Composition and distribution of Decapoda from Guanabara Bay, RJ.

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Abstract

The present study aims to characterize the spatial distribution of the main decapod species present in the Guanabara Bay, RJ. Crustaceans were captured by otter-trawling during the rainy and dry seasons. Thirteen species were found being the portunids *Callinectes ornatus, Callinectes danae* and the penaeids *Farfantepenaeus brasiliensis* and *Farfantepenaeus paulensis* the most abundant organisms. The portunids predominated at the inner areas, in the dry season, and near the bay mouth, during the rainy season. The penaeids showed preference for the central area of the bay, which also presents the highest species richness and abundance. Penaeids are correlated to deeper areas while portunids were associated to finer sediments.

Key words: Decapoda, distribution, tropical bay, pollution, Guanabara Bay

Introduction

In estuarine systems, which are frequently subjected to an environmental gradient, decapods can be often found. Their ecological importance remains on active burrowing into the sediments (bioturbation), predation on macrobenthos, deposit feeding, scavenging dead organisms and serving as prey for demersal nekton (Day *et al.*, 1989). Many species use estuaries as nursery grounds, since these systems are regions of great productivity, increasing the survival of the young in this food-rich environment. Crustacean survival, growth, reproduction and abundance are affected by natural processes as also by human activities. Because their life cycle and growth are relatively complex, they are vulnerable to any physical and chemical changes in their habitat during their lifetime (Engel and Thayer, 1998). At Guanabara Bay, the uncontrolled urban development caused a profound change in the estuarine environment, with an increase in organic loading, erosion, turbidity and also a reduction in oxygen levels (Mayr *et al.,* 1989; Lavrado *et al.*, 1991). Environmental State Agency (FEEMA, 1990) had already registered a significant decline in crustacean catches, specially shrimps and swimming crabs. In 1955, 300 tons of shrimp per year were captured while in 1990, shrimp catches reached only 1% (ca 3 tons). Unfortunately, despite shrimp capture being still the most common fishing activity in the bay, there are scarce quantitative data concerning to the distribution and biology of the crustaceans.

The present study is the first attempt to describe the spatial distribution of decapods in this bay and also to analyse possible relationships with environmental factors. This work, which focuses on macrobenthic community of the bay, belongs to the interdisciplinary program "Anthropic impacts in aquatic environments: changes in structure, dynamics and mitigating proposals" developing by the "Universidade Federal do Rio de Janeiro/Pronex".

Study area:

Guanabara Bay (381 km^2) is one of the most important estuarine systems in the Rio de Janeiro State. It is a typical environment subjected to a fast process of degradation since it is characterized by a shallow water system that receives continuous input of domestic sewage and periodical inflows of freshwater by a large drainage basin (ca. 4,000 km^2) (FEEMA, 1990). Thirty-five rivers, none of

Nauplius

them of significant discharge, flow into the bay, bringing sediment, organic matter, industrial waste and garbage.

Water quality of Guanabara Bay is not uniform, differing from place to place depending on circulation patterns and pollution foci. Some gradients can be observed in many of the hydrobiological characteristics, like higher salinities towards the mouth and an increase of pollution levels towards the inner regions. Circulation is controlled by tides and winds allowing water inflow from the ocean through the bottom layer. This system is subject to a remarkable dry (May to September) and rainy seasons (October to April). At the bottom, sediments are not evenly distributed, predominating mud at inner areas and fine sand near the mouth (JICA, 1994).

Material and Methods

The bay was divided into 4 areas (Fig. 1), selected in function of water quality differences detected by other studies (Mayr *et al.*, 1989; Villac *et al.*, 1991). In each area, 2 to 3 transects were made in four distinct periods, two at the end of the rainy season (May/1998 and May/2000) and two at the end of the dry season (September/ 1997 and August/2000) (Fig. 2). A total of 39 samples were obtained by means of a shrimp fishery boat equipped with an otter-trawl with 10 mm mesh cod end. Each transect lasted 30 minutes at ca. 2 knots in a constant speed.

