Spatial and temporal distribution of decapod larvae in the subtropical waters of the Arvoredo archipelago, SC, Brazil

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ABSTRACT. The present paper aims to describe the temporal and spatial distribution of the composition and abundance of Decapoda larvae in the shallow waters around Arvoredo Marine Biological Reserve. Stomatopod occurrence is also discussed. Plankton samples were collected at five sites around the Arvoredo Island every two months for one year from May, 2002 to April, 2003. Thirty-nine morphotypes, 11 genus and 4 species (*Artemesia longinaris* Bate, 1888, *Hexapanopeus schmitii* Rathbun, 1930, *Menippe nodifrons* Stimpson, 1859 and *Pleoticus muelleri* Bate, 1888) were identified, among them only two morphotypes of Stomatopoda larvae, and the remainder Decapoda larvae. Brachyuran zoeae were the most abundant group and they were well represented by Portunidae and Xanthidae zoeae. *Lucifer* sp. and Caridea zoeae were the most abundant non-brachyuran taxa. Decapod larvae were observed to occur at all sampling sites, however the spatial distribution demonstrated a general tendency to greater abundance and diversity at the southern sites of the Island. Decapoda and Stomatopoda larvae occurred throughout the year, showing that reproduction is continuous, but that larval input in planktonic community was significantly higher during autumn and spring.

KEYWORDS. Decapods, crustaceans, meroplankton, distribution, Brazil.

RESUMO. Distribuição espacial e temporal de larvas de decápodos nas águas subtropicais do arquipélago do Arvoredo, SC, Brasil. Este trabalho tem como objetivo a descrição da distribuição temporal e espacial da composição e abundância de larvas de decápodes nas águas rasas ao redor da Reserva Biológica Marinha do Arvoredo. A ocorrência de larvas de estomatópodes também foi discutida. Foram realizadas coletas de plâncton em cinco estações ao redor da Ilha do Arvoredo, de maio de 2002 a abril de 2003 a cada dois meses. Foram identificados 39 morfotipos, 11 gêneros e 4 espécies (*Artemesia longinaris* Bate, 1888, *Hexapanopeus schmitii* Rathbun, 1930, *Menippe nodifrons* Stimpson, 1859 and *Pleoticus muelleri* Bate, 1888), sendo apenas dois morfotipos da Ordem Stomatopoda e o restante da Ordem Decapoda. Zoés de Brachyura foi o grupo mais abundante, bem representado por larvas das famílias Portunidae e Xanthidae. Entre os não-braquiúros, *Lucifer* sp. e zoés de Caridea foram os taxa mais abundantes. As larvas de decápodes ocorreram ao redor de toda a Ilha, havendo uma tendência geral de maior abundância e diversidade nas estações do sul (Saco das Balas e Baía do Farol). Larvas de Decapoda e Stomatopoda ocorreram durante todo o ano, mostrando que a reprodução é contínua, com picos de contribuição de larvas na comunidade planctônica durante o outono e primavera.

PALAVRAS-CHAVE. Decápodes, crustáceos, meroplâncton, distribuição, Brasil.

The occurrence of pelagic larvae in the life cycle of benthonic crustaceans is considered an advantage for the species, since their dispersal improves genetic flow and the colonization of new or remote areas. Furthermore, larval dispersal reduces competition for space, the predation rate of young stages in the adult habitat and osmoregulation problems due to low salinity in estuarine or coastal parental habitats. Marine reserves can be designed to reinforce on-going efforts to preserve biological diversity, increasing fishing yields and protecting particularly vulnerable life stages of marine species. The dynamics of larval movement are critical to reserve design and placement; reserves can be self-seeding, require external larval input or exist in a stepping stone array (Palumbi, 2003). The demographic rates of larvae are one of the main sources of information used to investigate larval dispersal (Sale & Kritzer, 2003).

It is currently accepted that the management of crustacean resources must include fishery records, adult biology, larval transport and recruitment studies (Fehlauer & Freire, 2002).

Temporal analysis of commercial decapod species has shown that, for the most studied species, there are fisheries and adult population data since 1850, whereas larval records have been kept for just 15 years (Botsford *et al.*, 1994).

In spite of their obviously important role in developmental biology, recruitment and population dynamics, ecology, biogeography, genetics, and other fields of the basic and applied sciences, our general knowledge of the larval development of crustaceans is rather poor compared to the one which has been published about benthic juveniles and adults. After 200 years of steadily intensifying research, much of that we currently know about decapod crustacean larvae is still restricted to their external morphology and the number of pelagic stages. In the past forty years, however, a rapidly increasing number of studies have also been produced on larval ecology, physiology, and biochemistry, so that the ontogeny of various basic biological functions in Decapoda is increasingly understood, and new fields of science research have recently been propagating (Anger, 2001).

