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Biodiversity, distribution and abundance of shrimps Penaeoidea and Caridea communities in a region the vicinity of upwelling in Southeastern of Brazil

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ABSTRACT - This study evaluated the spatial-temporal distribution of the abundance of Caridean and Penaeid shrimps during the period of two years in the coastal region of Macaé, state of Rio de Janeiro, southeastern Brazil, using ecological indices (Shannon-Wiener diversity and Pielou's equitability). Monthly samples were carried out from March 2008 to February 2010 distributed in six stations located Inner Area (5, 10 and 15 m depth) and Outer Area (25, 35 and 45 m depth) using a commercial fishery boat equipped with an otter-trawl net. Water samples were taken for determination of temperature and salinity, and sediment samples for determination of texture and organic matter content. Ten species of Decapoda, including Penaeids and Carideans, have been identified, from a total of 49.941 collected individuals. There was a strong correlation between Penaeid and Caridean shrimps abundance and the bottom temperature and sediment. It could be inferred that *Artemesia longinaris* acted as a keystone species regulating the shrimps community in the coast of Macaé, given that both species diversity and equitability were controlled by the migratory events of *A. longinaris* following the variations in temperature caused by the SACW. These results provide as a basis for management actions to prevent significant losses of population stocks since it is an important marine area considering of its peculiar relevance to the fishery.

Key words: Abiotic factors, *Artemesia longinaris,* Decapoda, *Pleoticus muelleri*, *Xiphopenaeus kroyeri*

Introduction

The knowledge on the relationship between organisms and the environmental characteristics where they live permits diagnosing environmental impacts in an efficient way and, in the case of fishery regions, to allow for a rational exploitation of resources (Santos, 2000). Thus, investigating ecological aspects of species in these regions, particularly those of economical importance, are highly relevant, given that studies on their biodiversity, abundance and distribution can help adjustments in the use of these resources, as well as to prevent substantial decreases in their populations (Fransozo *et al.*, 2002).

Water temperature, substrate type, and the circulation of marine currents have a strong influence on the composition of crustacean communities (Chou, 1999). According to Clarke *et al.* (1993), the structure of organisms in a community can modify with an increase in depth of water and with a change in the substrate. Variation in the distribution and abundance of organisms can also result from processes related to their life cycle, such as birth, death, and dispersal (Castilho *et al.*, 2007; Costa *et al.*, 2005, 2007, 2008; Castro *et al.,* 2005, Simões *et al.,* 2010). In the case of Penaeoid shrimps, sediment is a factor of great importance in their choice of habitat given that many species display the behavior of burying, which has an important function in the defense of these organisms against predators or environmental changes (Freire *et al.*, 2011).

The Penaeoid shrimps *Artemesia longinaris* Spence Bate, 1888 and *Pleoticus muelleri* (Spence Bate, 1888) usually prefer substrates with higher mud and silt content (Dall *et al.,* 1990; Costa *et al.*, 2007). Coastal species such as *Xiphopenaeus kroyeri* (Heller, 1862) was usually strongly associated with fine and very fine sand and mud (Costa *et al.*, 2011; Freire *et al.*, 2011).

Studies concerning the composition and distribution of crustaceans were conducted in southeastern Brazil (Pires-Vanin, 1993; Nakagaki *et al.*, 1995; Fransozo *et al.*, 2002; De Léo and Pires-Vanin, 2006), especially on the coast of São Paulo. However, this kind of studies are scarce on the coast of Rio de Janeiro, a region with peculiar characteristics due to the dynamics of water masses and upwelling event that provides an increase in the concentration of nutrients in the water and thus increases the primary productivity. Only the studies of Sancinetti *et al.* (in press) in the same region of the present study and Semensato and Di Beneditto (2008) somewhat further north were performed with the species *A. longinaris* focusing on the reproduction of the species.