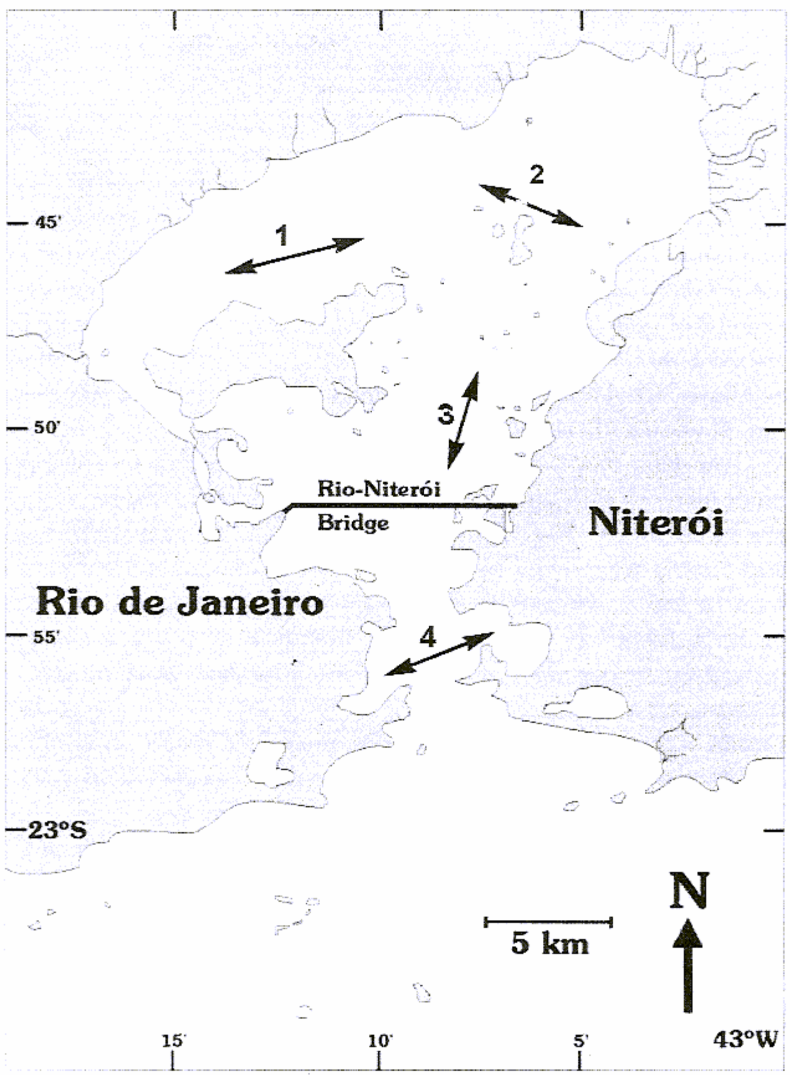

Figure 1 - Map of Guanabara Bay, showing the four sampling areas for otter-trawling.

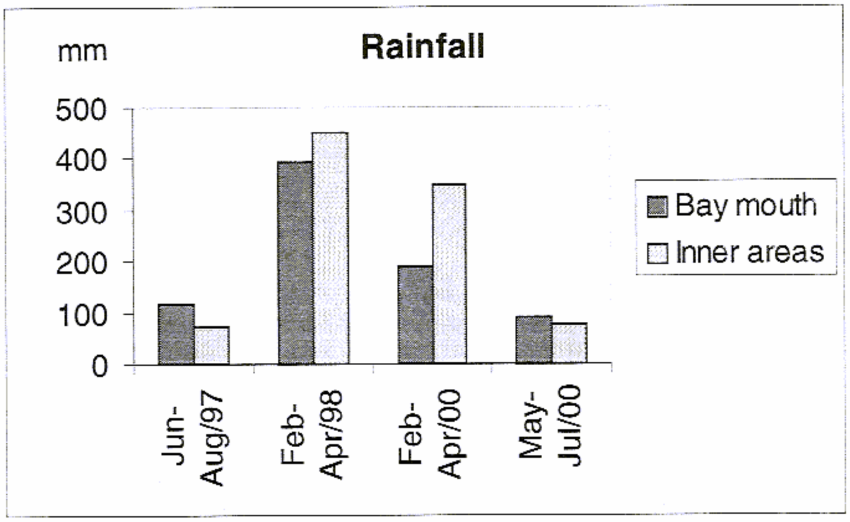

Figure 2 - Total rainfall (mm) three months before each sampling data in two points at Guanabara Bay (at Urca beach - bay mouth and Governador Island - inner areas).

