 1999a). For this reason in recent years there has been an impressive number of studies of the intertidal zone and continental shelf centered on the crab faunal composition of a variety of habitats in the Ubatuba area. Forneris (1969) performed the pioneering study which provided a brachyuran check-list in Flamengo Bay; Abreu (1980) described ecological aspects in an estuarine area of Ubatuba; Pires (1992) reported the structure and dynamics on the continental shelf offshore of Ubatuba; Fransozo et al. (1992) established the composition and the distribution at the non-consolidated sublittoral from Fortaleza Bay; Hebling et al. (1994) reported the crabs sampled in the Anchieta Island region; Mantelatto and Corrêa (1996) described the composition and seasonal variations of the species living on the algae *Sargassum cymosum* C. Agarth, 1820 from three different Ubatuba beaches; Pinheiro et al. (1997) studied the composition and the relative abundance of crabs associated with sand reefs created by *Phragmatopoma lapidosa* Kimberg, 1867, and Mantelatto and Souza-Carey (1998) reported the species inhabiting the bryozoan colonies of *Schyzoporella unicornis* (Johnston 1847). The purpose of the present paper is to report the species composition of brachyuran crabs from a sublittoral location with non-consolidated sediments in Ubatuba Bay as a contribution to the study of the biodiversity of Brachyura from the São Paulo coast.

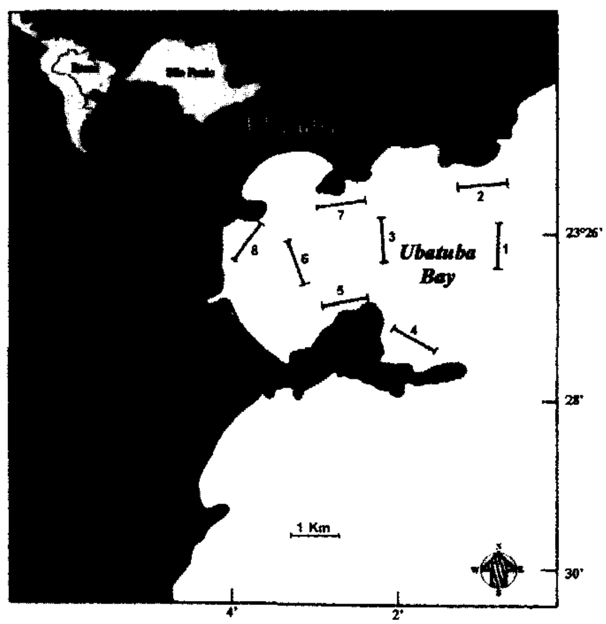

Figure 1. Map of Ubatuba Bay (São Paulo State) showing the position of the sampling transects.

TABLE 1.

Total species composition and number of individuals in each transect in Ubatuba Bay calculated for whole year. (CN, constancy; Co, constant; Ac, accessory, and Ad, accidental).