Considering the region is widely exploited by fishing activity and that this is an area with distinct characteristics such as high water nutrients concentration and lower water temperatures at certain periods due to the influence of the Cabo Frio upwelling, the goal of the present study was to survey the Caridea and Penaeoidea faunas on the coast of Macaé, northern coast of the state of Rio de Janeiro, Brazil, focusing on community composition in relation to depth, and diversity patterns. The influence of environmental factors on the species distribution patterns was also investigated.

Material and Methods

Samples were obtained monthly from March 2008 to February 2010 (Autumn: March-May; and so on) in Macaé, state of Rio de Janeiro, Brazil (22° 22'S and 41° 46'W) (Fig. 1).

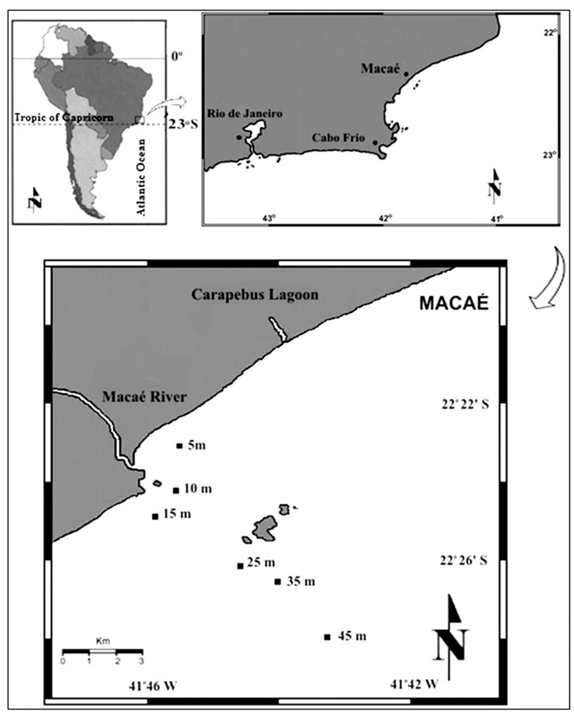

Figure 1. Map of the coast of Macaé and the position of the collection sites sampled in Inner Area (5, 10 and 15 m) and in Outer Area (25, 35, 45 m). The figure below is a zoom of the first two figures above.

According to Castro-Filho *et al.* (1987), the region of Macaé is influenced by the Brazil Current (T > 20°C, S > 36) and the Malvinas Current (T < 15°C, S < 34). During specific periods of the year, the confluence of both currents between latitudes 25° S and 45°S in the western south Atlantic gives forms the

SACW (South American Coastal Waters) (T < 18ºC, S < 36), which accounts for a fraction of the subtropical conversion and gives rise to the Cabo Frio upwelling (Acha *et al.*, 2004). The SACW brings cold, nitrate-rich waters near the coast (Acha *et al.*, 2004), shifting the physical conditions and increasing the concentration of water nutrients (Valentin, 1984). As a consequence, there is an increase in the primary productivity in the southeastern region of Brazil, particularly in Cabo Frio, RJ (23°S) (De Léo and Pires-Vanin, 2006).

Captures were carried out in six stations parallel to the coastline (Fig. 1). The shallowest stations (5, 10 and 15 m depth) were classified in this study as the "Inner Area", whereas the deepest ones (25, 35 and 45 m depth) were classified as "Outer Area". These terminologies were used only to characterize stations closest to the coast (shallow) and those distant (deep).

A shrimp fishing boat equipped with an otter-trawl net (3.5 m of mouth width, 20 mm of mesh size and 15mm in the cod end) was used for trawling. The trawls were standardized in 15 minutes at 2.0 knots. Salinity and temperature (°C) were measured in surface and bottom water samples, obtained monthly in each station using a Van Dorn bottle. In the laboratory, the salinity was verified with a manual salinometer calibrated with distilled water. The water temperature was verified with a mercury thermometer immediately after sampling in a thermic isolated container in the shade. Depth was determined using an echobathymeter coupled with a GPS (Global Positioning System). Sediment samples were also collected at the beginning end of the trawling on alternate months using a Van Veen grab (0.06 m^2).