After trawling, a van Dorn bottle was used to collect the bottom water from which salinity, with an optical rephractometer, and temperature, with a stem thermometer, were obtained. Depth was determined by an probe, transparence by a Secchi disc, and sediment for granulometric analysis was collected by means of an Eckman grab. The content of organic matter by ash-weighing and granulometric fractions by differential sieving, based on the Wenthworth scale, were also obtained. All decapods were sorted, counted, identified, sex determined and the presence of eggs was also recorded, in the case of the Pleocyemata decapods.

Statistical differences in environmental factors among areas were obtained through an one-way ANOVA, and *a posteriori* Tukey test. A two-way ANOVA was performed to detect significant differences in abundance of penaeids and portunids among areas and seasons. Homogeneity of variances was checked by a Cochran test (Zar, 1996). Spearman correlation was made in order to determine relationships between decapod abundances and environmental factors.

Results

Thirteen species were found at the bay (Table 1), mainly at the central area (area 3), characterized by a fine sediment rich in organic matter (18%) and also by a saline and less turbid water. Species composition of the inner areas (1 and 2) are very similar as also their environmental characteristics

Table 1: Spatial distribution of the decapod species in Guanabara Bay, total number of captured individuals and their relative abundance (%).

Taxon	Family	Area 1	Area 2	Area 3	Area 4	Total	%
Arenaeus cribrarius	Portunidae				x	1	0.1
Callinectes danae	Portunidae	x	x	x	x	149	12.5
Callinectes ornatus	Portunidae	x	x	x	x	373	31.3
Portunus spinimanus	Portunidae			x	x	48	4.0
Charybdis hellerii	Portunidae			x		1	0.1
Cronius ruber	Portunidae			x		1	0.1
Hepatus pudibundus	Calappidae			x		1	0.1
Sicyonia typica	Sicyoniidae			x		2	0.2
Farfantepenaeus brasiliensis	Penaeidae	x	x	x	x	343	28.8
Farfantepenaeus paulensis	Penaeidae	x	x	x	x	150	12.6
Litopenaeus schmitti	Penaeidae	x	x	x	x	106	8.9
Xiphopenaeus kroyeri	Penaeidae				x	14	1.2
Alpheus sp.	Alpheidae				x	3	0.3

(Table 2). These two areas have turbid and shallow waters with anoxic muddy sediments, with high organic matter content (up to 23%). Preliminary data showed extreme low levels of dissolved oxygen (0.7-1.5 ml.l^{-1}). Two swimming crab species, *Callinectes ornatus* Ordway, 1863 and *Callinectes danae* Smith, 1869, and two pink shrimps, *Farfantepenaeus brasiliensis* (Latreille, 1817) and *Farfantepenaeus paulensis* (Pérez Farfante, 1967) were found in all sampled areas, while eight species occurred only at the areas near the bay mouth (Table 1). *Xiphopenaeus kroyeri* (Heller, 1862) and *Alpheus sp.* were exclusively found at area 4, characterized by sandy sediments, with low organic matter content (ca. 2%) and higher saline and less turbid waters.

A total of 1192 individuals were captured, being *C. ornatus* and *F. brasiliensis* the most abundant species, with aproximately 31% and 29 %, respectively (Table 1). Penaeids were found mainly at the central area ($F = 7.92$, $p = 0.001$). Portunids, such as *Callinectes* spp., are often found at the inner areas (areas 1 and 2), or at the bay mouth (area 4), where *Portunus spinimanus* Latreille, 1819 is also abundant (Fig. 3). However, there were no statistical differences of portunid abundance among areas ($F = 0.83$, $p = 0.49$). Correlation analysis showed a significant positive relationship between portunids and finer sediments ($r_s = 0.60$, $p = 0.02$) and more saline waters ($r_s = 0.33$, $p = 0.04$). Penaeids, specially *F. brasiliensis*, seem to occur in deeper waters ($r_s = 0.35$, $p = 0.03$) , but also with fine sediments ($r_s = 0.63$, $p = 0.001$).

