Ecological distribution of three species of *Persephona* (Brachyura: Leucosiidae) in the Ubatuba region, São Paulo, Brazil.

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Abstract

The purpose of this study is to characterize the most relevant physical parameters at three bays within the Ubatuba region, SP, Brazil, that may explain the spatial and temporal distribution of three *Persephona* species: *P. mediterranea* (Herbst, 1794), *P. punctata* (Linnaeus, 1758) and *P. lichtensteinii* Leach, 1817. Monthly collections were conducted over a 2-yr period (98/99) at Mar Virado, Ubatuba and Ubatumirim bays. Six transects were trawled per bay, covering an area of 18,000m^2. The analyzed environmental factors (temperature, salinity and organic matter) showed seasonal variations related to the dynamics of different water masses in this region. The most abundant species was *P. mediterranea* (1,283 inds) followed by *P. punctata* (340) and *P. lichtensteinii* (139). Number of individuals varied little over the study period indicating seasonal stability. The species *P. mediterranea* was mostly found at the deeper outer transects of each bay, where sediments are mainly composed by very fine sand in the three bays, while *P. punctata* and *P. lichtensteinii* occupy shallower areas where the silt and clay proportion is higher than the others. The spatial distribution is probably related to a set of favorable environmental factors being depth and the texture of the sediment, determinant.

Key words: Distribution, Leucosiidae, physical parameters, *Persephona*, Brazil.

Introduction

Environmental factors are known to be of major importance for the control of community dynamics, mainly in coastal areas where such variables vary considerably according to space and time (Warwick and Uncles, 1980).

Several authors have studied species distribution in relation to the variation of certain environmental factors, such as water temperature, salinity, organic matter contents, sediment texture and depth (Ishikawa, 1989; González-Gurriarán *et al.*, 1991; Santos *et al.,* 1994; Negreiros-Fransozo and Fransozo, 1995; Pinheiro *et al.,* 1996; Mantelatto, 1999). Sediment texture is one of the most relevant factors affecting the distribution of benthic animals since larval stages already exhibit substrate preference. After settlement, changes of sediment composition may occur leading to seasonal displacement of benthic populations (Gray, 1974).

As far as the Brazilian coast is concerned, most studies on the family Leucosiidae have focused on zoogeographic considerations (Coelho and Torres, 1980; Coelho and Ramos-Porto, 1986; Melo *et al.,* 1989; Melo, 1996) and descriptions of new species (Melo and Torres, 1998 a, b). Larval descriptions were carried out for *Persephona mediterranea* (Herbst, 1794) by Negreiros-Fransozo *et al.* (1989), and information on the composition and distribution of brachyuran crabs, including the leucosiids belonging to *Persephona*, are also available (see Fransozo *et al.,* 1992; Negreiros-Fransozo *et al.,* 1992; Hebling *et al.,* 1994; Mantelatto and Fransozo, 2000).

This study aims the analysis of the distribution patterns of three species of leucosiid crabs in the bays of Mar Virado, Ubatuba and Ubatumirim in relation to the prevailing environmental conditions in the Ubatuba region, southeastern Brazil.

Materials and Methods

Monthly trawls over a 2-yr period (1998/99) were carried with the aid of double-rig nets at Mar Virado (MV), Ubatuba (UBA) and Ubatumirim (UBM) bays, all located within the Ubatuba region, SP, Brazil. At each bay, six 2 km transects covering 18,000 m^2 each were delimited at specific sites. Two of them were placed near rocky shores, parallel to the coastline, and the remaining four at the depths of 5, 10, 15 and 20 m depth (Figure 1).

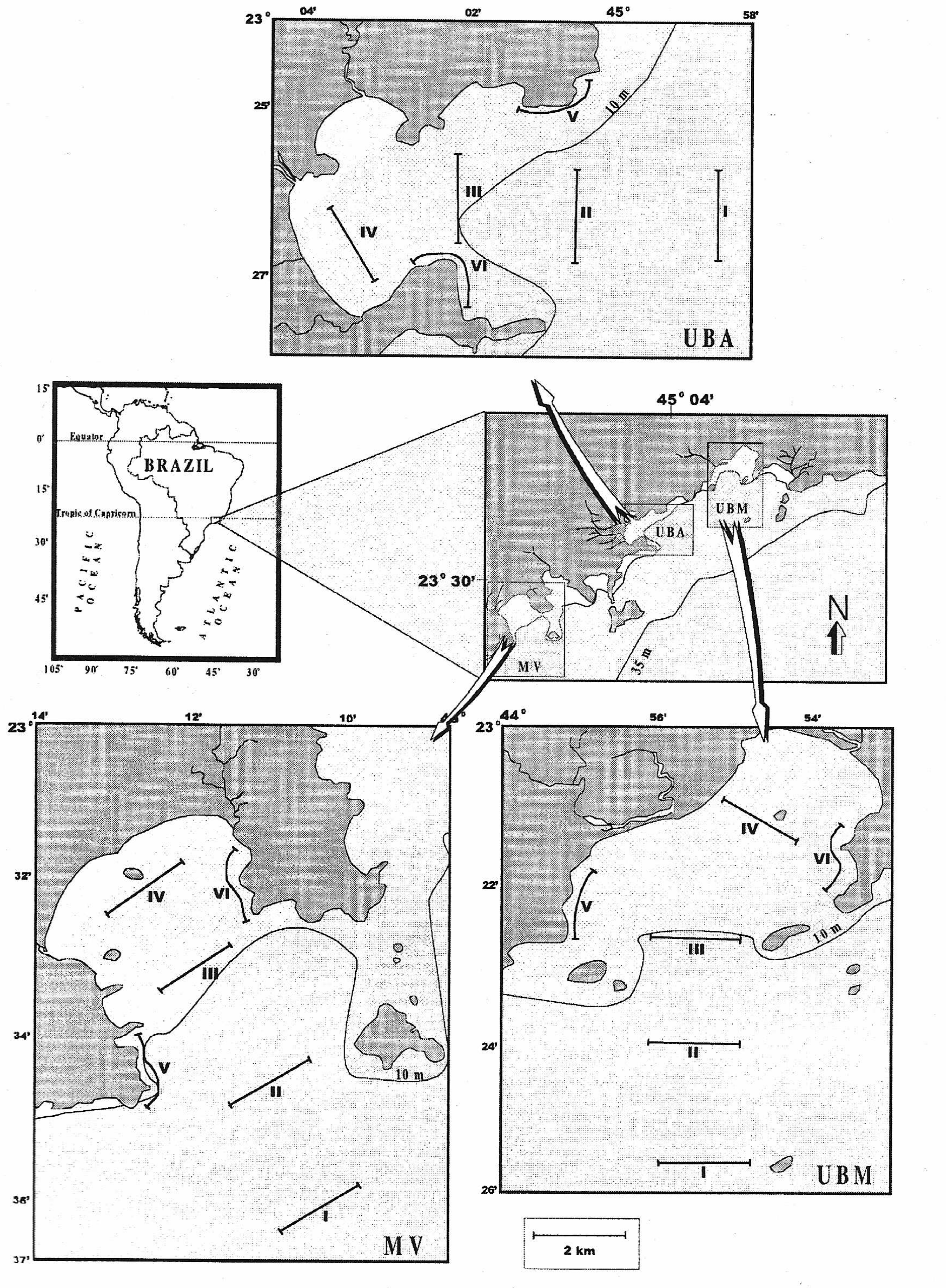


Figure 1. Map of Ubatuba region (São Paulo) showing the bays with the position of the sampling trasects. (MV = Mar Virado; UBA = Ubatuba; UBM = Ubatumirim)

Surface and bottom water samples were monthly collected at all transects using a Nansen bottle. Temperature was measured with a thermometer and salinity with an optical refractometer. Depth was measured at the beginning, midpoint, and end of each transect with an echobathymeter.

Sediment samples were collected seasonally with a 0.06 m^2 Van Veen grab. At the laboratory, the sediment was dried at 70°C for 72h in an oven. For the analysis of grain size composition, two 50-g subsamples were separated, treated with a 250 ml of a NaOH 0.2 N solution and stirred for five minutes to release silt and clay particles. Subsamples were then rinsed on a 0.063-mm sieve. The remaining sediments were dried again and subjected to differential sieving following the Wenthworth (1922) scale.