In the laboratory, shrimp were identified base Holthuis (1952), Pérez-Farfante and Kensley (1997) and Costa *et al.* (2003). The total wet weight (in grams) was obtained for each species in each trawl. A 300g subsample was randomly selected and all individuals were counted. Thus, based on the subsample and the total biomass, the estimate of the total number of individuals of each species in each station was determined.

The sediment was dried at 70°C for 72h in an oven. For the analysis of grain size composition, three 100g sub-samples were separated, treated with 250ml of a NaOH 0.2 N solution and stirred for 5min to release silt and clay particles. Afterwards sub-samples were rinsed on a 0.063-mm sieve. Sediments were sieved in: 2mm (gravel); 2.0-1.0mm (very coarse sand); 1.0-0.5mm (coarse sand); 0.5-0.25mm (medium sand); 0.25-0.125mm (fine sand); 0.125-0.063mm (very fine sand), and smaller particles classified as silt-clay. Cumulative particle size curves were plotted using the phi-scale. The phi values corresponding to 16th, 50th, 84th percentiles were read from the curves to determine the mean diameter of the sediment. This was calculated according to the formula $Md = \Phi_{16} + \Phi_{50} + \Phi_{84}/3$, after that, the phi was calculated using the formula $j = -\log_2 d$, where d = grain diameter (mm) (Hakanson and Jansson, 1983 and Tucker, 1988, respectively). The sediment texture was represented using the three most important grain size classes, as in Magliocca and Kutner (1965). Class A corresponds to sediments in which coarse sand (CS), very coarse sand (VCS), and gravel (G>0.25 mm) account for more than 70% by weight. In class B, fine sand (FS) and very fine sand (VFS) make up more than 70% by weight of sediment samples. More than 70% of sediments in class C are silt and clay (S+C).

The organic matter content (%) was obtained by ash weighing: three aliquots of 10g each per station, placed in porcelain crucibles for 3h at 500°C, and the samples were weighed one more time (Mantelatto and Fransozo, 1999).

The periods under upwelling influence were identified through the Temperature-Salinity diagram (T-S) and monthly difference between the highest surface temperature and the lowest bottom temperature.

The relative abundance (RAb) was calculated for each species, as RAb = n/N*100, where n = abundance recorded for a given species, and N = abundance of all species. The relative occurrence (RO) was represented as

RO = p/P*100, where p = number of samples in which the given species was recorded and P = the total number of samples. The Shannon-Wiener indices of diversity (H'= -∑ pi log2 (pi)) and Pielou's equitability (J'= (H'/ log S) were calculated as indicated by Krebs (1989).

All statistical analyses were performed using the R software (R Development Core Team, 2013), considering α = 0.05. The assumptions of normality were tested by a Shapiro-Wilk test and symmetry and multivariate kurtosis (Mardia, 1980) (with modifications proposed by Doornik and Hansen, 1994; omnibus test). To test the homogeneity of variances, Levene's test was performed (Zar, 2010). In addition, a Box's M test (Anderson, 1958) was performed to assess the equivalence (multivariate homogeneity) between the covariance matrices, with Monte Carlo permutations for the significance level.

A PERMANOVA analysis (permutational multivariate ANOVA) (Anderson *et al.*, 2008) was used to investigate the effects of different factors, including interaction effects on the diversity and equitability indices. It was used an experimental design with 2 factors: station (2 levels: shallow and deep), year-season (8 levels: 2 years; 4 seasons).

It was performed a Redundancy Analysis (RDA) to assess the relationship between species abundance and abiotic factors. The evaluation of the significance of the adjustment of vectors occurred by permutations (n = 9999) using the statistical "goodness of fit" of the correlation coefficient squared (r^2). For environmental variables, the coefficient was defined as r^2 = 1- SSw/SSt, where: SSw – sum of the squares within the groups, and SSt – total sum of squares (Oksanen *et al.*, 2012).