Table 2: Mean values and standard deviation of the environmental variables at the bottom of each area in Guanabara Bay, RJ. Mean statistical comparisons by Tukey test (p< 0.05)

Variable	Area 1 (n=8)	Area 2 (n=11)	Area 3 (n=12)	Area 4 (n=8)
Depth (m)	4.2 – 1.1 a*	7.2–5.3 a	11.6–6.4 b	6.9–1.8 a
Temperature (C)	24.0–0.0 a	23.9–0.7 a	23.7–0.7 a	23.8–1.3 a
Salinity (PSU)	32.9–1.2 a	32.7–1.4 a	35.3–1.8 b	35.8–1.6 b
Transparency (m)	0.9–0.3 a	1.1–0.5 a	1.2–0.3 ab	1.8–0.6 b
Organic Matter (%)	22.7–1.2 a	21.8–1.6 a	18.1–1.5 b	1.7–0.9 c
Grain size diameter (phi)	3.1–0.8 a	3.2–0.8 a	3.3–0.6 a	2.4–0.3 b

*line with same letters indicate statistical similar mean values

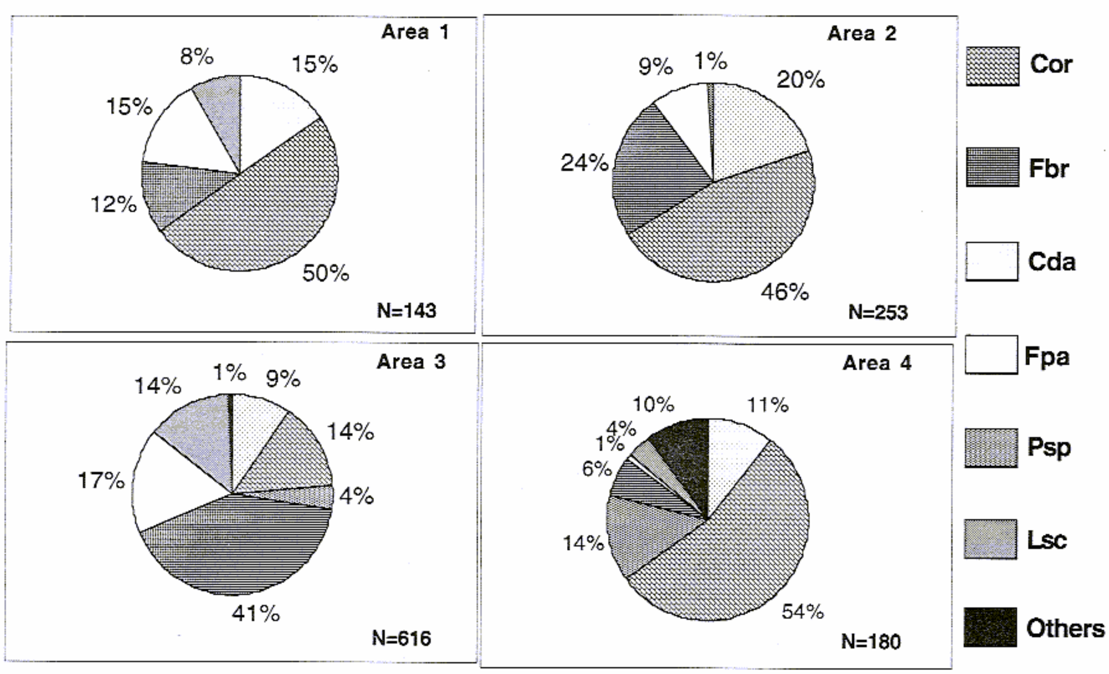

Figure 3 - Dominance (%) of the main decapod species at Guanabara Bay (Cda = *Callinectes danae*; Cor = *C. ornatus*; Psp = *Portunus spinimanus*; Fbr = *Farfantepenaeus brasiliensis*; Fpa = *Farfantepenaeus paulensis*; Lsc = *Litopenaeus schmitti*).