Cumulative particle size curves were plotted on computer using the phi-scale, phi values corresponding to 16^{th}, 50^{th}, 84^{th} percentiles were read from the curves to determine the mean diameter of the sediment. This was calculated according to the formula given by Folk and Ward (1957): $Md = (\varnothing_{16}+\varnothing_{50}+\varnothing_{84})/3$, after that, the phi was calculated from the formula $\varnothing = -\log_2 d$, where d = grain diameter (mm)(Suguio, 1973).

The organic matter content of sediments was calculated by the difference in their ash free dry weight. Prior to this, three 10-g substrate subsamples were placed in porcelain capsules at 500°C for three hours.

Abundance (number of individuals) values were log-transformed for each species in multiple linear regression analyses for testing the significance of more complex models in which all abiotic factors are simultaneously considered. A stepwise technique was applied to discriminate the most important factors explaining abundance variability (Montgomery and Peck, 1982). The SAS (1996) statistical package was used in the analyses.

Results

Environmental Settings

Grain size composition of sediments along the transects sampled in the examined embayments showed little variation, with a predominance of very fine sand, silt and clay. However, higher heterogeneity was recorded in transects I and VI than in the others transects (Figure 2).

Average grain size varied from medium sand to a combination of silt and clay, while all transects at Mar Virado Bay presented grains of average size higher than 4, that is, silt + clay (Figure 3).

The organic matter content present in the substract was lower in the offshore region (transect I) of the three bays, being the highest mean values obtained in transects III and IV (Figure 4).

As for the bottom salinity it was observed the highest mean values in transect I of the three bays and the lowest in transect IV e VI (Figure 5). As far as months are concerned grouping the obtained values of the three bays it was observed that the lowest mean value of salinity was obtained in October/98 (31.3‰) and the highest in November/99 (36.2 ‰) (Figure 6).

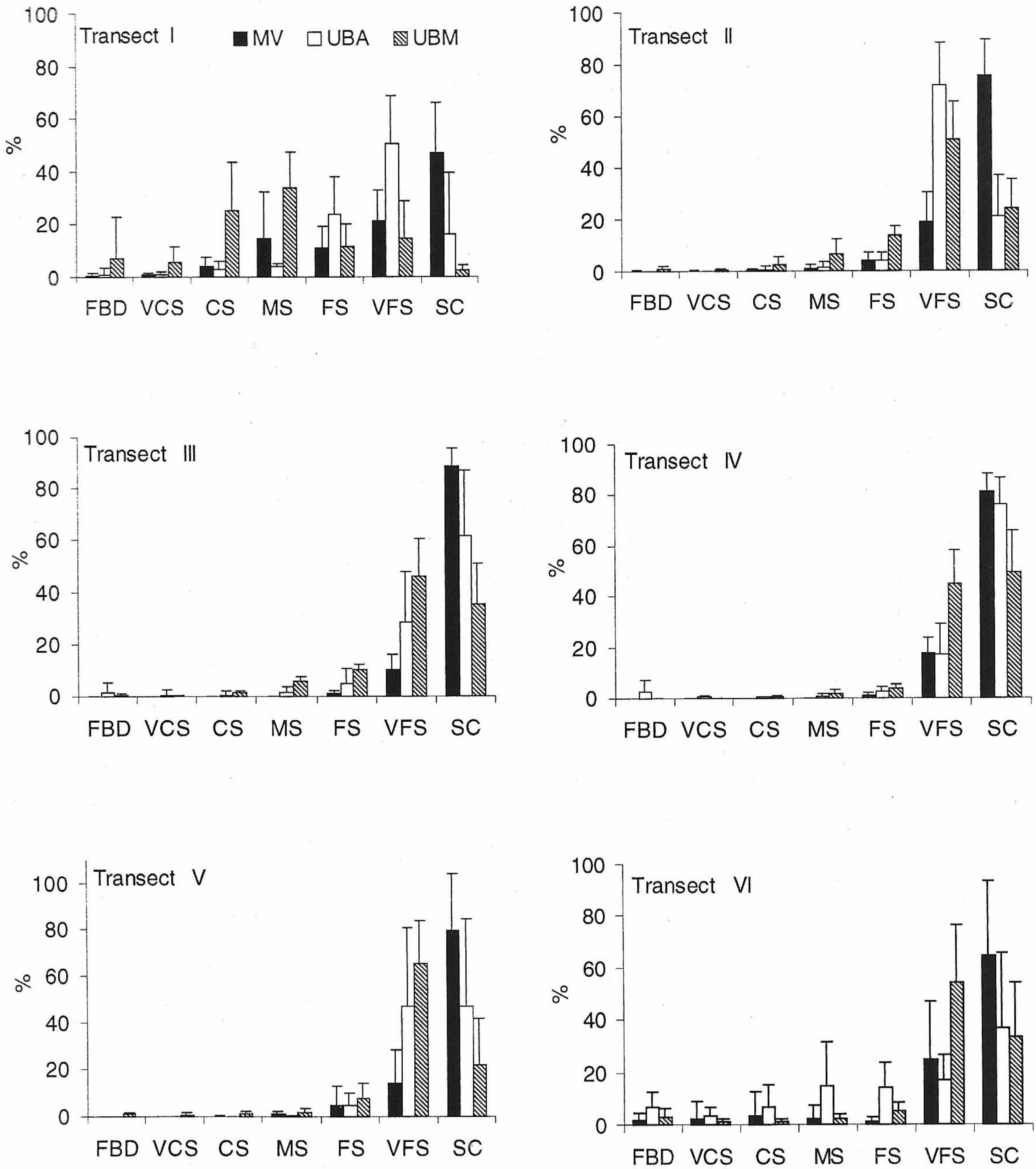
Figure 7 shows the minimum, maximun and mean values of bottom and surface temperatures during the sampled months of the three grouped bays, in which it was observed the highest variation during summer months.

Those bottom temperatures variation at transects during the seasons of both sampled years could be verified in figure 8, in which it was observed a well defined entrance of cold water until transect III in summer and spring months.

Distribution Patterns

The most abundant species was *P. mediterranea* (1,283 inds) followed by *P. punctata* (340) and *P. lichtensteinii* (139). Overall values for each bay are presented in figure 9. The studied species presented a different spatial distribution (Figure 10).

Figure 11 shows the number of individuals over the seasons. No statistical differences were found for temporal variation of *P. mediterranea* (ANOVA, $p > 0.05$), contrasting to *P. punctata*, in which was higher in spring than autumn, and *P. lichtensteinii*, in which the highest number of individuals was found during winter, significantly higher than the autumn (ANOVA, $p < 0.05$).



Granulometric fractions (%)

Figure 2. Mean frequency of granulometric fractions (%) for each transects of the three studied bays. (bars = mean; lines = standard desviation; FDB = biodetrict fragment; VCS = very coarse sand; CS = coarse sand; MS = medium sand; FS = fine sand; VFS = very fine sand; SC = silt + clay).

Multiple regression analyses evidenced significant differences of number of crabs among bays. Lower abundance of *P. mediterranea* was found at Ubatumirim Bay and higher abundance of *P. punctata* at Ubatuba Bay. The number of *P. lichtensteinii* differed among the three sampled sites.

Regarding the abiotic factors, multiple regression analyses for *P. mediterranea* indicated that variation of number of crabs is mostly explained by depth and mean diameter of the sediment (phi), with the latter also presenting a significant quadratic effect in the tested regression model. Depth and abundance are positively correlated. In the case of phi, a positive linear effect is also verified but as phi increases this tendency becomes attenuated, with a negative effect taking place at very high values as reflected in the significant quadratic effect of this variable. In Ubatumirim, where the abundance was the lowest one, the distribution of crabs is explained by the model: $\hat{y} = -4.41 + 0.10depth + 2.24phi - 0.30phi^2$, contrasting to a single model which explains variation for the other two bays: $\hat{y} = -3.55 + 0.10depth + 2.24phi - 0.30phi^2$ (where $\hat{y}$ is the estimated number of individuals).