Family/Species	Transects									
	I	II	III	IV	V	VI	VII	VIII	TOTAL	CN
DROMIIDAE										
Cryptodromiopsis antillensis (Stimpson 1858)	–	–	–	3	8	–	–	–	11	Co
Hypoconcha arcuata (Stimpson 1858)	–	–	–	–	2	–	–	–	2	Ad
CALAPPIDAE										
Hepatus pudibundus (Herbst 1785)	266	50	86	96	35	368	70	15	986	Co
Calappa gallus (Herbst 1803)	–	–	–	5	2	–	–	–	7	Ac
LEUCOSIIDAE										
Lithadia brasiliensis (von Martens 1872)	–	–	–	–	1	–	–	–	1	Ad
Persephona crinita (Rathbun 1931)	–	–	1	–	–	2	2	–	5	Ad
Persephona lichtensteinii (Leach 1817)	–	–	4	–	–	14	6	1	25	Co
Persephona mediterranea (Herbst 1794)	105	2	1	12	2	3	1	–	126	Co
Persephona punctata (Linnaeus 1758)	20	5	5	70	68	181	11	–	360	Co
MAJIDAE										
Apiomithrax violaceus (A. Milne Edwards 1868)	–	–	–	–	9	1	–	–	10	Ac
Collodes inermis (A. Milne Edwards 1878)	–	–	–	–	4	–	–	–	4	Ad
Collodes rostratus (A. Milne Edwards 1878)	–	–	–	1	–	–	–	–	1	Ad
Libinia ferreirae (Brito Capello 1871)	5	7	5	12	5	9	7	–	50	Co
Libinia spinosa (H. Milne-Edwards 1834)	7	1	3	1	–	3	1	–	16	Ac
Microphrys bicornutus (Latreille 1825)	1	–	1	–	–	–	–	–	2	Ad
Notolopas brasiliensis (Miers 1886)	–	–	–	–	6	–	–	–	6	Ac
Pelia rotunda (A. Milne Edwards 1875)	–	3	2	1	–	–	–	–	6	Ac
Pitho lherminieri (Schramm 1867)	–	–	–	1	–	–	–	–	1	Ad
Podochela gracilipes (Stimpson 1871)	–	–	–	–	1	–	–	–	1	Ad
Podochlae riisei (Stimpson 1860)	–	–	–	1	–	–	–	–	1	Ad
Pyromaia tuberculata (Lockington 1876)	–	–	–	–	1	–	–	–	1	Ad
Stenorhynchus seticornis (Herbst 1788)	–	–	–	–	11	–	–	–	11	Ac
PARTHENOPIDAE										
Parthenope (*Parthenope*) *agona* (Stimpson 1871)	–	–	–	–	1	–	–	–	1	Ad
Parthenope (*Platylambrus*) *guerini* (B. Capello 1871)	–	–	–	–	1	–	–	–	1	Ad
PORTUNIDAE										
Arenaeus cribrarius (Lamarck 1818)	213	98	2	1	–	–	85	47	446	Co
Callinectes danae (Smith 1869)	4	16	86	9	–	393	272	1,626	2,406	Co
Callinectes ornatus (Ordway 1863)	436	422	489	1,111	834	2,910	657	866	7,725	Co
Callinectes sapidus (Rathbun 1896)	–	–	–	–	–	2	1	1	4	Ac
Charybdis hellerii (A. Milne Edwards 1867)	–	1	–	4	131	3	–	–	139	Co
Cronius ruber (Lamarck 1818)	–	–	–	1	1	–	–	–	2	Ad
Portunus ordwayi (Stimpson 1860)	–	–	–	–	7	–	–	–	7	Ad
Portunus spinicarpus (Stimpson 1871)	–	4	–	–	10	–	–	–	14	Ad
Portunus spinimanus (Latreille 1819)	–	1	–	65	143	5	1	–	215	Co
Portunus ventralis (A. Milne Edwards 1879)	–	–	–	–	1	–	–	–	1	Ad
XANTHIDAE										
Eurypanopeus abbreviatus (Stimpson 1860)	–	–	–	–	–	1	–	–	1	Ad
Hexapanopeus sp.	–	–	–	–	–	1	–	–	1	Ad
Hexapanopeus paulensis (Rathbun 1930)	–	4	1	9	21	15	–	–	50	Co
Hexapanopeus schmitti (Rathbun 1930)	–	1	–	24	35	19	–	–	79	Ac
Menippe nodifrons (Stimpson 1859)	–	–	–	–	1	1	1	–	3	Ad
Micropanope nuttingi (Rathbun 1898)	–	–	–	1	–	–	–	–	1	Ad
Panopeus americanus (Saussure 1857)	–	–	–	2	1	–	–	–	3	Ad
Panopeus bermudensis (Benedict and Rathbun 1981)	–	–	1	–	–	–	–	–	1	Ad
Pilumnoides hassleri (A. Milne Edwards 1880)	–	–	–	4	2	–	1	–	7	Ad
Pilumnus diomedeae (Rathbun 1894)	–	–	–	–	1	–	–	–	1	Ad
Pilumnus reticulatus (Stimpson 1860)	–	–	–	–	20	2	–	–	22	Co
Pilumnus spinosissimus (Rathbun 1898)	–	–	–	1	–	–	–	–	1	Ad
Xanthidae sp.	–	–	–	2	–	–	–	–	2	Ad
GONEPLACIDAE										
Eucratopsis crassimanus (Dana 1852)	–	–	–	13	7	1	–	–	21	Ac
PINNOTHERIDAE										
Pinnixa sp.	–	–	1	–	–	–	1	–	2	Ad
OCYPODIDAE										
Ucides cordatus (Linnaeus 1763)	–	–	–	–	–	–	–	1	1	Ad
TOTAL	1,057	615	688	1,450	1,372	3,934	1,117	2,557	12,790	
Number of species	9	14	15	25	31	20	15	7		

TABLE 2.

Total number of individuals per month for all eight subareas combined, collected from September 1995 (S) to August 1996 (A).