Temporal data indicate that portunids (specially *Callinectes* spp.) showed a great reduction in abundance (F = 9.88, p = 0.004) at the inner areas during the rainy season (Figs.2 and 4). The pink shrimps (*F. brasiliensis* and *F. paulensis*) were more abundant in the dry season (Sep/97), but showed less spatial-temporal variations than portunids (F = 1.11, p = 0.30).

The abnormal absence of decapod in May/00 at inner areas was noticed as also the strong reduction of decapod numbers at areas 3 and 4 (Fig. 4). In this period, *C. danae* was represented only by females specimens. In both dry periods (Sep/97 and Aug/00), more females of *C. ornatus* than males (ca 94%) were captured at area 4, and many of them were ovigerous.

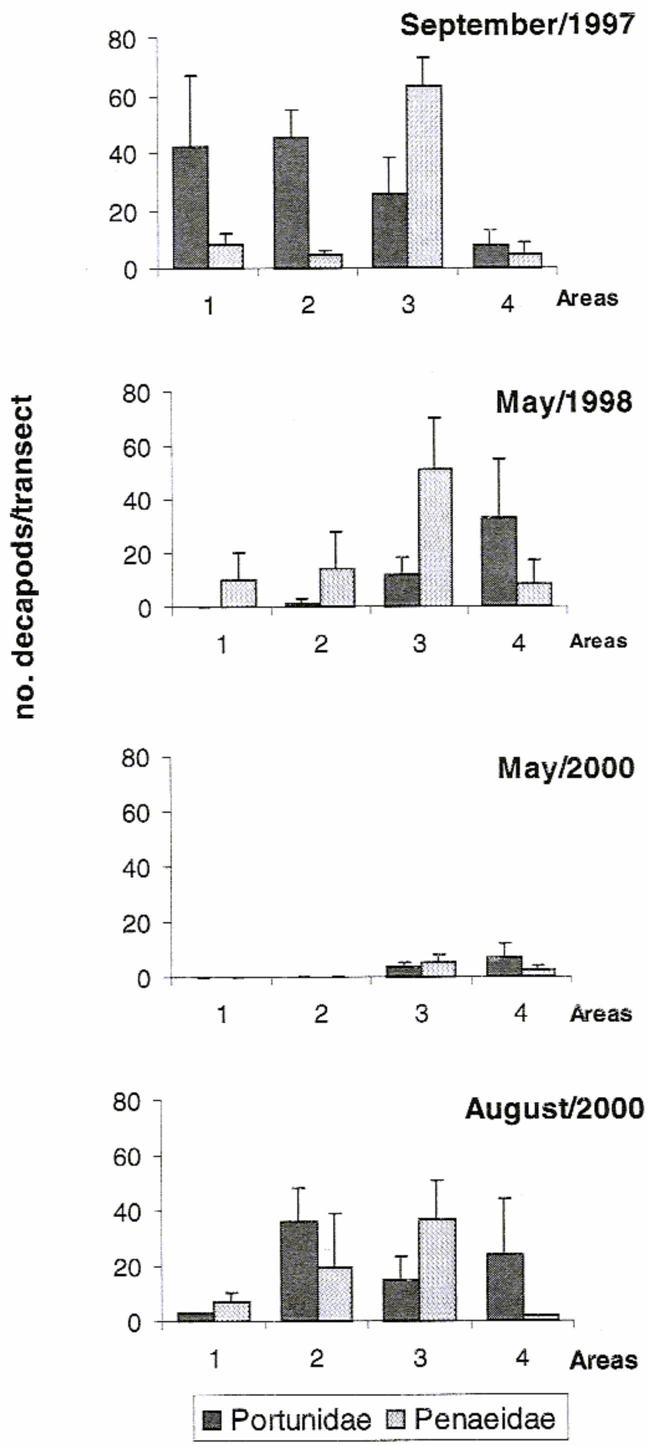

Figure 4 - Mean number of individuals per transect (± SE) of portunids and penaeids captured in four areas at Guanabara Bay, in rainy (May/98 and May/00) and dry periods (Sep/97 and Aug/00).