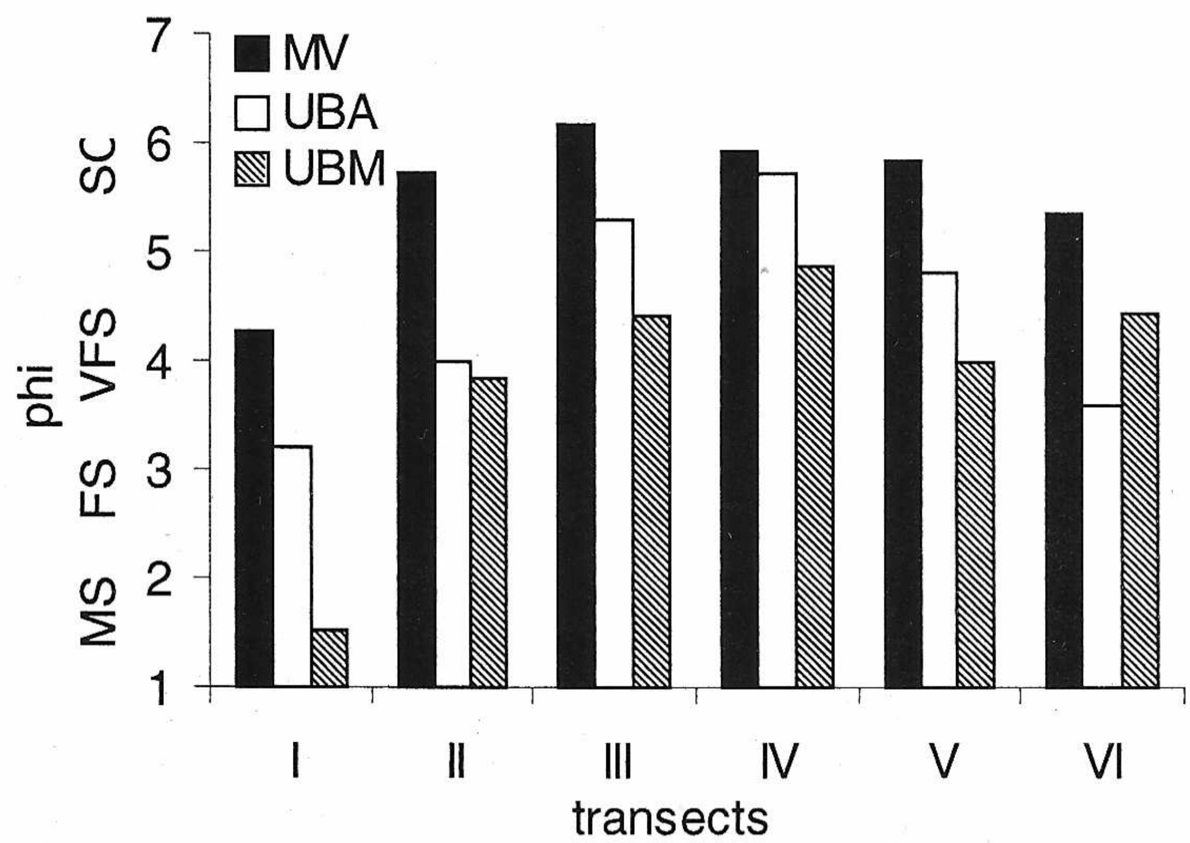


Figure 3. Central tendency of sediment represented by mean diameter (phi) for each transect in the three bays (MS = medium sand; FS = fine sand; VFS = very fine sand; SC = silt + clay; MV = Mar Virado; UBA = Ubatuba; UBM = Ubatumirim).

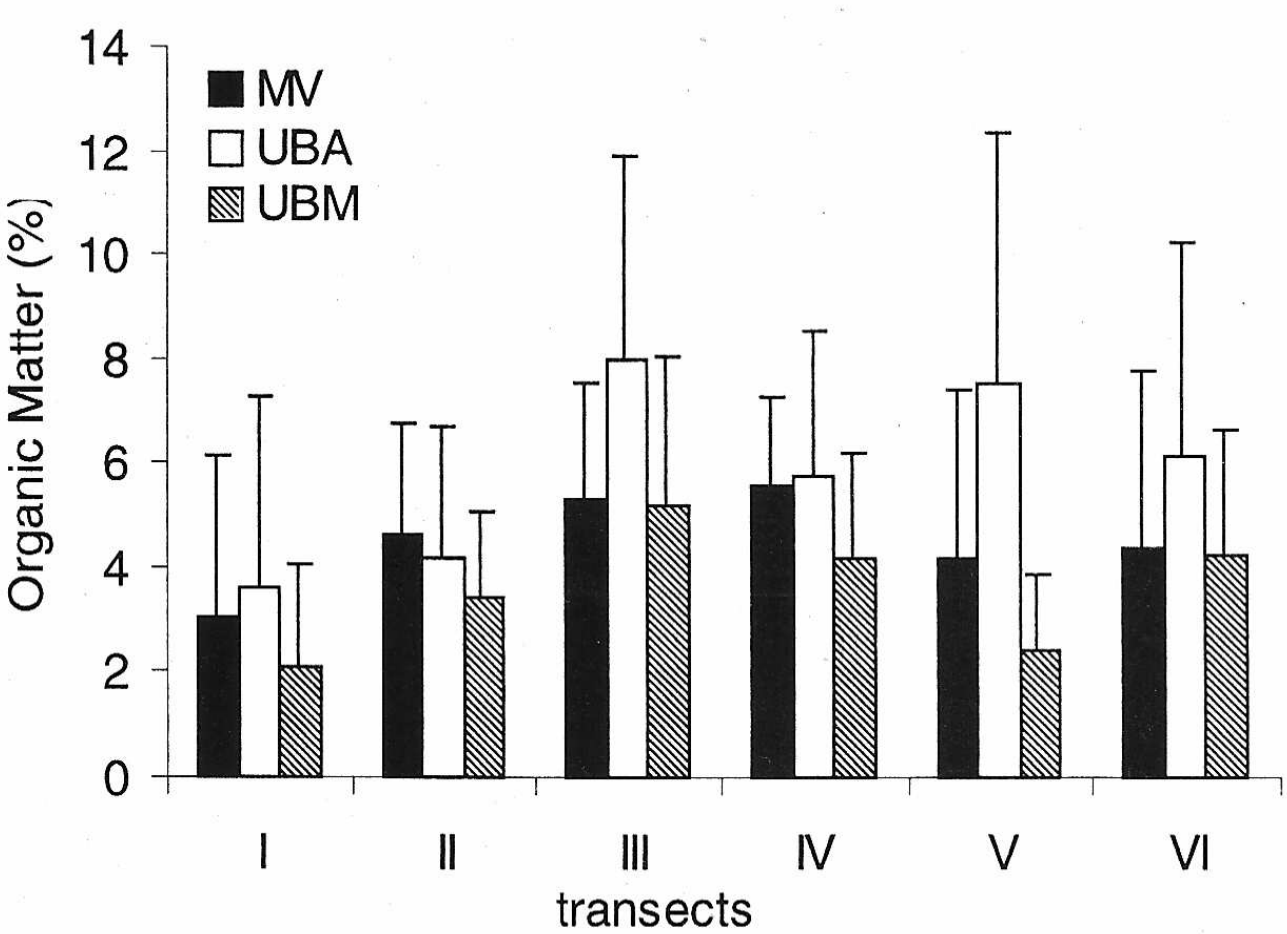


Figure 4. Organic matter mean values for each transect in the three bays (bars = mean; lines = standard desviation; MV = Mar Virado; UBA = Ubatuba; UBM = Ubatumirim).

The abundance variation of *P. punctata* is solely explained by depth, which exerts a negative linear effect. In Ubatuba Bay, where a higher number of individuals was obtained, the model explaining their distribution is $\hat{y} = 0.85 - 0.02depth$, while in the other two bays the following applies: $\hat{y} = 0.62 - 0.02depth$.