Results

During the study period the water masses Coastal Water (CW), Tropical Water (TW) and South Atlantic Central Water (SACW) were identified. It was evident the influence of SACW during spring-summer months in both years, and in autumn (March-April) of the second year (Fig. 2).

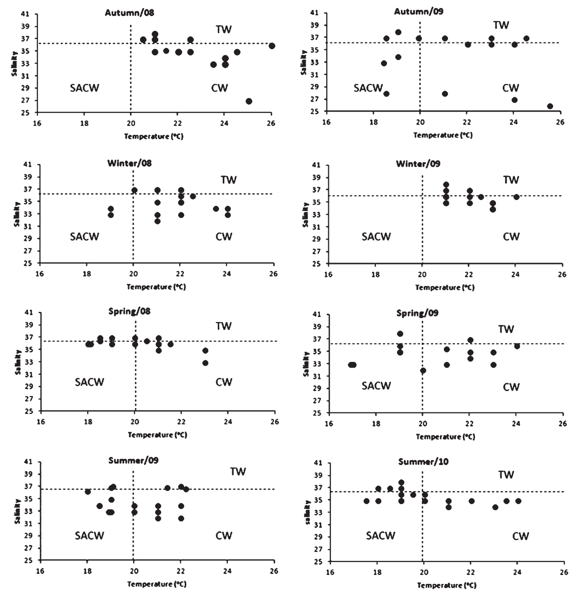

Figure 2. T-S Diagram showing the temporal variation of water temperature and salinity during the sampling period at upwelling area studied, Southeastern coast of Brazil. CW, Coastal Water; TW, Tropical Water; SACW, South Atlantic Central Water. (Autumn: March-May; Winter: June-August; Spring: September-November; and Summer: December-February).

A total of 49.441 individuals were captured, including 3 families belonging to the Penaeoidea group (Penaeidae, Solenoceridae and Sicyoniidae) and 2 families belonging to the Caridea group (Palaemonidae and Hippolytidae). The family Penaeidae was represented by the highest number of species (5 species). *Artemesia longinaris*, *Pleoticus muelleri* and *Xiphopenaeus kroyeri* (Heller, 1862) comprised more than 90% of the total number of individuals, and were also the only species recorded in all samples (Tabs. 1 and 2).

The species *A. longinaris*, *X. kroyeri* and *P. muelleri* had the highest relative abundances, followed by *Nematopalaemon schmitti* (Holthuis, 1950) and *Exhippolysmata oplophoroides* (Holthuis, 1950), respectively. *A. longinaris, P. muelleri, Farfantepenaeus brasiliensis* (Latreffle, 1817), *Farfantepenaeus paulensis* (Pérez-Farfante, 1967), *Sicyonia typica* (Boeck, 1864) and *Sicyonia dorsalis* Kingsley, 1878 had higher relative occurrences in the deeper stations. Whereas the species *X. kroyeri*, *E. oplophoroides, N. schmitti* and *Litopenaeus schmitti* (Burkenroad, 1936) had higher relative occurrences in the shallow area.

Table 1. Absolute abundance, Relative abundance (RAb) and Relative Occurrence (RO) of shrimps sampled in each station from March 2008 to February 2010 on the coast of Macaé.