Discussion

Guanabara Bay is one of the most important estuarine systems of the Rio de Janeiro State. Despite its importance, it seems that degradation levels are very high indeed. Only thirteen decapod species (7 brachyurans) were obtained in the present study, a very low richness index if one considers other similar systems along the southeast Brazilian coast, such as Fortaleza Bay, Ubatuba, SP, with almost 24 brachyuran species (Fransozo *et al.*, 1992) and Ilha Anchieta, SP, with 22 decapod species (10 brachyurans) (Hebling *et al.*, 1994), both studies using similar methodologies. Even considering historical data (Oliveira, 1940), only half of portunid species described by this author (10 species) was found nowadays. The central area presents the higher diversity and abundance, probably due to better water quality conditions prevailing at this area. The channel, which follows the major axis of the bay, where depths reach an average of 20 m, allows an input of coastal water through the bottom layer while the freshwater under strong pollution effects runs through the surface layer (Mayr *et al.*, 1989). Consequently, the central area seems to be the most stable environment in terms of water quality, being also a "road" to species migrate between the estuary and offshore waters.

The inner areas, despite the degradation levels represented by the low levels of oxygen and absence or scarceness of endofauna in the muddy sediments (Rebelo and Silva, 1987), still present some decapod species, specially *Callinectes* spp. The presence of mangrove areas nearby, high levels of organic matter and the coastal water influence, specially at the dry seasons, when the freshwater input is greatly reduced, may be responsible for the abundance found.

Despite other studies showing a habitat partitioning between *C. ornatus* and *C. danae* (Negreiros-Fransozo and Fransozo, 1995), our data did not corroborate this pattern. The two species co-occur at the same areas, being *C. ornatus* 2.5 times more abundant than *C. danae*. *C ornatus* is also abundant in other systems along the southeast Brazilian coast, as Ubatuba bay, São Paulo (Negreiros-Fransozo and Fransozo, 1995), and Sepetiba bay, Rio de Janeiro (Dias, 1996), and it is known for a large ecological niche and also a high niche overlap with other portunid species, such as *P. spinimanus* and *C. danae* (Pinheiro *et al.*, 1997).

Portunus spinimanus did not occur at the inner areas (areas 1 and 2). This species is known for its low tolerance to salinity variations and low oxygen levels (Williams, 1984; Santos *et al.*, 1994) and its presence is also related to sandy bottoms, mainly associated with gravel and very coarse sand (Fransozo *et al.*, 1992, Santos *et al.*, 1994), conditions only found near the bay mouth (area 4).

Another portunid species, *Arenaeus cribrarius* (Lamarck, 1818) and the calappid *Hepatus pudibundus* (Herbst, 1785), which are abundant in other estuarine and coastal systems (Branco *et al.*, 1990; Fransozo *et al.*, 1992; Pinheiro *et al.*, 1996) seem to be rare in the Guanabara Bay. As *A. cribrarius* showed negative correlation with organic content at Ubatuba Bay (Pinheiro *et al.*, 1996), it is possible that the higher levels of organic matter (more than 15%) found at inner areas of Guanabara Bay inhibit its occurrence somehow. There is not enough water movement to hinder high sedimentation rates at these areas, thus not providing better conditions for the suspension feeders, one of the food items of this species (Leber, 1982 *apud* Pinheiro *et al.*, 1996). Oshiro and Araujo (1987) and Branco *et al.* (1990) found this species in areas with good water movement, sandy bottoms and higher salinities.

One specimen of *Charybdis hellerii* (A. Milne-Edwards, 1867), a portunid from Indo-Pacific, was captured in Guanabara Bay, in September/1997. This exotic species has already been registered at Ubatuba region in 1995, by Negreiros-Fransozo (1996). That is the first record for this species in the Guanabara Bay.

Farfantepenaeus brasiliensis and *F. paulensis* were the main decapod species commercially captured in the bay. Silva (1977) reported Guanabara Bay, together with Araruama lagoon, as the main nursery grounds of these species in the Rio de Janeiro State. Juveniles and imature adults were found mainly at the central area, but no mature females were found, reinforcing the life cycle pattern of this family in which females spawn at the coastal adjacent areas and post-larvae enter estuary for feeding and growth. The dominance of *F. brasiliensis* in relation to *F. paulensis* could be explained by the preference exhibited by the first species for warmer waters (Silva, 1977).