Family/Species	Months												Total
	S	O	N	D	J	F	M	A	M	J	J	A	
DROMIIDAE													
Cryptodromiopsis antillensis	–	1	1	–	1	3	1	1	–	–	–	3	11
Hypoconcha arcuata	2	–	–	–	–	–	–	–	–	–	–	–	2
CALAPPIDAE													
Hepatus pudibundus	133	101	117	40	88	84	55	39	29	53	130	117	986
Calappa gallus	1	–	1	1	–	–	–	–	–	2	2	–	7
LEUCOSIIDAE													
Lithadia brasiliensis	1	–	–	–	–	–	–	–	–	–	–	–	1
Persephona crinita	–	–	–	1	–	–	–	–	–	–	2	2	5
Persephona lichtensteinii	6	5	–	–	3	–	1	1	1	–	6	2	25
Persephona mediterranea	21	11	18	3	15	3	9	–	1	3	29	13	126
Persephona punctata	70	17	43	6	9	11	6	12	10	8	54	114	360
MAJIDAE													
Apiomithrax violaceus	1	1	1	–	–	–	4	3	–	–	–	–	10
Collodes inermis	–	1	–	–	–	–	–	–	1	–	–	2	4
Collodes robustus	–	1	–	–	–	–	–	–	–	–	–	–	1
Libinia ferreirae	2	4	11	2	–	2	–	2	1	1	14	11	50
Libinia spinosa	–	–	4	–	1	–	–	–	6	–	4	1	16
Microphrys bicornutus	–	1	–	1	–	–	–	–	–	–	–	–	2
Notolopas brasiliensis	–	1	–	–	1	–	2	–	–	–	1	1	6
Pelia rotunda	–	1	1	–	–	–	–	1	–	–	1	2	6
Phito lherminieri	–	–	–	–	–	–	1	–	–	–	–	–	1
Podochela gracilipes	–	–	–	–	–	–	1	–	–	–	–	–	1
Podochela riisei	–	–	–	–	–	–	–	–	–	–	–	1	1
Pyromaia tuberculata	1	–	–	–	–	–	–	–	–	–	–	–	1
Stenorhynchus seticornis	–	–	4	–	–	–	1	1	–	–	2	3	11
PARTHENOPIDAE													
Parthenope agona	–	–	–	–	–	–	1	–	–	–	–	–	1
Parthenope (Platylambrus) guerini	–	–	–	–	–	–	–	–	1	–	–	–	1
PORTUNIDAE													
Arenaeus cribrarius	33	33	28	20	34	66	35	27	39	45	61	25	446
Callinectes danae	104	47	82	28	114	515	542	234	162	269	189	120	2406
Callinectes ornatus	824	426	592	466	696	1031	692	662	430	466	648	792	7725
Callinectes sapidus	1	1	–	–	1	1	–	–	–	–	–	–	4
Charybdis hellerii	7	1	7	–	–	–	16	40	32	2	15	19	139
Cronius ruber	–	–	–	–	–	–	–	2	–	–	–	–	2
Portunus ordwayi	–	–	–	–	–	–	–	7	–	–	–	–	7
Portunus spinicarpus	–	–	–	5	–	9	–	–	–	–	–	–	14
Portunus spinimanus	61	15	35	6	15	5	2	23	21	11	8	13	215
Portunus ventralis	–	–	–	–	–	–	–	–	1	–	–	–	1
XANTHIDAE													
Eurypanopeus abbreviatus	–	–	–	1	–	–	–	–	–	–	–	–	1
Hexapanopeus sp.	–	–	–	–	1	–	–	–	–	–	–	–	1
Hexapanopeus paulensis	1	–	–	3	7	3	4	18	5	2	2	5	50
Hexapanopeus schmitti	1	–	–	3	9	5	47	14	–	–	–	–	79
Menippe nodifrons	–	–	–	–	–	1	1	1	–	–	–	–	3
Micropanope nuttingi	–	–	–	–	–	–	–	1	–	–	–	–	1
Panopeus americanus	1	–	–	–	–	2	–	–	–	–	–	–	3
Panopeus bermudensis	–	–	–	–	–	–	–	1	–	–	–	–	1
Pilumnoides hassleri	1	1	–	–	5	–	–	–	–	–	–	–	7
Pilumnus diomedeae	–	–	–	–	1	–	–	–	–	–	–	–	1
Pilumnus reticulatus	–	1	4	1	–	–	12	2	–	–	1	1	22
Pilumnus spinosissimus	–	–	–	–	–	–	–	–	–	–	1	–	1
Xanthidae sp.	–	–	–	–	–	–	–	–	–	–	2	–	2
GONEPLACIDAE													
Eucratopsis crassimanus	2	–	–	–	4	9	2	3	–	–	1	–	21
PINNOTHERIDAE													
Pinnixa sp.	–	–	–	1	1	–	–	–	–	–	–	–	2
OCYPODIDAE													
Ucides cordatus	–	–	–	–	–	–	–	–	–	–	1	–	1
Number of species	21	20	16	17	19	16	21	22	15	11	22	20	

MATERIALS AND METHODS

Ubatuba Bay (23°26′S and 45°02′W) is adjacent to the town of Ubatuba situated on the northern coast of São Paulo, Brazil. The area of the bay is about 8 km^2 with a width of approximately 4.5 km at the entrance.

The study site was divided into eight subareas selected for their relation to the bay mouth, the presence of a rocky wall or a beach along the boundaries, the inflow of fresh water, the proximity of offshore water, depth, and granulometric composition. Each transect was assigned to a subarea for sampling of crabs and measurement of environmental factors (Fig. 1). During the study the environmental data was sampled throughout full transect and was checked at the beginning, middle, and end of each transect sample. There was no change in this data throughout each transect. Depth ranged from 2.5 (subarea 2) to 18.5 m (subarea 1), temperature ranged from 19.2 °C to 20.1 °C, salinity ranged from 33.5‰ to 34.8‰, and dissolved oxygen ranged from 5.21 to 5.87 mg/L. The overall organic matter content in bottom sediments ranged from 2.0% (subarea 2) to 30.2% (subarea 5) and fine sediments (<0.250 mm) prevailed in most subareas. Water samples were collected from the bottom using a Nansen bottle. Temperature was measured with a thermometer attached to the bottle, salinity was measured using an optical refractometer (Atago S/1000), and dissolved oxygen was measured by the Winckler method modified by the addition of azide. Depth was measured in each sampling station using a graduated rope that was attached to the Van-Veen grab sampler (1/40 m^2) used for sampling sediment. Sediment (≈ 200 g) was dried at 70 °C for 72 h before organic matter and grain size analyses. The Wenthworth (1922) scale was used for the grain size analyses. The phi (Φ = mean diameter) value was used according to Suguio (1973) to calculate the central sediment tendency. Organic matter was obtained by ash-weighting, three aliquots of 10 g each per subarea per month were heated in porcelain crucibles for 3 h at 500 °C and then reweighed. Detailed descriptions of physical and chemical features characterizing this area and statistical similarity of environmental factors among transects can be found in Mantelatto and Fransozo (1999a).