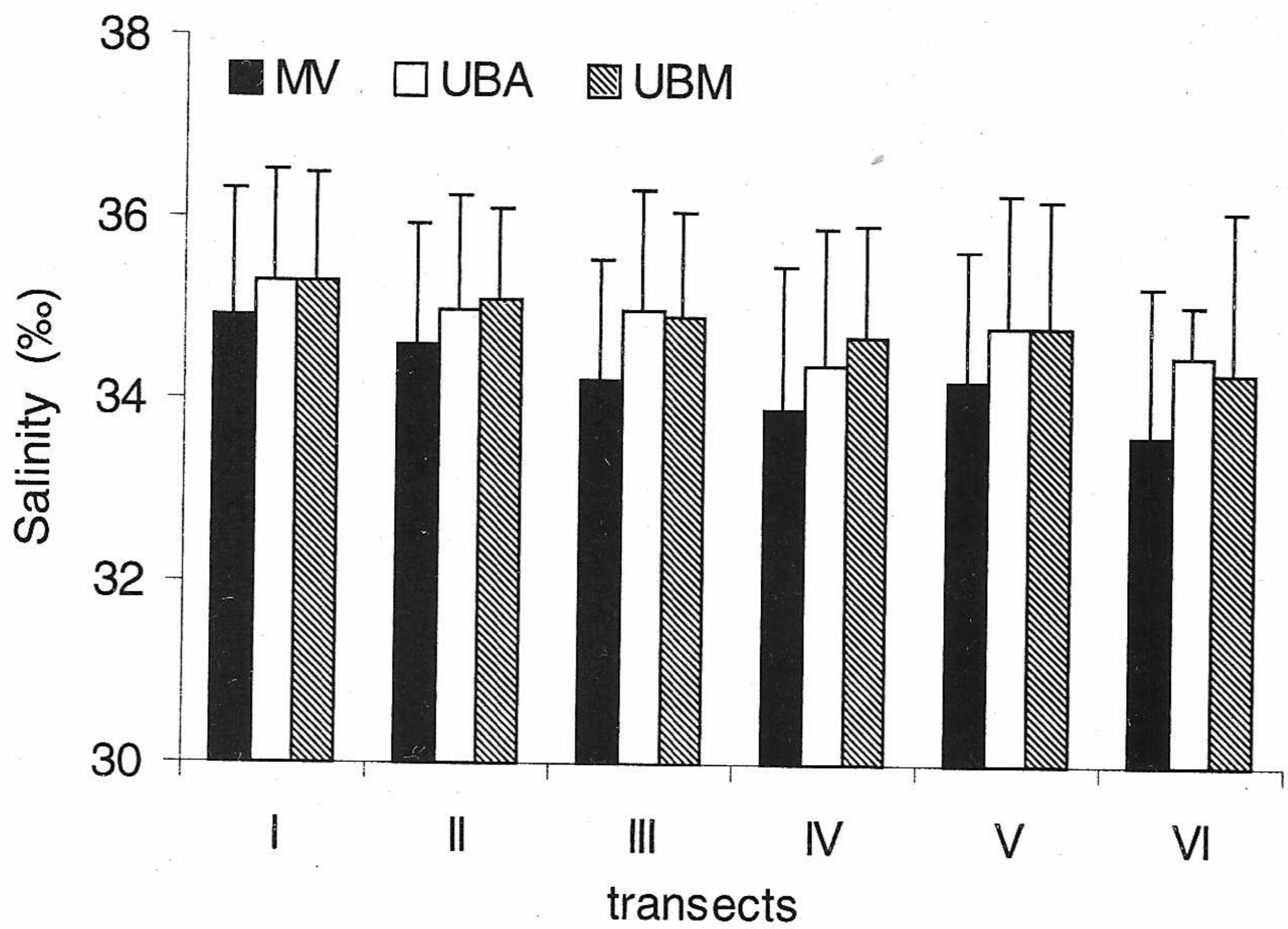


Figure 5. Mean values of bottom salinity for each transect in the three bays (bars = mean; lines = standard desviation; MV = Mar Virado; UBA = Ubatuba; UBM = Ubatumirim).

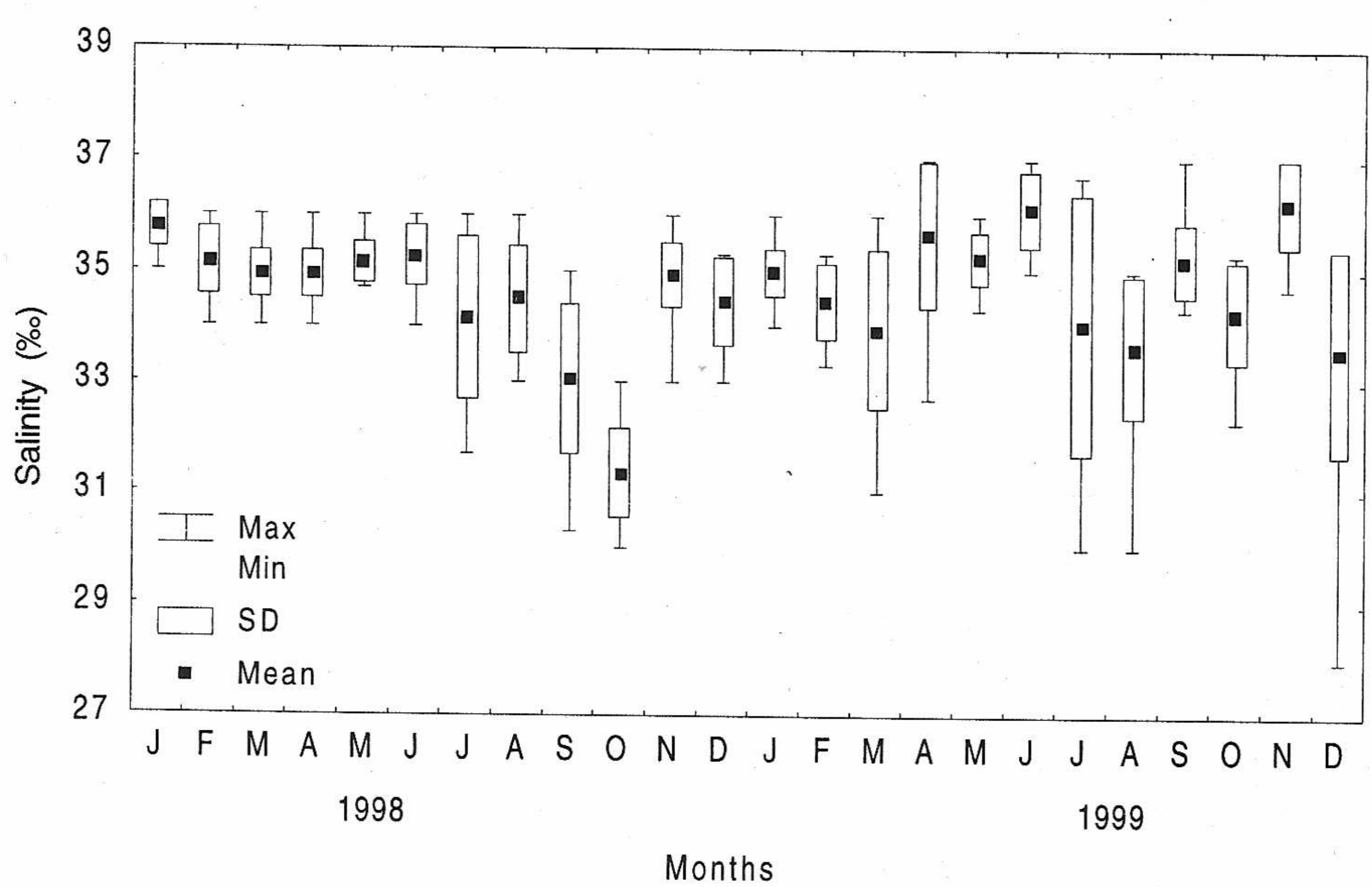


Figure 6. Variation of bottom salinity for two years.

For *P. lichtensteinii,* bottom salinity present a negative linear effect while phi and depth presents a linear positive effect but a negative quadratic one. Since abundance varied among all bays, a different model is proposed to each of them:

Mar Virado: $\hat{y} = -0.88 - 0.04 salinity + 0.09 depth - 0.002 depth^2 + 0.48 phi - 0.04 phi^2$;

Ubatuba: $\hat{y} = -0.61 - 0.04 salinity + 0.09 depth - 0.002 depth^2 + 0.48 phi - 0.04 phi^2$;

Ubatumirim: $\hat{y} = -0.35 - 0.04 salinity + 0.09 depth - 0.002 depth^2 + 0.48 phi - 0.04 phi^2$.