FAMILIES/SPECIES	STATIONS (m)					
	5	10	15	25	35	45
PENAEIDAE						
Artemesia longinaris	1.027	7.539	5.053	7.870	4.319	835
RA (%)	**18.1**	**77.7**	**76.9**	**58.0**	**44.4**	**19.9**
RO (%)	**29.9**	**29.7**	**31.2**	**34.8**	**32.2**	**33.3**
Xiphopenaeus kroyeri	4.182	1.646	1.042	156	101	19
RA (%)	**73.6**	**17.0**	**15.9**	**1.1**	**1.0**	**0.5**
RO (%)	**34.3**	**29.7**	**28.6**	**15.9**	**13.6**	**2.6**
Farfantepenaeus brasiliensis	0	0	0	3	2	23
RA (%)	**0**	**0**	**0**	**0.02**	**0.02**	**0.55**
RO (%)	**0**	**0**	**0**	**2.9**	**3.4**	**25.6**
Farfantepenaeus paulensis	0	0	0	0	0	3
RA (%)	**0**	**0**	**0**	**0**	**0**	**0.07**
RO (%)	**0**	**0**	**0**	**0**	**0**	**2.6**
Litopenaeus schmitti	0	1	0	0	0	0
RA (%)	**0**	**0.01**	**0**	**0**	**0**	**0**
RO (%)	**0**	**1.6**	**0**	**0**	**0**	**0**
Subtotal	5.209	9.186	6.095	8.029	4.422	880
SOLENOCERIDAE						
Pleoticus muelleri	41	80	138	5500	5205	3304
RA (%)	**0.72**	**0.8**	**2.1**	**40.5**	**53.5**	**78.9**
RO (%)	**6.0**	**6.3**	**9.1**	**34.8**	**32.2**	**33.3**
Subtotal	41	80	138	5.500	5.205	3.304
SICYONIIDAE						
Sicyonia dorsalis	0	3	4	35	28	0
RA (%)	**0**	**0.03**	**0.06**	**0.26**	**0.29**	**0**
RO (%)	0	0	5.2	5.8	11.9	0
Sicyonia typica	0	0	0	1	2	3
RA (%)	**0**	**0**	**0**	**0.01**	**0.02**	**0.07**
RO (%)	**0**	**0**	**0**	**1.4**	**1.7**	**2.6**
Subtotal	0	3	4	36	30	3
PALAEMONIDAE						
Nematopalaemon schmitti	379	231	145	4	26	0
RA (%)	**6.7**	**2.4**	**2.2**	**0.03**	**0.27**	**0**
RO (%)	**20.9**	**14.1**	**11.7**	**1.4**	**1.7**	**0**
Subtotal	379	231	145	4	26	0
HIPPOLYTIDAE						
Exhippolysmata oplophoroides	53	201	189	11	37	0
RA (%)	**0.93**	**2.07**	**2.88**	**0.08**	**0.38**	**0**
RO (%)	**9.0**	**15.6**	**14.3**	**1.4**	**1.7**	**0**
Subtotal	53	201	189	11	37	0
Total Abundance	**5.682**	**9.701**	**6.571**	**13.580**	**9.720**	**4.187**

Despite be noted that the diversity and equitability indices followed the inverse of the temperature, i.e., high indices in seasons with low temperature, there was no significant variation in the indices throughout the study (Fig. 3).

The PERMANOVA test indicated no significant difference between diversity and equitability indices and stations (6 depths) (Diversity, PERMANOVA F = 0.47924; p = 0.7943 and Equitability, PERMANOVA F = 0.63184; p = 0.673). However, it was detected significant difference between diversity and

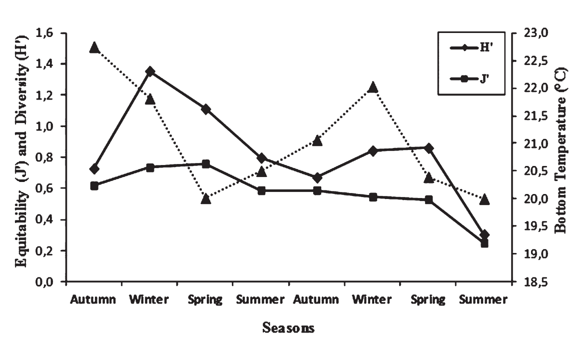

Figure 3. Variation of the Shannon-Winer diversity Index (H`) and Pielou's equitability Index (J`) and the Bottom Temperature during the study period (March 2008 to February 2010) on the coast of Macaé.

Table 2. Percentage and total abundance of shrimps sampled from March 2008 to February 2010 on the coast of Macaé.

