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## Occurrence of shrimp species (Crustacea: Decapoda: Natantia: Penaeidea and Caridea) in Ubatuba Bay, Ubatuba, SP, Brazil

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**Abstract.**—The species composition of Penaeidea and Caridea shrimp was studied in Ubatuba Bay, São Paulo, Brazil. Samples were taken monthly from September 1995 to August 1996, using two double-rig trawling nets. A total of 21 marine shrimps species were obtained, belonging to eight families. Sergestoids were represented by a single species of Sergestidae, while penaeoids comprised three families, Penaeidae, Sicyoniidae and Solenoceridae. Caridea shrimps belonged to two superfamilies, the Palaemonoidea, represented by Palaemonidae; and Alpheoidea by three families, Alpheidae, Ogyrididae and Hippolytidae. *Sicyonia laevigata* Stimpson, 1871 and *Nematopalaemon schmitti* (Holthuis, 1950) represent first records in São Paulo State, Brazil.

Seven families of Dendrobranchiata shrimps, represented by 26 genera and 61 species, have been reported for the Brazilian Coast (D'Incao 1995). For the Pleocyemata, Holthuis (1993) listed 15 caridean superfamilies and 31 families. Among these, most representatives belonged to Alpheoidea and Palaemonoidea with 38 and 48 species, respectively (Ramos-Porto 1986, Holthuis 1993). Taxonomic information on Dendrobranchiata and Caridea species found in the Brazilian coast is scant (Corrêa 1977; Christoffersen 1979, 1982; Bond-Buckup & Buckup 1989, D'Incao 1995). Most of the studies dealing with the biodiversity of this group have focused on bioecological aspects of these organisms (Iwai 1973, Abreu 1980, Pires 1992, Nakagaki et al. 1995). The objective of the present study is to determine the composition of marine shrimp species (Dendrobranchiata and Caridea) in Ubatuba Bay, northern coast of São Paulo State, in order to contribute to a better assessment of local marine biodiversity.

### Material and Methods

Ubatuba Bay is located on the northern part of São Paulo State (23°25'00" to 23°27'34"S and 45°00'30" to 45°03'30"W), where the coastline consists of several inlets and major bays. According to Castro Filho et al. (1987), this region is affected by three water masses, with different distributional patterns in the summer and winter. Coastal Water (CW) has a high temperature and low salinity ( $T > 20^{\circ}\text{C}$ ,  $S < 36\text{‰}$ ) Tropical Water (TW) has both a high temperature and salinity ( $T > 20^{\circ}\text{C}$ ,  $S > 36\text{‰}$ ), and South Atlantic Central Water (SACW) has both a low temperature and salinity ( $T < 18^{\circ}\text{C}$ ,  $S < 36\text{‰}$ ) following an annual cycle. The dynamics of these currents are responsible for seasonal alterations of temperature, salinity and nutrients concentrations. Ubatuba Bay can be divided into an inner and an outer section. The inner section is affected by direct fresh water drainage from four small

rivers (Indaiá, Grande de Ubatuba, Lagoa and Acaraú) and consequently receives a continuous input of domestic sewage and considerable deposition of organic matter. The outer section is exposed to oceanic influence. Detailed descriptions of environmental factors of the Bay, and the study site characteristics can be found in Mantelatto & Fransozo (1999).

Samples were obtained on a monthly basis from September of 1995 to August of 1996. A shrimp fishery boat supplied with 3.5 m-opening double-rig trawling nets was used. The mesh size was 12 mm except in the cod end where it was 10 mm.

Dendrobranchiata shrimps were identified according to D'Incao (1995) and Pérez Farfante (1997). In the case of juvenile specimens of *Farfantepenaeus* Burukovsky, 1997, the morphology of the last abdominal somite was used for identification as described by Pérez Farfante (1969) and F. D'Incao, pers. comm.