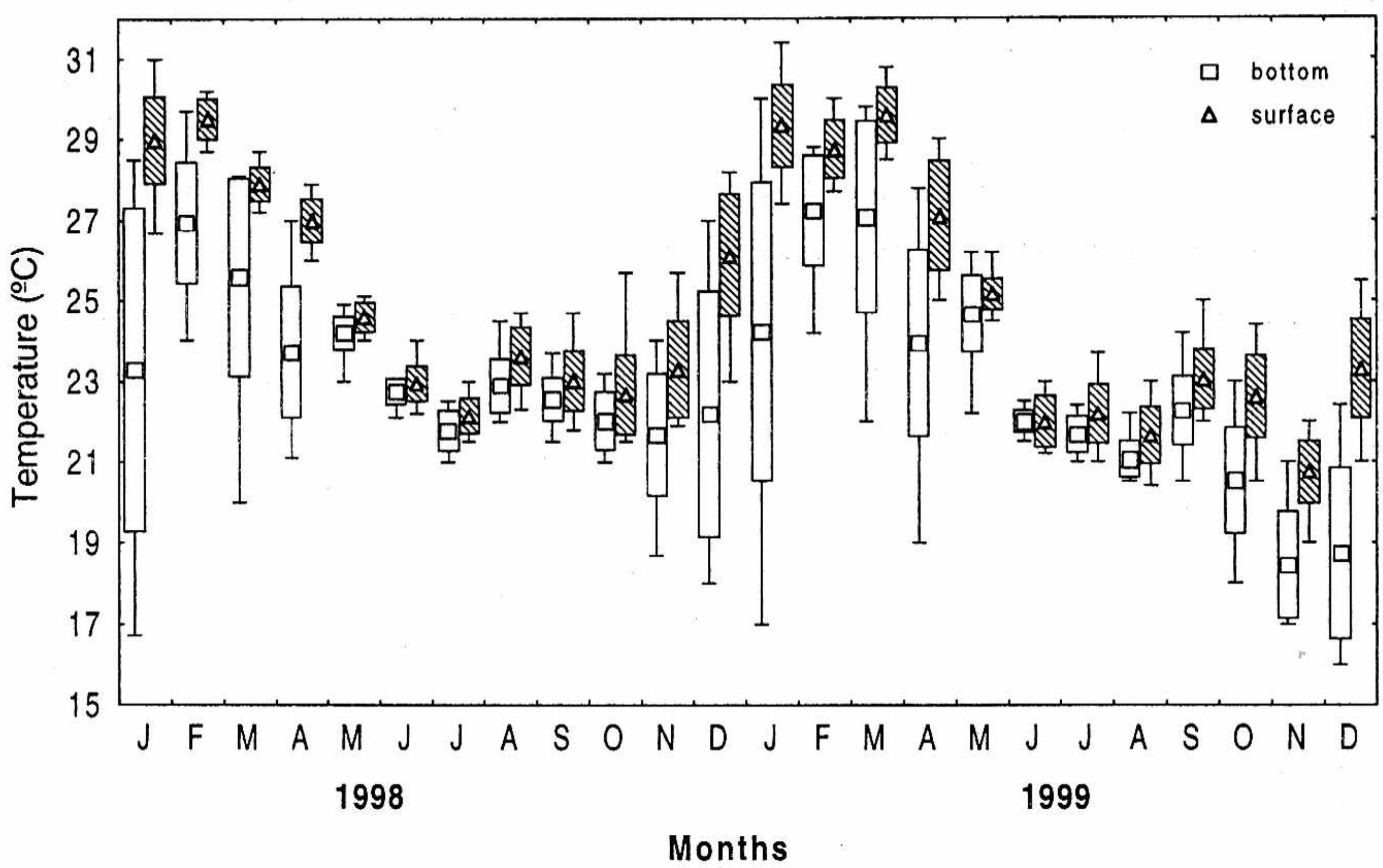


Figure 7. Variation of surface and bottom temperatures for two years (box = standard desviation; lines = minimum and maximum values).

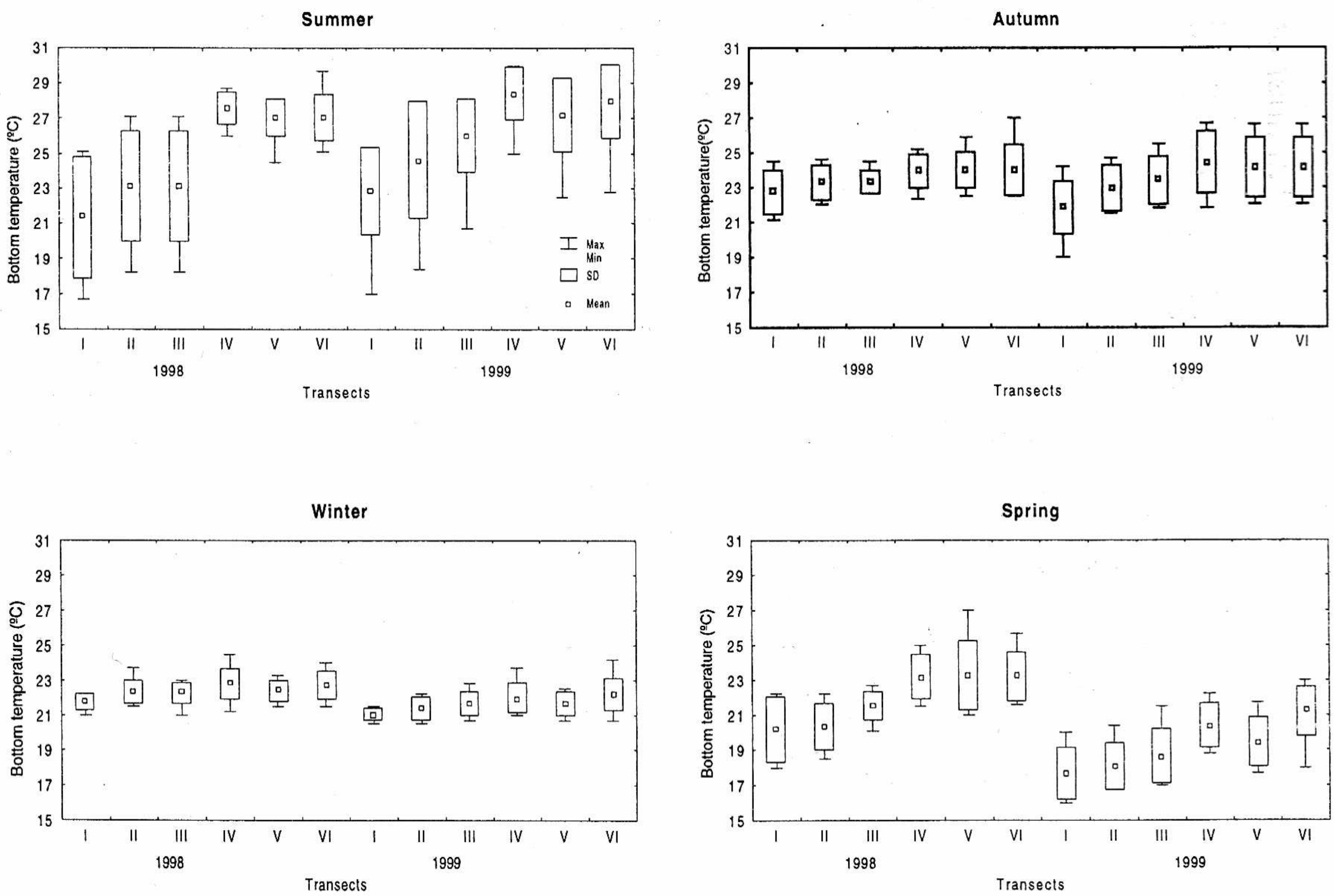


Figure 8. Variation of bottom temperature for each transect by season.

Discussion

Environmental Factors

The present study was carried out at shallow areas with depth always lower than 25 m. According to Castro-Filho *et al.* (1987), this inner region is under the prevailing influence of the coastal water (CW) mass, where salinity is always below 36‰ and temperature usually higher than 20ºC. Higher variation of surface and bottom temperature was observed during summer and spring in both sampled years. During the austral summer, there is a penetration of the cold Southern Atlantic Central Water (SACW) mass reaching the deeper layers of coastal regions forming a well-delimited thermocline (Pires, 1992). These variations were clear as for outer and deeper transects (15 to 20 m), especially when the temperature variation within each transect was analyzed throughout the seasons. Besides, it may be observed that the effect of the SACW is more pronounced during late spring 1999. Thereby, this mechanism directly affects the dynamics and structure of benthic communities year-round. Some decapod species penetrate in this region together with the incoming SACW, as the swimming crab *Portunus spinicarpus* (Stimpson, 1871), mentioned by Pires (1992) and the shrimp *Artemesia longinaris* (Bate, 1888) by Fransozo *et al.* (*in press*), which are species known to live in cold waters.