	2008												2009										2010	
Families/Species	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**
PENAEIDAE																								
Artemesia longinaris	67	57	44	44	48	40	35	23	36	48.1	68	86.3	89	70	63	64	43	17	27	22	60	62	87	74.4
Xiphopenaeus kroyeri	1.6	15	10	7.3	13	32	13	57	17	8.19	16	10.1	0.1	8.5	28	26	31	37	31	7.1	9.4	17	11	14.2
Farfantepenaeus brasiliensis			0.1						0.2		0.3		0.3	0.3				0.2	0.1	0.1	0.1	0.1		
Farfantepenaeus paulensis																						0.1		
Litopenaeus schimitti																						0.1		
SOLENOCERIDAE																								
Pleoticus muelleri	31	28	45	43	26	7.1	30	5.7	36	42.3	14	0.49	11	21	8.9	10	21	41	39	70	29	20	0.9	11.5
SICYONIIDAE																								
Sicyonia dorsalis									0.2		0.1		0.1		0.1				0.1		0.6	0.9	0.2	
Sicyonia typica					0.1																	0.2		
PALAEMONIDAE																								
Nematopalaemon schimitti				5.2	4	9	15	11	9.3	0.54	1	3.03				0.3	4.8	4.6	2.1		0.2			
HIPPOLYTIDAE																								
Exhippolysmata oplophoroides			0.7	0.4	8.3	12	7.2	3.5	0.6	0.81	0.8	0.07							0.4	0.9	0.8	0.1	0.1	
Total Abundance	**985**	**968**	**3103**	**3269**	**2129**	**520**	**640**	**945**	**475**	**2221**	**898**	**1418**	**728**	**1823**	**2217**	**2225**	**1462**	**1364**	**1267**	**5998**	**6099**	**2123**	**5815**	**749**

equitability indices and years (Diversity, PERMANOVA F = 15.154; p = 0.0003 and Equitability, PERMANOVA F = 13.937; p = 0.0002).

The PERMANOVA analysis using stations (shallow and deep) and year-season as factors showed statistically significant seasonal differences when analyzing each year of sampling and interannual statistical difference in the diversity and equitability indices (Tabs. 3 and 4).

Table 3. Results of PERMANOVA main test of Euclidian distance matrix and 9999 permutations of the normalized values of diversity indices as explanatory variable using station (shallow and deep) and year-season as factors.

Factor	F	df	p
Station	0.076461	1	0.785
Year-season	8.8643	7	**0.0001**
Station X Year-season	1.7328	7	0.1037
Residual	104		
Total	119		

Table 4. Results of PERMANOVA main test of Euclidian distance matrix and 9999 permutations of the normalized values of equitability indices as explanatory variable using station (shallow and deep) and year-season as factors.

Factor	F	df	p
Station	0.14448	1	0,1206
Year-season	0.2109	7	**0,0016**
Station X Year-season	0.0590	7	0,4204
Residual	104		
Total	119		

The RDA performed between abiotic data and species abundance in stations extracted two axes that explained of the total data variance (91.9%). The adjustment algorithm of the environmental variables in RDA identified B.T., O.M., and granulometric classes A and C as significant variables for data variation (Tab. 5; Fig. 4a). Spatially it was observed a positive correlation between the variables B.T. and A, shallower stations and the species *X. kroyeri*; and negative correlation between deeper stations and the species *A. longinaris* and *P. muelleri*. In contrast, variables O.M. and C correlated positively with the deepest stations and the species *A. longinaris* and *P. muelleri* (Fig. 4b). The other species were associated with depths of 10 to 15m.