Sampling of crabs occurred monthly from September 1995 to August 1996. The sample was performed at a diurnal 1-km-long trawl transect at each of the eight sampling subareas during a three consecutive days per month. The catches of crabs were done by trawler equipped with double rigged nets (3.5-m wide mouth, 10 mm of mesh size cod end). Each trawl was performed with velocity and time adequate to prevent significant scape from each net in function of the differences on bottom substrate surface and tidal currents. Immediately after capture all crabs were placed on ice and frozen until being examined in the laboratory.

The Constancy Index (C) for each species was calculated according to Dajoz (1983): C = $P \times 100/P$, where "P" is the number of samples in which a given species was recorded, and "P" is the total number of samples analyzed. Species were then classified into three different constancy categories; *i.e.* constant (C ≥ 50 %), accessory (25% < C < 50%), and accidental (C ≤ 25%). Diversity

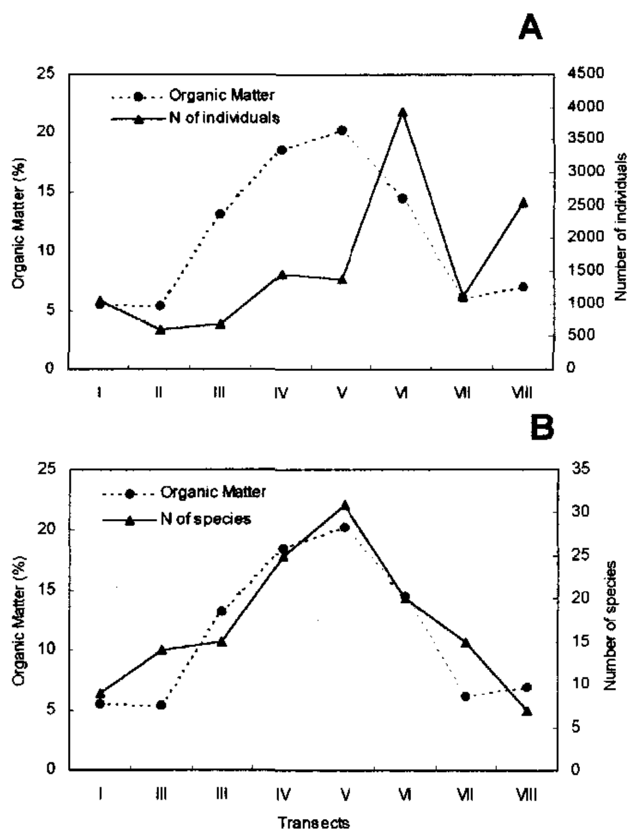

Figure 2. Total number of individuals (A) and species (B) as a function of organic matter in the sediment (percentage of dry weight) in each transect sample in Ubatuba Bay for whole year.

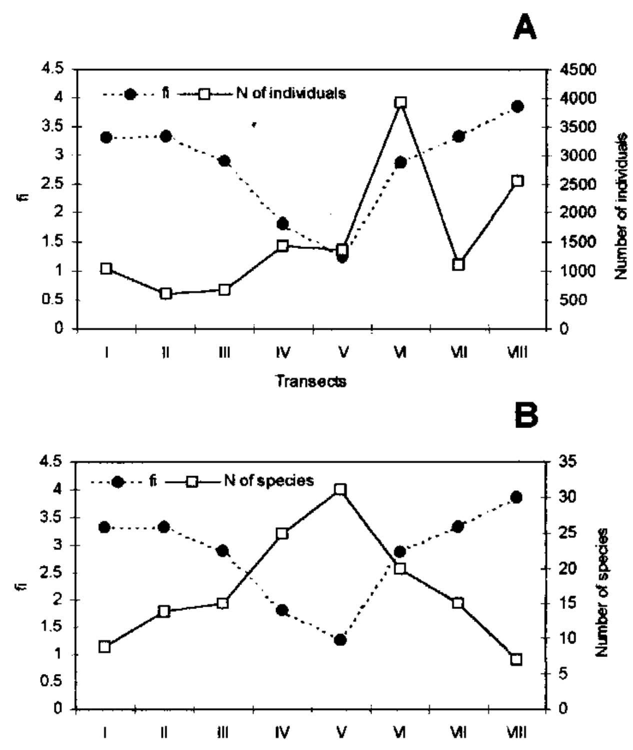

Figure 3. Number of individuals (A) and species (B) as a function of the central sediment tendency (fi = ϕ) in each transect sample of Ubatuba Bay for whole year. The ϕ was calculated according to Suguio (1973) from the formula $\phi = -\log_2 d$, where d = grain diameter (mm). The distribution curve was obtained by the formula ϕ 16 + ϕ 50 + ϕ 84/3.

was calculated using the Shannon-Weaver index (Shannon and Weaver 1963): $H' = \sum_{i=1}^{s} Pi.\log_2 P_i$, where "$s$" is the number of species and "P_i" is the proportion of i^{th} species. The equitability index (J') was calculated as indicated by García Raso and Fernandez Muñoz (1987): $J' = H'/\log_2 s$. Pearson coefficient was used to check relationships between the absolute values of each environmental factor studied and the number and frequency of species for all subareas combined.

RESULTS

A total of 12,790 brachyurans belonging to 50 species and 10 families was collected (Tables 1 and 2). The brachyuran taxocoenosis was dominated by *Callinectes ornatus* (60.4%), *Callinectes danae* (18.8%), and *Hepatus pudibundus* (7.7%), together representing 86.9% of the total collection. These three dominant species are differentially distributed in Ubatuba Bay (Table 1).