### Results

The material obtained contains eight families and 21 species. The Sergestoidea were represented by a single sergestid species. Species belonging to Penaeidae, Sicyoniidae and Solenoceridae were also collected (Table 1). Among the carideans, representatives of two superfamilies were found. Palaemonoidea was represented by the study area by the family Palaemonidae, while the Alpheoidea comprised alpheids, ogyridids and hippolytids (Table 2).

### Discussion

This study was restricted to a survey of the soft-sediment bottoms of Ubatuba Bay which is a small area compared to the vast Brazilian coast. This region is located at the Paulista biogeographic Province which comprises the coastal region between Espírito Santo and Santa Catarina States. The mixed feature of the fauna of this region can be explained by the thermal regime of the waters, which can harbor tropical, tem-

perate and subantarctic species (Coelho & Ramos 1972). Nevertheless, Melo (1985) based on the low level of endemism, asserts that the southeastern-south littoral of Brazil does not represent a faunal Province, but a transition area.

The finding of *S. laevigata* and *N. schmitti* is of significance as they represent first records of these species in the State of São Paulo.

The total number of species of Dendrobranchiata now known to occur in São Paulo State is 19. Species not found during our survey include four penaeoideans, such as *Solenocera necopina* Burkenroad, 1939, *Solenocera atlantidis* Burkenroad, 1939, *Mesopenaeus tropicalis* (Bouvier, 1905), and *Parapenaeus americanus* Rathbun, 1901; and three sergestoideans, *Lucifer faxoni* Borradaile, 1915, *Lucifer typus* H. Milne Edwards, 1837, and *Sergia robusta* (Smith, 1882).

*Parapenaeus americanus* is a species known to occur at depths of 50 to 70 m, much below the deepest trawl performed during the present survey in Ubatuba Bay (up to 17 m). Previous records of *S. necopina*, *S. atlantidis* and *M. tropicalis* in this region were considered atypical (Pires 1992), and this has been confirmed in our survey. Using a lower sampling effort and avoiding rocky coast areas, Nakagaki et al. (1995) did not find *S. laevigata*, *S. parri* and *F. paulensis* in Ubatuba Bay.

Considering the presence of *N. schmitti*, the number of palaemonid species in São Paulo State is now 14, including freshwater and estuarine species. Five of these are considered common marine species but only two were found during this study, *N. schmitti* and *L. paulensis*.

According to Bond-Buckup & Buckup (1989), *P. pandaliformis* preferably inhabits fresh or brackish water environments. However, Ramos-Porto (1986) occasionally found this species in marine habitats. During the present study, two specimens of *P. pandaliformis* were collected near the drainage of a river. Low-salinity conditions

Table 1.—List of shrimp species of Dendrobranchiata collected in the Ubatuba Bay. (SW = shallow water; PE = pelagic zone).