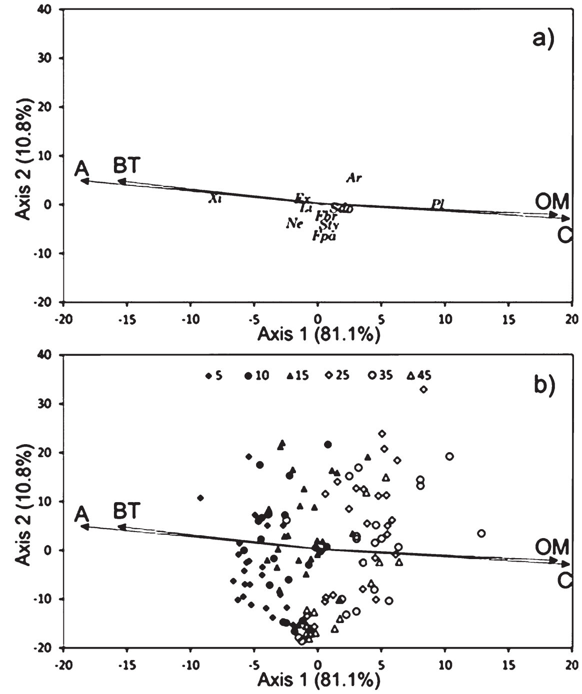

Figure 4. Redundancy Analysis showing the relationship between abiotic variables and species abundance (a) and the relationship between abiotic variables and stations (b) on the coast of Macaé (B.T. = bottom temperature; B.S. = bottom salinity; O.M. = organic matter content; A = sediments in which coarse sand (CS), very coarse sand (VCS), and gravel (G > 0.25 mm) account for more than 70% by weight; B = sediments in which fine sand (FS) and very fine sand (VFS) make up more than 70% by weight; and C = sediments in which silt and clay (S+C) make up more than 70% by weight).

Table 5. Statistical summary of axes generated by Redundancy analysis with final scores of species and correlations for environmental variables.

	Axis			
	RDA1	RDA2	R^2	p
Proportion Explained	81.1%	10.8%		
Species scores				
Xiphopenaeus kroyeri	-7,36239	1,706175		
Artemesia longinaris	2,419894	3,819079		
Farfantepenaeus brasiliensis	0,059645	-0,05272		
Farfantepenaeus paulensis	0,008724	-0,00754		
Litopenaeus schmitti	-0,00737	0,004997		
Pleoticus muelleri	8,406355	0,396255		
Sicyonia dorsalis	0,014969	-0,01239		
Sicyonia typica	0,268294	0,02605		
Nematopalaemon schmitti	-1,52642	-0,11063		
Exhippolysmata oplophoroides	-0,56233	0,326702		
Correlations				
Bottom Temperature	-0,99091	0,134529	0,2239	**0,001**
Bottom Salinity	0,997642	0,068634	0,0144	0,418
Organic Matter content	0,995372	-0,0961	0,38	**0,001**
A	-0,98988	0,141921	0,3274	**0,001**
B	0,753148	-0,65785	0,0447	0,061
C	0,995923	-0,09021	0,3619	**0,001**

Discussion

Considering the limited area covered by the present study it can be concluded that the shrimp fauna of the studied region was well represented. Of all 61 shrimp species in the suborder Dendrobranchiata recorded along the Brazilian coast (D'Incao, 1995), 8 species were captured in the coast of Macaé, being the Penaeidae family the most representative of the group. Previous studies conducted on the northern coast of São Paulo State have showed similar results, as observed by Costa *et al.* (2000) and Fransozo *et al.* (2002). These authors identified a total of 12 and 10 penaeid species, respectively. The species that compose the Penaeidea community along the studied coastal areas of the southeastern Brazil are virtually the same in the present study, comprising non-target species like *S. dorsalis* and *S. typica* and target species like *A. longinaris*, *F. brasiliensis*, *F. paulensis*, *L. schmitti*, *X. kroyeri* and *P. muelleri*.

The diversity of Caridea was lower than that of Penaeidea. The species *E. oplophoroides*, *N. schmitti* and *X. kroyeri* occurred nearby the coast and revealed a similar spatial and temporal distribution as indicated in the literature (Fransozo *et al.*, 2005; Almeida *et al.*, 2012). Such authors suggested that the distribution and the abundance of these species were influenced by the high concentration of biodetritus and plant fragments. In the present study, although these fragments were not quantified, it could be inferred that influence due to the local hydrodynamic conditions, proximity to the continent, as well as the input from the Macaé River.