The greatest number of species was recorded for transects VI (30.8%) and VIII (20.0%). Species richness was significantly correlated with coarse grains sediments ($P = 0.00017$; $r = -0.96$) and with high organic content (Figs. 2 and 3). No correlation was observed between the above factors and number of individuals ($P = 0.00265$; $r = 0.90$). Pearson's analysis revealed significant coefficients between some species and group correlation (Table 3).

Continuous and heterogeneous occurrence throughout the sampling period was recorded for *H. pudibundus, P. punctata, A. cribrarius, C. danae, C. onatus,* and *P. spinimanus*. The number of species and their respective frequencies did not show significant seasonal variation, although both parameters increased slightly during the warmest months (Fig. 4) when the abundance of omnipresent species was greatest. In terms of their temporal pattern of occurrence, 26% of species were classified as omnipresent or constant, 18% as accessory, and 56% as accidental. The data of the most abundant species from monthly sampling taken on eight different subareas are shown in Table 4.

The diversity index ranged from 1.10 to 2.06 within transects and from 1.34 to 2.22 within months, depending more on equitability than on richness (Table 2 and Fig. 5). The lowest richness values were detected in transect VIII (7.0) which was influenced by fresh water inflow and significantly contrasted with those observed in transects IV (31.0), which had a high percentage of medium sand and organic content. The highest diversity and equitability were recorded in transects V (high percentage of medium sand and organic content) and I (highest depth and high percentage of fine sand), while the lowest values were obtained in transect VIII. During the study period both indexes showed wide variation along.

DISCUSSION

Examination of the species collected in Ubatuba Bay provided new information on the Brachyura fauna of the area and confirmed the biological potential of this region. Of all the brachyuran species recorded from Brazilian waters, 15.9% were found in Ubatuba

TABLE 3.

Coefficients of Pearson's Linear Correlation carried out between the abundance of total individuals (TO), the most abundant species, and the sampled environmental factors for all subareas combined.

Variables	Coefficients										
	TO	Hp	Pm	Pp	Lf	Ac	Cd	Co	Ch	Ps	Hx	Hs
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Depth	0.135	–0.200	–0.174	0.171	–0.189	–0.173	0.094	0.178	0.225	–0.417	0.350	0.295
Dissolved oxygen	0.047	0.097	0.218	0.304	0.114	–0.398	–0.037	0.009	0.130	0.071	–0.234	0.412
Temperature	0.417	–0.436	–0.452	–0.678**	–0.670**	0.190	0.664*	0.339	–0.008	–0.174	0.363	0.607*
Salinity	0.123	–0.216	–0.056	–0.065	–0.147	0.106	0.252	0.010	0.360	–0.421	0.568*	0.362
Organic matter	–0.282	0.364	0.173	–0.008	0.056	–0.091	–0.391	–0.200	–0.327	0.230	–0.320	–0.297
Sediment												
Gravel	*–0.275*	*0.087*	*0.005*	*–0.244*	*0.055*	*0.231*	*–0.118*	*–0.375*	*0.038*	*0.122*	*–0.086*	*–0.264*
Very coarse sand	0.048	0.243	0.083	–0.088*	–0.065	0.503	0.106	–0.024	–0.360	0.096	–0.301	–0.313
Coarse sand	0.156	0.622*	0.501	0.160	0.133	0.205	–0.053	0.160	–0.567**	0.555	–0.628	–0.205
Medium sand	0.279	0.280	0.054	0.564*	0.422	–0.161	–0.019	0.387	–0.140	0.077	–0.159	–0.181
Fine sand	0.250	–0.477	–0.574	–0.268	–0.294	–0.112	0.269	0.359	0.253	–0.151	0.536	0.191
Very fine sand	–0.401	–0.371	–0.096	–0.404	–0.219	–0.378	–0.251	–0.321	0.028	–0.240	0.184	0.236
Silt and clay	0.141	–0.078	–0.023	0.453	0.228	0.005	0.159	–0.007	0.622*	–0.200	0.291	0.131
Species												
TO		0.311	0.164	0.246	0.054	0.524	0.749*	0.927*	0.031	–0.035	0.084	0.390
HP			0.879*	0.723*	0.669*	0.178	–0.265	0.414	–0.346	0.412	–0.481	–0.338
Pm				0.581*	0.663*	0.164	–0.288	0.197	–0.234	0.337	–0.436	–0.168
Pp					0.692*	–0.139	–0.316	0.357	0.105	0.377	–0.183	–0.336
Lf						0.115	–0.305	0.068	0.069	0.030	–0.262	–0.390
Ac							0.560*	0.388	–0.165	–0.289	–0.231	–0.089
Cd								0.504	0.095	–0.423	0.135	0.667*
Co									–0.079	0.110	0.105	0.168
Ch										0.087	0.705*	0.204
Ps											–0.077	–0.314
Hx												0.277

The pairs of variables show a tendency to increase (*) or to decrease (**) correlation together ($P < 0.05$). Hp, *Hepatus pudibundus;* Pm, *Persephona mediterranea;* Pp, *Persephona punctata;* Lf, *Libinia ferreirae;* Ac, *Arenaeus cribrarius;* Cd, *Callinectes danae;* Co, *Callinectes ornatus;* Ch, *Charybdis hellerii*, Ps, *Portunus spinimanus;* Hx, *Hexapanopeus paulensis;* and Hs, *Hexapanopeus schimitti.*