Species	Distribution	Depth (m)
SERGESTOIDEA		
SERGESTIDAE		
<i>Acetes americanus</i> Ortmann, 1893	Western Atlantic: Guyana, Puerto Rico to Brazil (from Pará to Rio Grande do Sul).	PE to 40
PENAEOIDEA		
PENAEIDAE		
<i>Farfantepenaeus brasiliensis</i> (Latreille, 1817)	Western Atlantic: USA (Cape Hatteras, North Carolina) to Brazil (from Amapá to Rio Grande do Sul).	SW to 366
<i>Farfantepenaeus paulensis</i> (Pérez Farfante, 1967)	Western Atlantic: Brazil (from Bahia to Rio Grande do Sul) to Argentina (Mar del Plata).	SW to 150
<i>Litopenaeus schmitti</i> (Burkenroad, 1936)	Western Atlantic: Baía de Matanzas, Cuba to Brazil (from Amapá to Rio Grande do Sul).	SW to 50
<i>Artemesia longinaris</i> Bate, 1888	Western Atlantic: Brazil (from Rio de Janeiro to Rio Grande do Sul) to Argentina (province of Chubut).	2 to 125
<i>Rimapenaeus constrictus</i> (Stimpson, 1874)	Western Atlantic: USA (Chesapeake Bay, Virginia) to Brazil (from Amapá to Santa Catarina).	1.5 to 127
<i>Xiphopenaeus kroyeri</i> (Heller, 1862)	Western Atlantic: USA (Virginia) to Brazil (from Amapá to Rio Grande do Sul).	SW to 70
SOLENOCERIDAE		
<i>Pleoticus muelleri</i> (Bate, 1888)	Western Atlantic: Brazil (from Espírito Santo to Rio Grande do Sul) to Argentina (Santa Cruz).	SW to 600
SICYONIIDAE		
<i>Sicyonia dorsalis</i> Kingsley, 1878	Western Atlantic: USA (Cape Hatteras, North Carolina) to Brazil (from Amapá to Santa Catarina).	3 to 420
<i>Sicyonia typica</i> (Boeck, 1864)	Western Atlantic: USA (North Carolina) to Brazil (from Amapá to Rio Grande do Sul).	SW to 100
<i>Sicyonia laevigata</i> Stimpson, 1871	Western Atlantic: USA (Beaufort, North Carolina) to Brazil (from Amapá to Rio Grande do Sul).	SW to 100
<i>Sicyonia parri</i> (Burkenroad, 1934)	Western Atlantic: USA (North Carolina) to Brazil (from Maranhão to São Paulo).	SW to 87

at the time of sampling (see Mantelatto & Fransozo 1999) probably favored the presence of *P. pandaliformis* at this site.

Alpheoids are represented by 23 species in the State of São Paulo, of which six were obtained during our study. *Ogyrides alphaerostris* occurs preferably in estuaries and was also found with *A. floridanus* and *E. oplophoroides* in marine habitats. *Alpheus intrinsecus* is commonly found in protected embayments areas (Christoffersen 1979, 1980, 1982). The occurrence of the alpheid *A. bouvieri* was also presumably atypical because this species lives in the intertidal zone, frequently in rocky crevices or associated to sand colonies of tubicolous

polychaetes belonging to the genus *Phragmatopoma* Mörch, 1863 (Christoffersen 1979).

Based on data from this study and on others research (Fransozo et al. 1992, 1998; Negreiros-Fransozo et al. 1997) we can infer that Ubatuba Bay represents an important site in the establishment and development of diverse marine shrimp populations. Continuing studies of inshore and offshore areas will provide a more accurate characterization of the diversity of the region.

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Table 2.—List of shrimp species of Caridea collected in the Ubatuba Bay. (SW = shallow water; FW = fresh water; IT = intertidal zone; BW = brackish water).