Artemesia longinaris, *X. kroyeri* and *P. muelleri* were dominant species at spatial and temporal scales throughout the study periods. *Artemesia longinaris* dominance influenced considerably the temporal diversity and equitability values, which decreased when the highest dominance values were recorded, as observed in summer of both years and spring/09.

Several authors have pointed out that some environmental variables, as temperature, salinity and substrate type, make an important ecological role in structuring communities of Decapod crustacean (Fransozo *et al.*, 2002, 2009; De Léo and Pires-Vanin, 2006; Castilho *et al.*, 2008). The present study suggests that the shrimp community distribution in the study region is closely linked to the SACW thermal front seasonality. There were bathymetric and seasonal fluctuations in the distribution of the species in the region resulting from variation in bottom temperature. During spring-summer months in both years, and in autumn (March-April) of the second year there was a strong decrease in bottom temperature, indicating the presence of the South Atlantic Coastal Waters (SACW). The presence of the SACW recorded in the present study promoted the increase in the abundance of the species *A. longinaris* and *P. muelleri*, particularly at the end of the spring, and of the species *A. longinaris* during the entire summer. According to Nascimento (1981), Ruffino (1992) and Costa *et al.* (2004, 2005), *A. longinaris* is typical of colder regions and is considered as migratory, following the SACW. According to D'Incao (1995), species such as *P. muelleri* and *A. longinaris* are broadly distributed in Argentinian waters, where temperatures are usually below 20ºC. The lower water temperature mean values and the increase of nutrient concentration throughout the year might offer similar conditions to the ones found in the South of the continent, where the species is commonly found. Therefore, the study area that is under influence of Cabo Frio upwelling provides a suitable location for the establishment of the species (Sancinetti *et al.*, in press).

The species *X. kroyeri* remained in the region of Macaé all year long, yet its highest abundance was recorded in shallower regions. The presence of the SACW during the spring and summer leads the species to migrate to shallower regions where temperatures are higher and more suitable for their development. Similar results were described for the region of Ubatuba, northern coast of the state of São Paulo (Costa *et al.*, 2007, 2011).

In the studied region, between the beach and the Santana archipelago, there is the formation of a submarine submerged sandy strip that allows for the removal of finer sediments through the action of waves in shallow areas (Garcêz, 2007). This leads to the establishment of a pattern of medium and very coarse sand in the inner areas and a sediment composed of finer grains at depths higher than 15 meters.

The penaeoid shrimps usually prefer substrates with higher mud and silt content, probably to facilitate their burying, and this characteristic may affect their distribution, as observed for Dall *et al.* (1990) and Costa *et al.* (2007, 2011) and Freire *et al.* (2011), *X. kroyeri* was strongly associated with fine and very fine sand and mud content of the substrate. Similar results were observed to *A. longinaris* and *P. muelleri* in the studied area, which were found in finer sediments, however, such results are not supported by the present study for *X. kroyeri*. This study indicates that water temperature may be the spatial regulating factor of the species, in particular, *X. kroyeri*. This shrimp occurs at temperatures above 21°C (Costa *et al.*, 2007). In this study, stations with predominantly muddy sediments showed lower temperature than 21°C. Due to the study area located near upwelling region and under the influence of the SACW, *X. kroyeri* was substantially sampled in areas with depths less than 10m where the sediment showed greater diameter.

The abiotics factors that most influenced the distribution of Penaeidae and Caridea shrimps were the water temperature and the sediment. Therefore, the distinct environmental characteristics of a region makes a particular environmental factor be more important for the distribution patterns of a benthic invertebrates community, and even be a limiting factor in the occupation of a habitat. More generalist species are able to establish with greater success both spatially and temporally may become key-species. Based on the results obtained in the present study, it could be inferred that *A. longinaris* acted as a keystone species regulating the shrimp community in the coast of Macaé, given that both species diversity and equitability were controlled by the migratory events of *A. longinaris* following the variations in temperature caused by the SACW.

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