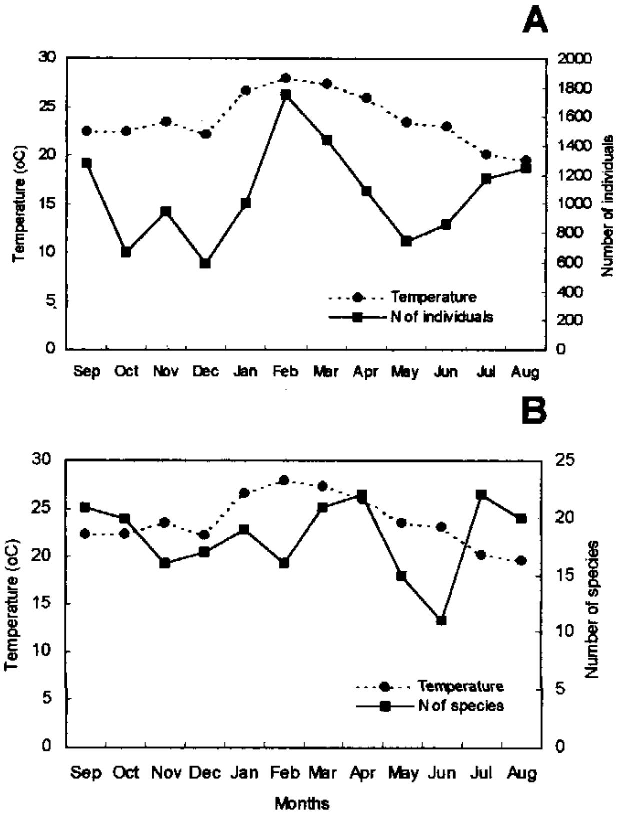

Figure. 4. Number of individuals (A) and species (B) as a function of temperature throughout the study period (September 1995 to August 1996) in Ubatuba Bay for transects and subareas combined.

Bay. As discussed by Fransozo et al. (1998) in a study of anomurans, the above percentage may be regarded as relatively high, considering the small area of this bay compared to the extent of the Brazilian coast. The present study revealed a diversity at least two times higher than that obtained in similar studies in the Ubatuba region carried out by Fransozo et al. (1992) in Fortaleza Bay, and by Negreiros-Fransozo and Nakagaki (1998) in Ubatuba Bay. It is likely that this difference was partly due to the sampling methodology (higher capture effort associated with the higher number of sampled subareas).

In all three study areas the dominant families in terms of numbers of individuals were the Portunidae and Calappidae. The largest temporal variation in species composition and density was strongly influenced by two species, *C. ornatus* and *C. danae*. The relatively large abundance of both species is probably due to their high fecundity as they have more than one reproductive cycle a year in this bay (Costa and Negreiros-Fransozo 1998, Mantelatto and Fransozo 1999b). Even though *C. danae* was common in the three aforementioned transects it only dominated the transect VIII collections. *Callinectes ornatus* was the most common brachyuran species in every other transect in addition to being common in transect VIII. This pattern was also found by Negreiros-Fransozo and Fransozo (1995) in Fortaleza Bay, adjacent to Ubatuba. *Callinectes danae* was most frequent in subareas 6, 7, and 8 influenced by freshwater. Euryhaline species such as *C. ornatus* and *C. danae* are found at both low and high salinity environments, as function of their growth, development, spawn, and larvae dispersion phases.

Among the environmental factors that influence the occurrence of brachyuran crabs in Ubatuba Bay, the sediment texture and organic content may be the most important agents. Both parameters accounted for the spatial distribution of *H. pudibundus* and *C. ornatus* in the Ubatuba region, studied by Mantelatto et al. (1995) and Mantelatto (2000), respectively.

Although environmental factors can delimit the distribution of benthic species (Pinheiro et al. 1996), their relative importance may differ among species, for the same species in different regions, or in the same region in different years. According to Fransozo et al. (1998), organic matter was deposited among sediment particles or laid over the substratum as a covering layer in Ubatuba Bay, with biogenic fragments mainly consisting of remains of polychaetes, mollusks, crustaceans, and echinoderms. In this study the organic matter content of the substrate was much higher than data reported previously for three other areas of Ubatuba region (see Mantelatto and Fransozo 1999a). Since organic matter has been known to play an essential role in benthic crustacean distribution, it along with abiotic conditions such as salinity, sediment size, and temperature, may determine the development and establishment of benthic invertebrates in Ubatuba.

One purpose of this study was to delimit both spatially and chronologically the brachyuran distribution in Ubatuba Bay so as to identify important parameters for experimental investigations to determine their relative influence on specific brachyuran species.