Species	Distribution	Depth (m)
<b>PALAEMONOIDEA</b>		
<b>PALAEMONIDAE</b>		
<i>Leander paulensis</i> Ortmann, 1897	Western Atlantic: USA (Florida) and Brazil (from Maranhão to São Paulo).	SW to 16
<i>Nematopalaemon schmitti</i> (Holthuis, 1950)	Western Atlantic: Guyana and Brazil (from Amapá to São Paulo).	SW to 60
<i>Palaemon pandaliformis</i> (Stimpson, 1871)	Western Atlantic: Antilles, northern South America and Brazil (from Rio Grande do Norte to Rio Grande do Sul).	SW, FW, and BW
<b>ALPHEOIDEA</b>		
<b>ALPHEIDAE</b>		
<i>Alpheus intrinsecus</i> Bate, 1888	Western Atlantic: Tobago, Puerto Rico and Brazil (from Ceará to Santa Catarina). Eastern Atlantic: Western Sahara to Zaire.	IT to 40
<i>Alpheus floridanus</i> Kingsley, 1878	Western Atlantic: Bahamas, USA (southeastern Florida), Mexico (Veracruz). Gulf of Mexico, Cuba, Haiti, Puerto Rico, Antigua, Guadeloupe, Bonaire, Curaçao and Brazil (Atol das Rocas and from Bahia to Rio Grande do Sul).	IT to 78–81
<i>Alpheus nuttingi</i> Schmitt, 1924	Western Atlantic: Bermuda, USA, Cat Cay, Barbuda to Tobago Cays, Panama and Brazil (Alagoas and from Espírito Santo to Santa Catarina).	IT to 2
<i>Alpheus bouvieri</i> A. Milne-Edwards, 1878	Western Atlantic: Bermuda, USA (east coast of Florida), Cuba, Antigua to Tobago, Aruba and Brazil (Fernando de Noronha and from Ceará to Rio Grande do Sul).	IT, between rocky
<b>OGYRIDIDAE</b>		
<i>Ogyrides alphaerostris</i> (Kingsley, 1880)	Western Atlantic: USA (from Virginia to South Carolina, Eastern Florida, Gulf Coast and Louisiana). Dominican Republic and Brazil (Pará and from Rio de Janeiro to Rio Grande do Sul).	0–0.30 to 52
<b>HIPPOLYTIDAE</b>		
<i>Exhippolysmata oplophoroides</i> (Holthuis, 1948)	Western Atlantic: USA (North and South Carolina, Georgia, Texas), Guyana, and Brazil (from Amapá to Pernambuco and from Espírito Santo to Rio Grande do Sul) to Uruguay.	5 to 45