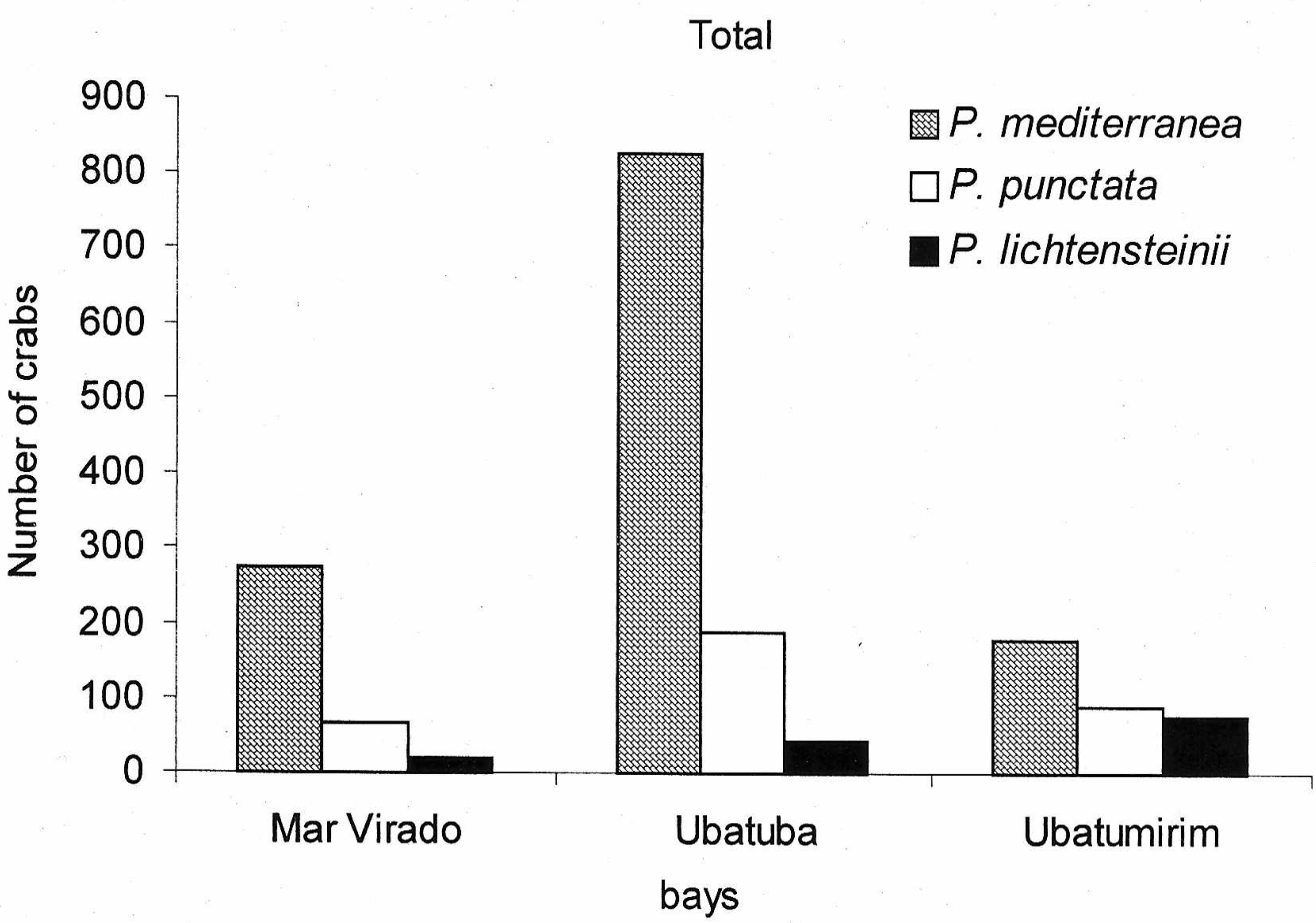


Figure 9. Abundance of three species of *Persephona* in the studied bays.

According to Mahiques *et al.* (1998), the direct interaction of wave direction and the extension and orientation of the bays' mouth, together with the presence of islands in the inner shelf, promote significant variations in the sedimentary dynamics within the embayments in the Ubatuba region by reducing hydrodynamism, thus favoring the deposit of fine sediments such as silt and clay.

The present study shows that sediments at the sampled areas are mostly composed by fine grains, namely silt and clay, being that at Mar Virado Bay, it was verified the highest values supporting the results obtained by Furtado and Mahiques (1990) who mentioned that the southern region of the northern coast of São Paulo State is characterized by finer sediments due to the proximity of the São Sebastião Island and its respective channel.

According to Magliocca and Kutner (1964), the amount of organic matter deposited in sublittoral sediments reflects prevailing hydrodynamic regimes. In general, higher contents of organic matter were recorded at transects III and IV, in which sediments were mainly composed by very fine sand, silt and clay. Besides, these transects are located in the median region of the bays at the isobaths of 5 and 10 m, and transect IV is directly exposed to river drainage, therefore to the accumulation of organic debris coming from inner estuarine areas. Mantelatto and Fransozo (1999) had also recorded high organic matter contents in central shallower regions in Ubatuba Bay.

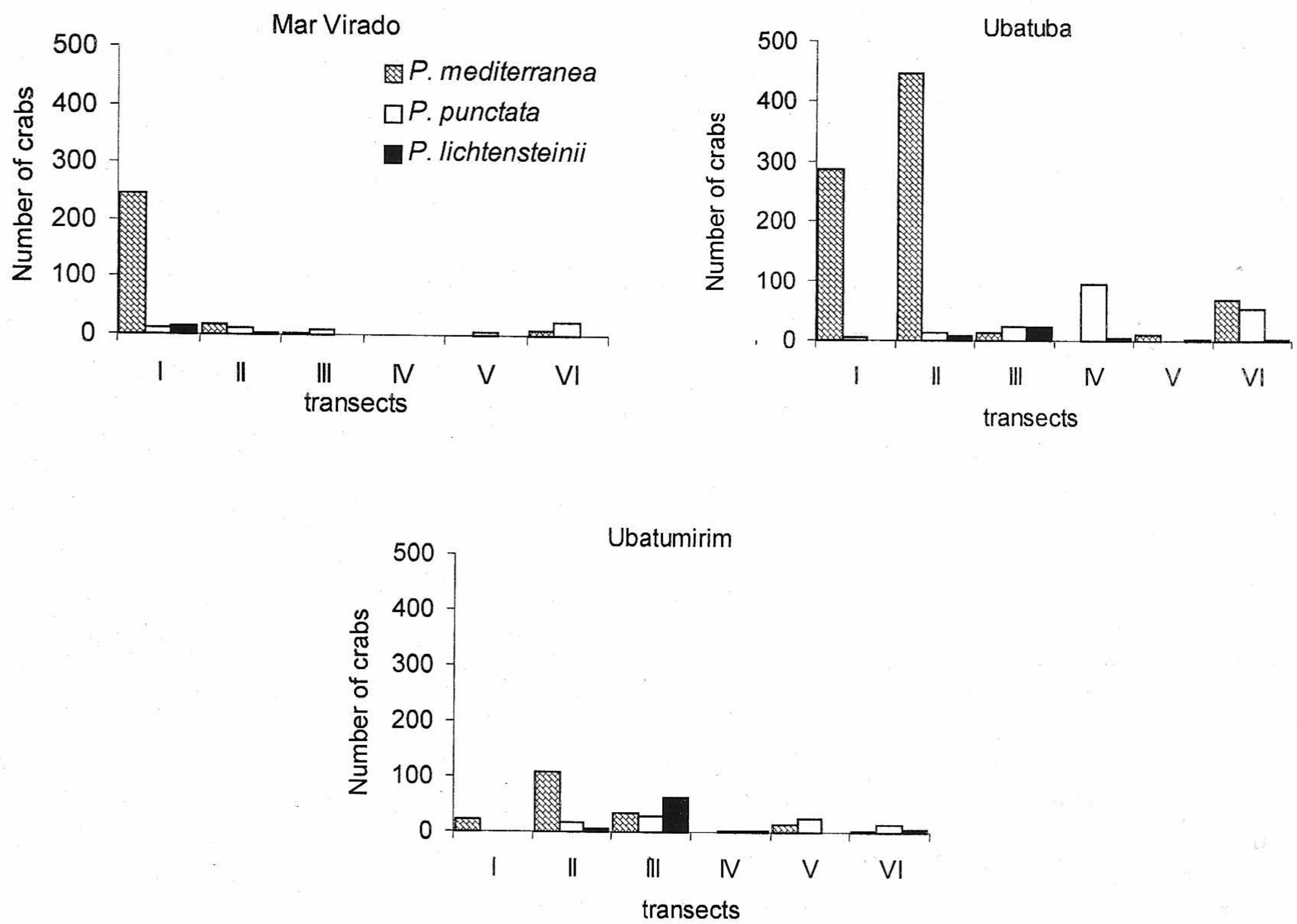


Figure 10. Spatial distribution of the species of *Persephona* for each bay.