Temporal variations in decapod abundances seem to be related to rainfall and/or reproductive migration. The presence of ovigerous females of *C. ornatus* near the bay mouth, in Sep/97 and Aug/00, probably indicates a migratory behaviour to the sea during the dry season. Negreiros-Fransozo and Fransozo (1995) found a higher proportion of ovigerous females of *C. ornatus* during summer, in deeper and saline areas of Fortaleza Bay, SP. Dias (1996) also found ovigerous females of this species in the deeper and higher saline areas of Sepetiba bay, also in summer, corroborating *C. ornatus* females preference for areas where they can find better conditions for larval success or protection (Mantelatto, 1998). Negreiros-Fransozo and Fransozo (1995) detected a higher abundance of ovigerous females of *C. danae* in May, the same period we found ovigerous females of this species in the bay. These two species have different reproductive strategies, releasing larvae in different periods of the year in Ubatuba region (Negreiros-Fransozo and Fransozo, 1994; Costa and Negreiros-Fransozo, 1998; Mantelatto and Fransozo, 1997, 1999). Negreiros-Fransozo *et al.* (1999) also considered that this strategy could reduce competition between these portunids, but they also recommended more detailed studies to get a more precise information about these species interaction.

The lowest abundances were found in May/2000, almost three months after a huge oil spill (ca. 1.2 million liters of fuel oil) occurred at the inner areas, covering almost 40 km^2. A possible relationship between the oil impact and the reduction in abundance is not discarded but there are not enough consistent temporal data to establish a cause-consequence effect. Further studies are now being carried out to clarify the spatial-temporal variations detected in the present study.

Acknowledgements

Financial support for this study was granted by the Science and Technology Ministry (MCT) and by the National Research Council of Brazil (CNPq). We are greatly indebted to Dr. Yocie Yoneshigue Valentin, coordinator of the Benthos Monitoring Program -Pronex.

References

Branco, J. O.; Porto-Filho, E. and A. Thives. 1990. Estrutura das populações, abundância e distribuição dentro de espécies integrantes da família Portunidae (Crustacea, Decapoda) na lagoa da Conceição e área adjacente, ilha de Santa Catarina, SC, Brasil. Anais do II Simpósio de Ecossistemas da Costa Sul e Sudeste Brasileira, Águas de Lindóia, SP, 2: 294-300.

Costa, T. M. and Negreiros-Fransozo, M. L. 1998. The reproductive cycle of *Callinectes danae* Smith, 1869 (Decapoda, Portunidae) in the Ubatuba Region, Brazil. Crustaceana, 71(6): 615-627.

Day, J. W.; Hall, C. A. S.; Kemp, W. M. and Yáñez-Arancibia, A. 1989. Estuarine Ecology. New York, John Wiley and Sons, 558p.

Dias, G. V. 1996. Ocorrência e distribuição de Portunídeos (Crustacea, Decapoda) do sublitoral da Baía de Sepetiba. Under-Graduation dissertation, Universidade Federal Rural do Rio de Janeiro, 31p.

Engel, D. W. and Thayer, G. W. 1998. Effects of habitat alteration on blue crabs. Journal of Shellfish Research, 17(2): 579-585.

FEEMA. Fundação Estadual de Engenharia do Meio Ambiente. 1990. Projeto de recuperação gradual do ecossistema da Baía de Guanabara, Rio de Janeiro, Vol. I.

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.

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

JICA. Japan International Cooperation Agency. 1994. The study on the recuperation of the Guanabara Bay ecosystem. Supporting Report, Tokyo, Kokusai Kogyo Co., Ltd, Vol. 1-4.

Lavrado, H. P.; Mayr, L. M.; Carvalho, V. and Paranhos, R. 1991. Evolution (1980 – 1990) of ammonia and dissolved oxygen in Guanabara Bay, RJ, Brazil. *In*: Proceedings of the 7th Symposium on Coastal and Ocean Management. Coastal Zone 91, 4. 3234-3245.

Mantelatto, F. L. M. 1998. Allocation of the portunid crab *Callinectes ornatus* (Decapoda, Brachyura) in the Ubatuba Bay, northern coast of São Paulo State, Brazil. Proceedings of the Fourth International Crustacean Congress, Amsterdam, The Netherlands: 431-443.