The number of individuals collected and the species diversity

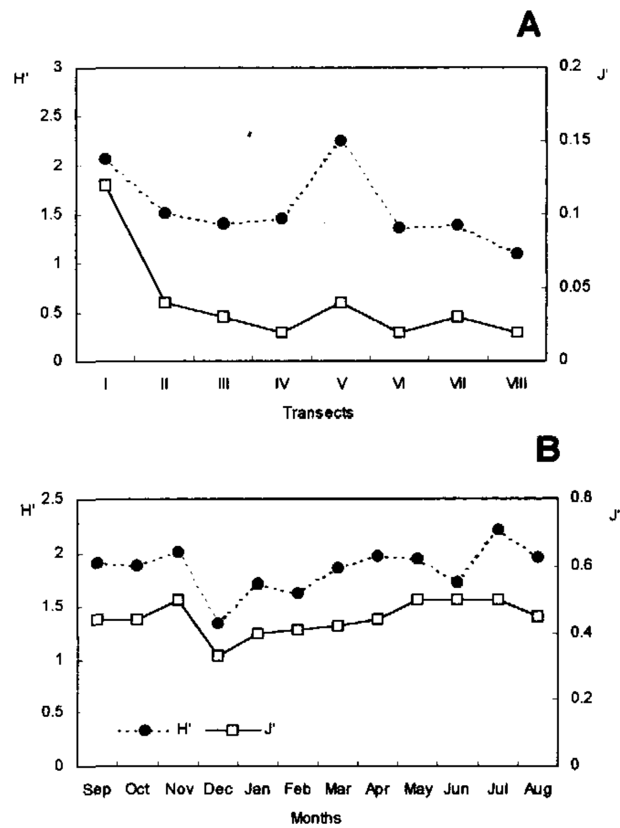

Figure. 5. Spatial and monthly oscillation of diversity (H') and equitability (J') for both each transect area (A) and month (B) during the study period (September 1995 to August 1996) in Ubatuba Bay for transects and subareas combined.

TABLE 4.

Number of individuals of the most abundant species from monthly sampling on eight subareas.

Subareas	Months												Total
	S/95	O	N	D	J/96	F	M	A	M	J	J	A	
Hepatus pudibundus													
I	32	20	17	6	16	60	30	–	1	18	55	11	266
II	9	4	5	2	11	4	5	2	1	2	–	5	50
III	20	5	8	4	21	1	1	1	1	7	12	5	86
IV	2	5	1	–	–	–	–	13	14	2	33	26	96
V	22	–	4	1	–	–	–	5	2	–	–	1	35
VI	45	47	71	18	20	16	17	18	8	20	25	63	368
VII	3	18	7	9	19	3	1	–	2	2	2	4	70
VIII	–	2	4	–	1	–	1	–	–	2	3	2	15
Persephona mediterranea													
I	19	8	17	3	14	3	8	–	–	1	24	8	105
II	–	–	–	–	–	–	–	–	–	–	2	–	02
III	–	–	–	–	–	–	–	–	–	–	1	–	01
IV	–	3	1	–	–	–	–	–	1	1	2	4	12
V	2	–	–	–	–	–	–	–	–	–	–	–	02
VI	–	–	–	–	–	–	1	–	–	1	–	1	03
VII	–	–	–	–	1	–	–	–	–	–	–	–	01
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Persephona punctata													
I	1	–	4	–	–	2	1	–	–	–	3	9	30
II	1	–	–	–	3	–	–	–	–	1	–	–	05
III	2	–	–	2	–	–	–	–	–	–	–	1	05
IV	1	2	–	–	–	1	–	5	4	–	25	32	70
V	52	–	12	1	1	–	–	1	1	–	–	–	68
VI	13	15	27	2	2	8	4	6	4	6	25	69	181
VII	–	–	–	1	3	–	1	–	1	1	1	3	11
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Libinia ferreirae													
I	–	2	1	–	–	1	–	–	–	–	1	–	05
II	–	–	1	–	–	–	–	–	1	–	1	4	07
III	–	–	2	1	–	–	–	–	–	1	–	1	05
IV	–	–	3	1	–	–	–	–	–	–	4	4	12
V	2	2	–	–	–	–	–	–	–	–	–	1	05
VI	–	–	4	–	–	–	–	2	–	–	3	–	09
VII	–	–	–	–	–	1	–	–	–	–	5	1	07
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Arenaeus cribrarius													
I	16	17	19	8	8	49	28	1	12	23	22	10	213
II	15	8	5	2	11	14	7	3	13	9	7	4	98
III	–	–	1	–	1	–	–	–	–	–	–	–	02
IV	–	–	–	–	–	–	–	–	1	–	–	–	01
V	–	–	–	–	–	–	–	–	–	–	–	–	–
VI	–	–	–	–	–	–	–	–	–	–	–	–	–
VII	2	6	–	10	8	1	–	11	11	8	17	11	85
VIII	–	2	3	–	6	2	–	12	2	5	15	–	47
Callinectes danae													
I	1	–	–	–	–	2	–	–	–	–	1	–	04
II	1	1	–	1	1	1	4	1	1	5	–	–	16
III	5	2	3	–	–	5	23	4	15	16	11	2	86
IV	1	–	–	–	–	–	5	1	1	–	1	–	09
V	–	–	–	–	–	–	–	–	–	–	–	–	–
VI	20	20	38	7	5	34	33	35	30	72	56	43	393
VII	10	5	20	7	9	40	86	18	39	16	10	12	272
VIII	66	19	21	13	99	433	391	175	76	160	110	63	1626
Callinectes ornatus													
I	41	19	23	21	16	154	114	5	7	27	8	1	436
II	47	7	11	39	81	108	32	22	17	33	9	16	422
III	41	12	13	71	60	51	103	23	17	36	21	41	489

TABLE 4.