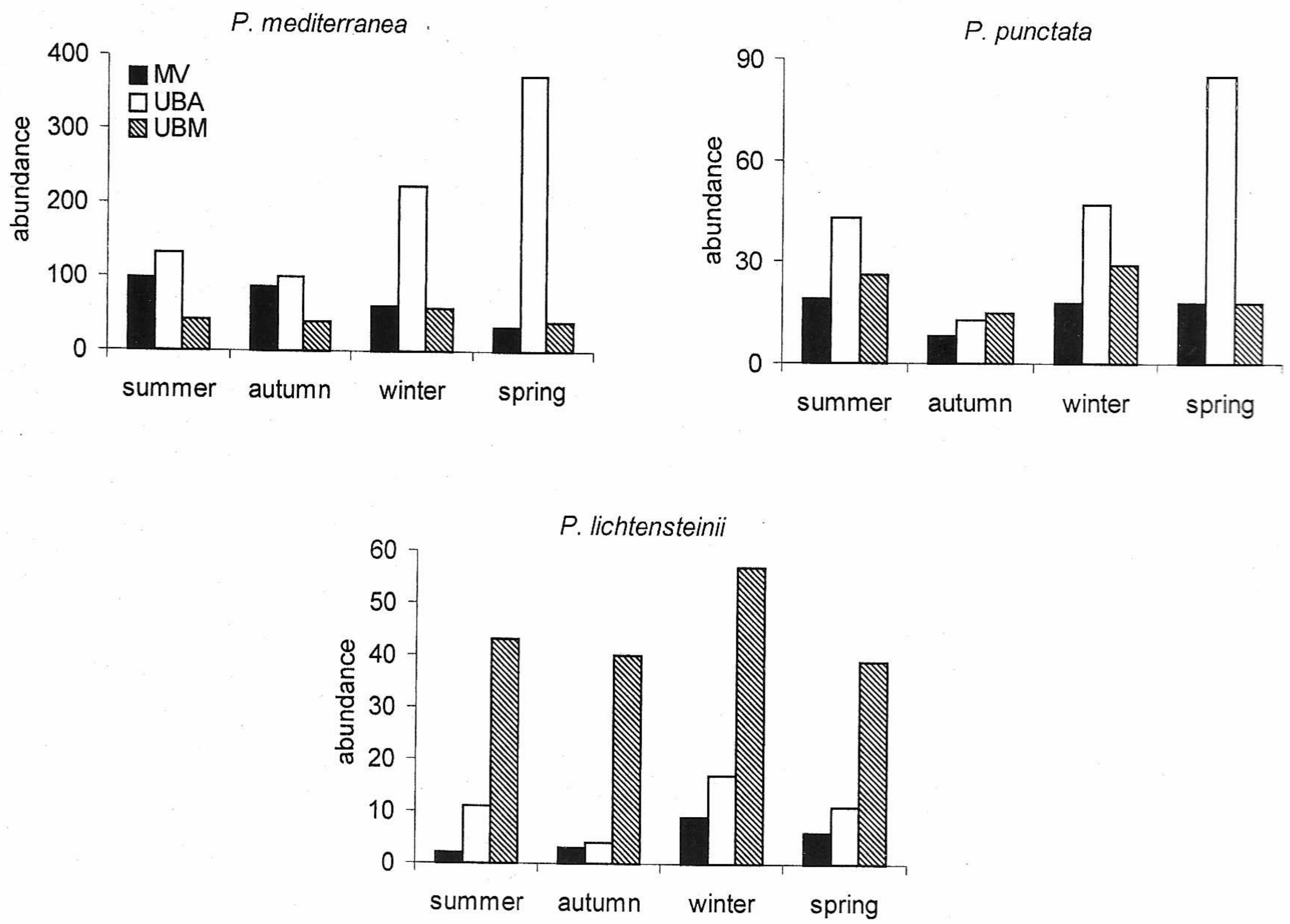


Figure 11. Temporal distribution of species of *Persephona* for each bay (MV = Mar Virado; UBA = Ubatuba; UBM = Ubatumirim).

Distribution Patterns

The different patterns of distribution found in this study are probably related to the specificity of suitable environmental conditions within the examined species. Depth and sediment texture seem to be the most important factors. Leucosiids are known to remain buried in the sediment, for what grain size should be of most importance delimiting the distribution of these organisms. According to Coelho and Torres (1980), crabs belonging to the subfamily Iliinae prefer terrigenous bottoms, namely muddy, sandy-muddy and sandy. The *Persephona* species studied herein follow a similar trend of those other members of the Iliinae.

Seasonal abundance variations have been verified for a number of decapods in the same region (Pires, 1992; Mantelatto and Fransozo, 2000) and in other areas (Wenner and Read, 1982). Temporal variations were not so evident for the examined species, probably indicating that variation of environmental factors did not restrain the occurrence of these crabs in the inner areas of the studied embayments. Boesch *et al.* (1977) had also found similar variation patterns on benthic communities in the Middle Atlantic Bight, suggesting seasonal stability.

The species *P. mediterranea* presented a spatial distribution markedly distinct when compared to the other studied species, occurring preferentially at deeper areas where very fine sand prevailed. This observation is supported by the results obtained from multiple regression analyses. Pires (1992), who studied the benthic megafauna in the Ubatuba region, found a high abundance of *P. mediterranea* in the inner continental shelf, from 10 to 50m, while no other congener was found. Otherwise, other *Persephona* species were recorded in the proximal areas of coastal bays where depth does not exceed 10m (Fransozo *et al.*, 1992; Negreiros-Fransozo *et al.*, 1992 and 1999). Mantelatto and Fransozo (2000) have also investigated the brachyuran community at Ubatuba Bay, they found that *P. mediterranea* occurs at higher depths (16.6 m), while *P. punctata* and *P. lichtensteinii* are confined to shallower areas. The distribution of the latter species were similar concerning the type of sediment, inhabiting areas where it is mainly composed by silt and clay, as previously observed by Fransozo *et al.* (1992) and Negreiros-Fransozo *et al.* (1999).

The most important feeding items of *P. mediterranea* are polychaetes of the families Capitellidae and Maldanidae which are infaunal, deposit-feeding organisms (Petti *et al.*, 1996). Therefore, the organic matter contents in the sediment are apparently not directly related to the distribution of these leucosiids. Yet, the organic matter associated to sediments may be an important food resource for their prey. This possibility has been also regarded by other authors investigating the distribution of other decapods (Santos *et al.*, 1994; Mantelatto *et al.*, 1995; Bertini and Fransozo, 1999).

The ecological distribution of these *Persephona* species is shown to be tightly related to given environmental conditions. Nevertheless, additional studies addressing eventual migrations for reproduction and other inter and intraspecific interactions should provide a basis for a better understanding of the ecology of these species within the studied area.

Acknowledgments

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References

Bertini, G. and Fransozo, A. 1999. Spatial and seasonal distribution of *Petrochirus diogenes* (Anomura, Diogenidae) in the Ubatuba Bay, São Paulo, Brazil. Iheringia, Série Zoológica, (86): 145-150.

Boesch, D. F.; Kraeuter, J. N., and Serafy, D. K. 1977. Distribution and structure of communities of macrobenthos on the outer continental shelf of the Middle Atlantic Bight: 1975-1976. Invest. Spec.

Rep. *In:* Applied Marine Science and Oceanography Engineering No. 175. Va. Institute of Marine Science, Gloucester Pt., Va. 111p.

Castro-Filho, B.M.; Miranda, L. B. and Myao, S.Y. 1987. Condições hidrográficas na plataforma continental ao largo de Ubatuba: variações sazonais e em média escala. Boletim do Instituto Oceanográfico, 35(2): 135-151.

Coelho, P. A. and Ramos-Porto, M. 1986. Sinopse dos crustáceos decápodos brasileiros (família Dorippidae e Leucosiidae). Caderno Ômega Série Ciências Aquáticas, 2: 67-77.