Mantelatto, F. L. M. and Fransozo, A.. 1997. Fecundity of the crab *Callinectes ornatus*_Ordway, 1863 (Decapoda, Brachyura, Portunidae) from the Ubatuba region, São Paulo, Brazil. Crustaceana, 70(2): 214-226.

Mantelatto, F. L. M. and Fransozo, A. 1999. Reproductive biology and moulting cycle of the crab *Callinectes ornatus* (Decapoda, Portunidae) from the Ubatuba Region, Brazil. Crustaceana, 72(1): 63-76.

Mayr, L. M.; Tenenbaum, D. R.; Villac, M. C.; Paranhos, R.; Nogueira, C. R.; Bonecker, S. L. C. and Bonecker, A.C.T. 1989. Hydrobiological characterization of Guanabara Bay. *In*: Coastlines of Brazil. Magoon, O. and Neves, C. (eds). American Society of Civil Engineers, New York, 124-138 pp.

Negreiros-Fransozo, M. L. 1996. The zoea I of *Charybdis helleri* (A.Milne-Edwards, 1867) (Decapoda, Portunidae) obtained in laboratory. Nauplius, 4: 165-168.

Negreiros-Fransozo, M. L and Fransozo, A. 1994. Avaliação preliminar de *Callinectes ornatus* Ordway, 1863 e *Callinectes danae* Smith, 1869 (Crustacea, decapoda, Portunidae) na região de Ubatuba (SP), Brasil. Anais do III Simpósio de Ecossistemas da Costa Brasileira, vol. I : 122-130.

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 (Zool.), 79: 13-25.

Negreiros-Fransozo, M. L.; Mantelatto, F. L. M. and Fransozo, A.. 1999. Population biology of *Callinectes ornatus* Ordway,1863 (Decapoda, Portunidae) from Ubatuba (SP), Brazil. Scientia Marina, 63(2): 157-163.

Oliveira, L. P. H. 1940. Contribuição ao conhecimento dos crustáceos do Rio de Janeiro. Catálogo dos Crustáceos da Baía de Guanabara. Memórias do Instituto Oswaldo Cruz, 35(1): 137-151.

Oshiro, L. M. Y. and Araújo, F. G. 1987. Estudo preliminar de peixes jovens e crustáceos decápodos da Baía de Sepetiba, RJ. Anais do Simpósio sobre Ecossistemas da Costa Sul e Sudeste, vol. 3: 283-297.

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.

Pinheiro, M. A. A.; Fransozo, A. and Negreiros-Fransozo, M. L.. 1997. Dimensionamento e sobreposição de nichos dos Portunídeos (Decapoda, Brachyura), na Enseada da Fortaleza, Ubatuba, São Paulo, Brasil. Revista Brasileira de Zoologia, 14(2): 371-378.

Rebelo, F. A. and Silva, S. H. G. 1987. Macrofauna bêntica de substratos móveis infralitorais da Baía de Guanabara, RJ. Anais do Simpósio sobre Ecossistemas da Costa Sul e Sudeste Brasileira: 389-400.

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.

Silva, O. 1977. Aspectos bioecológicos e pesqueiros de três espécies de camarões do gênero *Penaeus* nas costas do estado do Rio de Janeiro e experimentos de cultivo. Master Science Dissertation – Universidade Federal do Rio de Janeiro, 74 p.

Villac, M. C.; Mayr, L. M.; Tenenbaum, D. R. and Paranhos, R. 1991. Sampling strategies proposed to monitor Guanabara Bay, RJ, Brasil. Proceedings of the Seventh Symposium on Coastal and Ocean Management, California: 1168-1182.

Williams, A. B. 1984. Shrimps, lobsters and crabs of the Atlantic coast of the eastern of United States, Maine to Florida. Washington, Smithsonian Institution Press, 550p.

Zar, J. H. 1996. Biostatistical Analysis. 3rd ed., Upper Saddle River, New Jersey, Prentice-Hall Inc, 662 p.

Received: 15th / 12 / 2000
Approved: 15th / 12 / 2001