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## Literature Cited

- Abreu, J. 1980. Distribuição e ecologia dos Decapoda numa área estuarina de Ubatuba (SP).—*Boletim do Instituto Oceanográfico* 29:1–2.
- Bate, C. S. 1888. Report on the Crustacea Macrura collected by the H. M. S. Challenger during the years 1873–76.—Report on the scientific results of the Voyage of H. M. S. Challenger during the years 1873–76 24:i-xc + 942.
- Boeck, A. 1864. Beskrivelse og fremlagde Tegninger af 4 norske Decapoder, undersøgte af overlaege Danielssen og ham.—*Forhandlingeri Videnskabs-Selskabeti Christiana* (1863):189–190.
- Bond-Buckup, G., & L. Buckup. 1989. Os Palaemonidae de águas continentais do Brasil meridional (Crustacea, Decapoda).—*Revista Brasileira de Biologia* 49:883–896.
- Borradaile, L. A. 1915. On the species of *Lucifer* and their distribution.—*Annals and Magazine of Natural History* 16(8):226–231.
- Bouvier, E. L. 1905. Sur les Pénéides et les Sténopides recueillis par les expéditions françaises et monégasques dans l'Atlantique orientale.—*Comptes rendus hebdomadaires des Séances de l'Académie des Sciences, Paris* 140:980–983.
- Burkenroad, M. D. 1934. Littoral Penaeidea chiefly from the Bingham Oceanographic collection, with a revision of *Penaeopsis* and descriptions of two new genera and eleven new American species.—*Bulletin of the Bingham Oceanographic Collection* 4(7):1–109.
- . 1936. A new species of *Penaeus* from the American Atlantic.—*Anais de Academia Brasileira de Ciencias* 8:315–318.
- . 1939. Further observations on Penaeidae of the northern Gulf of Mexico.—*Bulletin of the Bingham Oceanographic Collection* 6(6):1–62.
- Burukovsky, R. N. 1997. Selection of a type species for *Farfantepenaeus* Burukovsky, 1972 (Crustacea: Decapoda: Penaeidae).—*Proceedings of the Biological Society of Washington* 110:154.
- Castro Filho, B. M., L. B. Miranda, & S. Y. Myao. 1987. Condições hidrográficas na plataforma continental ao largo de Ubatuba: variações sazonais e em média escala.—*Boletim do Instituto Oceanográfico* 35(2):135–151.
- Christoffersen, M. L. 1979. Decapod Crustacea: Alpheoidea. Campagne de la Calypso au large des cotes Atlantiques de L'Amérique du Sud (1961–1962).—*Résultats Scientifiques des Campagnes de la Calypso, Paris*, 11:297–337.
- . 1980. Taxonomia e distribuição dos Alpheoidea (Crustacea: Decapoda: Natantia) do Brasil, Uruguai e norte da Argentina, incluindo considerações sobre a divisão do sul do continente em províncias biogeográficas marinhas. Unpublished Ph.D. Thesis, Universidade de São Paulo (USP), São Paulo, 700 pp.
- . 1982. Distribution of warm water alpheoid shrimp (Crustacea: Caridea) on the continental shelf of eastern South America, between 23° and 35° Lat. S.—*Boletim do Instituto Oceanográfico* 31:93–112.
- Coelho, P. A., & A. Ramos. 1972. A constituição e a distribuição da fauna de decápodos no litoral leste da América do Sul, entre as latitudes de 5°N e 39°S.—*Trabalhos do Instituto Oceanográficos, Universidade Federal de Pernambuco* 13:133–236.
- Corrêa, M. M. G. 1977. Paleomonídeos do Brasil (Crustacea, Decapoda, Natantia). Unpublished M.S. Thesis, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, 135 pp.
- D'Incao, F. 1995. Taxonomia, padrões distribucionais e ecológicos dos Dendrobranchiata (Crustacea: Decapoda) do litoral brasileiro. Unpublished Ph.D. Thesis, Universidade Federal do Paraná (UFPR), Curitiba, 365 pp.
- Franzoso, A., M. L. Negreiros-Franzoso, F. L. M. Mantelatto, M. A. A. Pinheiro, & S. Santos. 1992. Composição e distribuição dos Brachyura (Crustacea, Decapoda) do substrato não consolidado da Enseada da Fortaleza, Ubatuba, SP.—*Revista Brasileira de Biologia* 52:667–675.
- . F. L. M. Mantelatto, G. Bertini, L. C. Fernandez-Góes, & J. M. Martinelli. 1998. Distribution and assemblages of Anomuran Crustaceans in Ubatuba Bay, north coast of São Paulo State, Brazil.—*Acta Biologica Venezuelica* 18(4):17–25.
- Heller, C. 1862. Beiträge zur näheren Kenntnis der Macrouren.—*Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der kaiserliche Akademie der Wissenschaften, Wien* 45:389–426.
- Holthuis, L. B. 1948. Note on some Crustacea Decapoda Natantia from Surinam.—*Proceedings Koninklijke Nederlandse Akademie van Wetenschappen* 52(9):1051–1057.
- . 1950. Subfamily Palaemoninae. The Palaemonidae collected by Siboga and Snellius Expeditions with remarks on other species. 1. The Decapoda of the Siboga Expedition. Part 10.—*Siboga Expedition Monography* 39a(9):1–100.
- . 1993. The recent genera of the caridean and stenopodidean shrimps (Crustacea, Decapoda), with an appendix on the Order Amphionidacea. Leiden: Nationaal Natuurhistorisch Museum, 328 pp.
- Iwai, M. 1973. Pesca exploratória e estudo biológico sobre camarão na costa centro-sul do Brasil do N/O "Prof. W. Besnard" em 1969–1971.—*SUDELPA* (Superintendência do Desenvolvimento do Litoral Paulista) e Instituto Oceanográfico da Universidade de São Paulo, São Paulo, 71 pp.
- Kingsley, J. S. 1878. Notes on the North American