Coelho, P. A. and Torres, M. F. A. 1980. Zoogeografia marinha do Brasil. II – Considerações ecológicas e biogeográficas sobre a família Leucosiidae (Decapoda, Brachyura). Revista Nordestina de Biologia, 3 (especial): 67-77.

Folk, R. L and Ward, W. C. 1957. Brazos River bar: a study of the significante of grain size parameters. Journal of Sedimentary Petrology, 27(1): 3-27.

Fransozo, A.; Costa, R. C.; Mantelatto, F. L. M.; Pinheiro, M. A. A., and Santos, S. (*in press*). Distribution and assemblages of shrimps species (Penaeidea and Caridea) in Fortaleza bay, Ubatuba, São Paulo, Brazil. *In:* Modern Approaches to the Study of Crustacea.

Fransozo, A.; Negreiros-Fransozo, M. L.; Mantelatto, F. L. M.; Pinheiro, M. A. A. and Santos, S. 1992. Composição e distribuição dos Brachyura (Crustacea, Decapoda) do sublitoral não consolidado na Enseada da Fortaleza, Ubatuba (SP). Revista Brasileira de Biologia, 52(4): 667-675.

Furtado, V. V. and Mahiques, M. M. 1990. Distribuição de sedimentos em regiões costeiras e plataforma continental norte do Estado de São Paulo. *In*: Simpósio de Ecossistemas da Costa Sul e Sudeste Brasileira: Estrutura, Função e Manejo. 2. Águas de Lindóia, São Paulo, Academia de Ciências do Estado de São Paulo. Vol. 1, p. 20-29.

González-Gurriarán, E.; Fernández, L.; Freire, J.; Muiño, R. and Rodríguez Solórzano, M. 1991. Estructura de la comunidad megabentónica (crustáceos decápodos - Brachyura - y peces demersales) de la Ría de Ferrol (Galicia, NW España). Boletin del Instituto Espanol de Oceanografia, 7(2): 89-99.

Gray, J. S. 1974. Animal – sediment relationships. Oceanography and Marine Biology Review, 12: 233-261.

Hebling, N. J.; Mantelatto, F. L. M.; Negreiros-Fransozo, M. L., and Fransozo, A. 1994. Levantamento e distribuição de braquiúros e anomuros (Crustacea, Decapoda) dos sedimentos sublitorais da região da Ilha Anchieta, Ubatuba (SP). Boletim do Instituto de Pesca, 21(único): 1-9.

Ishikawa, K. 1989. Relationship between bottom characteristics and benthic organisms in the shallow water of Oppa Bay, Miyagi. Marine Biology, 102: 265-273.

Magliocca, A. and Kutner, A. S. 1964. Conteúdo orgânico dos sedimentos de fundo de Cananéia, São Paulo. Contribuições Avulsas do Instituto Oceanográfico, 195: 1-15.

Mahiques, M. M.; Tessler, M. G., and Furtado, V. V. 1998. Characterization of energy; gradient in enclosed bays of Ubatuba region, south-eastern Brazil. Estuarine, Coastal and Shelf Science, 47: 431-446.

Mantelatto, F. L. M. 1999. Allocation of the portunid crab *Callinectes ornatus* (Decapoda: Brachyura) in the Ubatuba Bay, northern coast of São Paulo State, Brazil. *In*: Klein JCVV and Schram, F. R. (eds.) The Biodiversity Crisis and Crustacea, Crustacean Issues Vol. 12 (pp. 431-443). A. A. Balkema, Rotterdam, Brookfield.

Mantelatto, F. L. M. and Fransozo, A. 1999. Characterization of the physical and chemical parameters of Ubatuba Bay, northern coast of São Paulo State, Brazil. Revista Brasileira de Biologia, 59(1): 23-31.

Mantelatto, F. L. M. and Fransozo, A. 2000. Brachyura community in Ubatuba Bay, Northern Coast of São Paulo State, Brazil. Journal of Shellfish Research, 19 (2):701-709.

Mantelatto, F. L. M.; Fransozo, A., and Negreiros-Fransozo, M. L. 1995. Distribuição do caranguejo *Hepatus pudibundus* (Herbst, 1785) (Crustacea, Decapoda, Brachyura) na Enseada da Fortaleza, Ubatuba, SP, Brasil. Boletim do Instituto Oceanográfico, 43(1): 51-61.

Melo, G. A. S. 1996. Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro. Plêiade/FAPESP Ed., São Paulo, 604p.

Melo, G. A. S. and Torres, M. F. A. 1998 a. Novo gênero e espécie de Leucosiidae (Decapoda, Brachyura) no litoral brasileiro. Iheringia, Série Zoologia, (84): 129-132.

Melo, G. A. S. and Torres, M. F. A. 1998 b. O gênero *Speloeophorus* (Decapoda, Brachyura, Leucosiidae) no litoral brasileiro, com descrição de uma nova espécie. Iheringia, Série Zoologia, (84): 121-128.

Melo, G. A. S.; Veloso, V. G. and Oliveira, M. C. 1989. A fauna de Brachyura (Crustacea, Decapoda) do litoral do Estado do Paraná. Nerítica, 4(1/2): 1-31.

Montgomery, D. C. and Peck, E. A. 1982. Introduction to linear regression analyses. Ed. John Wiley & Sons. New York. 504p.

Negreiros-Fransozo, M. L. and Fransozo, A. 1995. On the distribution of *Callinectes ornatus* Ordway, 1863 and *Callinectes danae* Smith, 1869 (Brachyura, Portunidae) in the Fortaleza Bay Ubatuba, Brazil. Iheringia,

Série Zoologia, 79: 13-25.
Negreiros-Fransozo, M. L.; Fransozo, A. and Hebling, N. J. 1989. Larval development of *Persephona mediterranea* (Herbst, 1794) (Brachyura, Leucosiidae) under laboratory conditions. Crustaceana, 57(2): 177-193.
Negreiros-Fransozo, M. L.; Nakagaki, J. M., and Reigada, A. L. D. 1999. Seasonal occurrence of decapods in shallow waters of a subtropical area. *In*: Klein, J. C. V. V. and Schram, F. R. (eds.) The Biodiversity Crisis and Crustacea, Crustacean Issues Vol. 12 (pp. 351-361). A. A. Balkema, Rotterdam, Brookfield.
Negreiros-Fransozo, M. L.; Reigada, A. L. D. and Fransozo, A. 1992. Braquiúros (Crustacea, Decapoda) dos sedimentos sublitorais da Praia da Enseada, Ubatuba (SP). Boletim do Instituto de Pesca, 19 (único): 17-22.
Petti, M. A. V.; Nonato, E. F. and Paiva, P. C. 1996. Trophic relationships between polychaetes and brachyuran crabs on the southeastern Brazilian coast. Revista Brasileira de Oceanografia, 44(1): 61-67.
Pinheiro, M. A. A.; Fransozo, A. and Negreiros-Fransozo, M. L. 1996. Distribution patterns of *Arenaeus cribrarius* (Lamarck, 1818) (Crustacea, Portunidae) in Fortaleza Bay, Ubatuba (SP), Brazil. Revista Brasileira de Biologia, 56(4): 705-716.
Pires, A. M. S. 1992. Structure and dynamics of benthic megafauna on the continental shelf offshore of Ubatuba, Southeastern Brazil. Marine Ecology Progress Series, 86: 63-76.
Santos, S.; Negreiros-Fransozo, M. L. and Fransozo, A. 1994. The distribution of the swimming crab *Portunus spinimanus* Latreille, 1819 (Crustacea, Brachyura, Portunidae) in Fortaleza Bay, Ubatuba, SP, Brazil. Atlântica, 16: 125-141.
SAS Institute Inc. 1996. SAS/STAT Software, Release 6.12. Cary: SAS Institute Inc.
Suguio, K. 1973. Introdução à sedimentologia. Edgard Blucher, Ed. da Universidae de São Paulo. 317p.
Warwick, R. M. and Uncles, J. 1980. Distribution of benthic macrofauna associations in the Bristol Channel in relation to tidal stress. Marine Ecology Progress Series, 3: 97-103.
Wenner, E. L. and Read, T. H. 1982. Seasonal composition and abundance of decapod crustacean assemblages from the south Atlantic Bight, USA. Bulletim of Marine Science, 32(1): 181-206.
Wentworth, C. K. 1922. A scale of grade and terms for cladistic sediments. Journal of Geology, 30: 377-392.

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