continued

Subareas	Months												Total
	S/95	O	N	D	J/96	F	M	A	M	J	J	A	
IV	42	52	47	58	5	2	5	277	155	43	164	261	1111
V	400	15	89	5	8	107	13	117	45	6	21	8	834
VI	215	236	359	173	296	230	246	157	134	198	309	357	2910
VII	25	48	28	72	126	110	65	12	38	38	42	53	657
VIII	13	37	22	27	104	269	114	49	17	85	74	55	866
Charybdis hellerii													
I	–	–	–	–	–	–	–	–	–	–	–	–	–
II	–	–	–	–	–	–	–	1	–	–	–	–	01
III	–	–	–	–	–	–	–	–	–	–	–	–	–
IV	–	–	–	–	–	–	1	1	–	1	1	–	04
V	07	01	06	–	–	–	15	36	32	1	14	19	131
VI	–	–	01	–	–	–	–	2	–	–	–	–	03
VII	–	–	–	–	–	–	–	–	–	–	–	–	–
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Portunus spinimanus													
I	–	–	–	–	–	–	–	–	–	–	–	–	–
II	–	–	–	–	–	1	–	–	–	–	–	–	01
III	–	–	–	–	–	–	–	–	–	–	–	–	–
IV	14	–	5	6	8	–	–	9	16	3	2	2	65
V	47	14	29	–	5	3	2	14	5	8	6	10	143
VI	–	1	1	–	1	1	–	–	–	–	–	1	05
VII	–	–	–	–	1	–	–	–	–	–	–	–	01
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Hexapanopeus paulensis													
I	–	–	–	–	–	–	–	–	–	–	–	–	–
II	–	–	–	–	2	–	–	1	–	1	–	–	04
III	–	–	–	–	–	–	–	–	–	–	1	–	01
IV	–	–	–	–	3	1	–	4	–	–	–	1	09
V	1	–	–	3	2	2	4	4	–	1	–	4	21
VI	–	–	–	–	–	–	–	9	5	–	1	–	15
VII	–	–	–	–	–	–	–	–	–	–	–	–	–
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–
Hexapanopeus schmitti													
I	–	–	–	–	–	–	–	–	–	–	–	–	–
II	–	–	–	–	–	–	–	1	–	–	–	–	01
III	–	–	–	–	–	–	–	–	–	–	–	–	–
IV	1	–	–	2	–	4	5	12	–	–	–	–	24
V	–	–	–	1	9	1	23	1	–	–	–	–	35
VI	–	–	–	–	–	–	19	–	–	–	–	–	19
VII	–	–	–	–	–	–	–	–	–	–	–	–	–
VIII	–	–	–	–	–	–	–	–	–	–	–	–	–

increased during the summer months in the Ubatuba region. This can be explained by the interaction of two water masses, i.e. Coastal Water (CW) and South Atlantic Central Water (SACW), with temporal and spatial effects dependent on the penetration intensity of SACW. The SACW is rich in nutrients and when it reaches shallow areas in summer primary production increases causing pronounced eutrophication. Consequently, more food should be channeled to the benthos in summer, which would explain the seasonal variation in its biomass (Pires 1992).

We infer that both brachyuran community composition and diversity are controlled, at least in part, by seasonal abundance of dominant species associated with monthly changes in environmental conditions (Table 3). In this respect, intra- or interspecific factors (segregation of the sexes, competition, prey-predator relations, reproductive, and molt cycles, among others) could act to partition the resources of living space during a specific period when more food is available to adults or larvae (Mantelatto 2000). Alternatively, the presence of rare species such as *Collodes inermis*, *Podochela riisei*, and *Portunus ventralis* reported by Góes et al. (1998) might be the result of accidental introduction by offshore fishermen who sort their catch in Ubatuba Bay before taking it to commercial wholesalers.

Because of the large number of species and individuals documented in this study, it is difficult to explain in full the brachyuran distribution in this bay, but we may infer, as reported for *Callinectes ornatus* in a previous study, that the presence or absence in an area results from interdependence between phases of ontogenetic development and the conditions of the physical environment (Mantelatto 2000). Field observations on the extent of wave intensity, buoy movements, fishing sites, commercial trawling activity, scuba diving, and deposition of particles in the subareas implied the existence of a strong circulation, with a predominant inflow reaching successively the following subareas: 1→2→7→8. Mantelatto and Fransozo (1999a), found subareas 4 and 5 to be reproductive sites judging by the numerous ovigerous females of Brachyura and Anomura collected there, suggesting that these subareas are favorable to brooding and larval dispersion. The greater number of species (31) in subareas 4 and 5 (southern portion of bay) and the presence of 22 species found nowhere else in the bay probably is related to the higher density of biogenic fragments and the proximity of a steep, protective coastal shoreline. This idea is supported by the presence of predominant species such as *A. violaceus, N. brasiliensis, S. seticornis, C. hellerii*, and *P. reticulatus*, which live in consolidated habitats (reefs) or in association with algae, and not in the non-consolidated area. In this way the abiotic conditions and intra- or interspecific relationships may be cross-correlated and lead to the distribution observed.

The present study documents the distribution of some 50 species of Brachyura found in Ubatuba Bay and points out the need for more detailed studies on the environmental parameters, biodiversity, larval dispersion, and larval settlement in different biotopes to improve knowledge of the underlying factors determining population structure and dynamics of the brachyuran community of this important faunal transition zone on the northern coast of São Paulo State.

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