- Caridea in the museum of the Peabody Academy of Science at Salem, Mass.—Proceedings of the Academy of Natural Sciences of Philadelphia 30:89–98.
- . 1880. On a collection of Crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Crangonidae and Palaemonidae.—Proceedings of the Academy of Natural Sciences of Philadelphia 31(1879):383–427.
- Latreille, P. A. 1817. *Penaeus*.—Nouveau Dictionnaire d'Histoire Naturelle 25:152–156, Paris, Deterville.
- Mantelatto, F. L. M., & A. Fransozo. 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.
- Melo, G. A. S. 1985. Taxonomia e padrões distribucionais ecológicos dos Brachyura (Crustacea, Decapoda) do litoral sudeste do Brasil. Unpublished Ph.D. Thesis, Zoology Museum of the University of São Paulo (MZUSP), São Paulo, 215 pp.
- Milne-Edwards, A. 1878. Description de quelques espèces nouvelles de Crustacés provenant du Voyage aux îles du Cap-Vert de MM. Bouvier et de Cessac.—Bulletin de la Société Philomathique de Paris 7(2):225–232.
- Milne Edwards, H. 1837. Histoire naturelle des crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux, vol. 2. Robert, Paris, 532 pp.
- Mörch, O. A. L. 1863. Revisio critica Serpulidarum.—Et Bidrag til Rörormenes Naturhistorie, Naturhist. Tidssk, Copenhagen 3:347–470.
- Nakagaki, J. M., M. L. Negreiros-Fransozo, & A. Fransozo. 1995. Composição e abundância de camarões marinhos (Crustacea: Decapoda: Penaeidae) na Enseada de Ubatuba, Ubatuba, Brasil.—Arquivos de Biologia e Tecnologia 38:583–591.
- Negreiros-Fransozo, M. L., A. Fransozo, F. L. M. Mantelatto, M. A. A. Pinheiro, & S. Santos. 1997. Anomuran species (Crustacea, Decapoda) and their ecological distribution at Fortaleza Bay, Ubatuba, São Paulo, Brazil.—Iheringia (Série Zoológica) 83:187–194.
- Ortmann, A. 1893. Decapoden und Schizopoden.—Ergebnisse der Plankton-Expedition der Humboldt-Stiftung 2 G b:1–120.
- . 1897. Os camarões de água doce da América do Sul.—Revista do Museu Paulista 2:173–216.
- Pérez Farfante, I. 1967. A new species and two new subspecies of shrimp of the genus *Penaeus* from the Western Atlantic.—Proceedings of the Biological Society of Washington 80:83–100.
- . 1969. Western Atlantic shrimps of the genus *Penaeus*.—Fishery Bulletin 67(3):461–590.
- , & B. Kensley. 1997. Penaeoid and segestoid shrimps and prawns of the World. Keys and diagnoses for the families and genera.—Mémoires Muséum National d'Histoire Naturelle, Paris, 175 (Zoologie):1–233.
- 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.
- Ramos-Porto, M. 1986. Crustáceos decápodos marinhos do Brasil: família Palaemonidae. Unpublished M.S. Thesis, Universidade Federal de Pernambuco (UFPE), Recife, 347 pp.
- Rathbun, M. J. 1901. The Brachyura and Macrura of Porto Rico.—Bulletin of the United States Fish Commission 20(20):1–137.
- Schmitt, W. L. 1924. Bijdragen tot de Kennis der fauna van Curaçao. Resultaten eener Reis van Dr. C. J. van der Horst in 1920. The Macruran, Anomuran and Stomatopod Crustacea.—Bijdragen tot de Dierkunde 23:61–81.
- Smith, S. I. 1882. Reports on the results of dredging, under the supervision of Alexander Agassiz, on the east coast of the United States, during the summer of 1880, by the U. S. Coast Survey Steamer "Blake", Commander J. R. Bartlett, U. S. N., commanding.—Bulletin of the Museum of comparative Zoology at Harvard College 10: 1–108.
- Stimpson, W. 1871. Notes on North American Crustacea, in the Museum of the Smithsonian Institution. No 3.—Annals of the New York Lyceum 10:92–136.
- . 1874. Notes on North American Crustacea, in the Museum of the Smithsonian Institution. No III.—Annals of the Lyceum of Natural History of New York 10(6):119–163.