Worldwide larval ecology studies were mainly conducted in estuarine and bay areas on commercially important species. There is good information on the blue crab in Cheasapeake Bay, USA (Epifanio & Garvine, 2001) and shrimps in Carpentaria Gulf, Australia (Vance *et al*., 1990, 1998, 2002). Decapod larval ecology studies are scarce in Brazil and a proportion of these studies remain as unpublished thesis and monographs of limited availability. Published research includes studies of blue crabs and shrimps conducted by Calazans (2002) in the Patos Lagoon estuary, studies of shrimps (Fehlauer & Freire, 2002; Calazans, 1994, 1999) on the southern coast and studies of decapods in the Guanabara Bay (Fernandes *et al.*, 2002), on the eastern coast and in the Itamaracá estuarine system on the northeastern coast (Schwamborn, 1997; Schwamborn *et al*., 2001). Other data could be available in general zooplankton studies or in an thesis on mangrove crabs (A. S. Freire, unpublished data) or in the surf zone (J. G. Bersano, unpublished data).

The Arvoredo Marine Biological Reserve (AMBR) was created in 1990 to protect the high level of biodiversity generated by the confluence of Tropical and Cold Waters in the area. Although the Arvoredo Archipelago, and also the Santa Catarina coast, is the southern limit of tropical fauna, zooplankton studies had been restricted to the classic expeditions like those made by the Challenger and the Meteor. Brandini *et al.* (1997) showed that few planktonic studies have been performed along the Santa Catarina coast. Around Arvoredo Island, among the planktonic communities, some studies of dinoflagelates, phytoplankton and ichthyoplankton have been conducted as theses but are still unpublished.

At present, the Brazilian environmental agency (IBAMA) and the AMBR Scientific Committee are gathering scientific information to improve the management program in the area and Crustacean larval studies will help to quantify reproductive potential and biodiversity in the area.

This paper aims to describe the temporal and spatial distribution of the composition and abundance of Decapoda larvae in the waters around Arvoredo Island. Stomatopoda larvae occurrence is also discussed.

MATERIAL AND METHODS

Arvoredo Island is close to the Subtropical Convergence (33- 38° S), where the Brazilian Current flowing to the south, meets the Malvinas Current, which flows northwards. The South Atlantic Central Water (SACW) is formed in the area of the Convergence and enters the Subtropical Gyre, circulating in the South Atlantic Ocean. At around 28° S, the Brazilian Current flows southwards, down to a depth of 750 m, transporting the Tropical Water (TW) and the SACW (Silveira *et al*., 2001). Emilsson (1959) demonstrated the influence of the Subtropical Convergence on the Santa Catarina coast in the winter. The intrusion of the SACW into the whole continental shelf area up to 20 m depth during late spring and summer has been described as a large scale phenomenon in the Central South Brazil Bight (coastal area from Cape Frio/ RJ to Cape Santa Marta/ SC) and the presence of the Subantarctic Water (SAW) has been registered along the Paraná state continental shelf, a little to the north of the archipelago, during winter (Borzone *et al*., 1999). Along the Santa Catarina Central-North Inner shelf the water column is stratified during spring and summer. SACW upwelling occurs with northern winds while downwelling events near the coast occur with southern winds. During autumn-winter there is advection of modified subantarctic water through the area (Carvalho *et al*., 1998). In the Arvoredo Archipelago area the SACW occurs at 20 m depth and the Tropical Shelf Water dominates the surface waters (Carvalho *et al*., 1998). According to the Köppen classification, this area is located inside a "CFa" region, an intermedian subtropical zone, which belongs to the humid mesotermic group, with rains equally distributed throughout the year. Seasons are very distinctive, with summer and winter very distinct and autumn and spring having similar characteristics.

Plankton samples were collected from five sites around Arvoredo Island every two months for one year from May 2002 to April 2003, with the exception of one site in July and another in September, due to bad weather conditions (Fig. 1). At each site, horizontal tows were made for five minutes using a conical cylindrical plankton

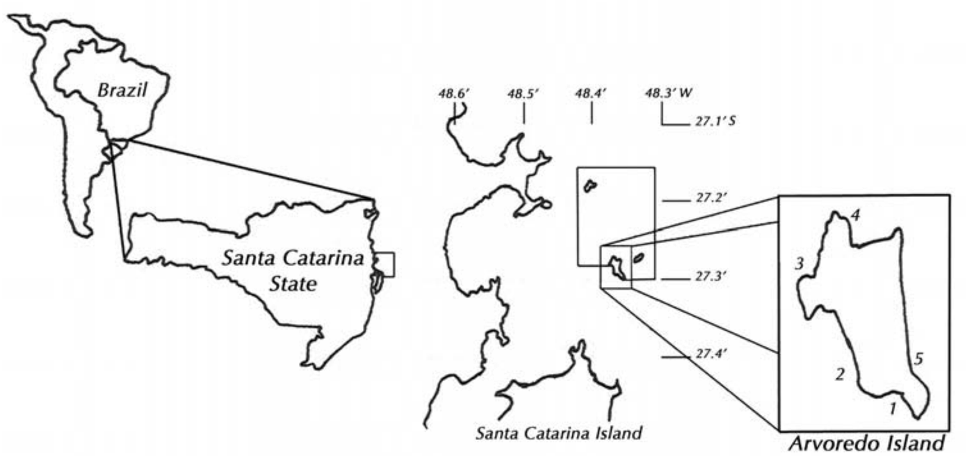


Fig. 1. Geographic location of Arvoredo Island (SC, Brazil). Numbers indicate plankton sampling sites (1, Baía do Farol; 2, Saco do Batismo; 3, Rancho Norte; 4, Saco d'Água; 5, Saco das Balas). Source: Marinha do Brasil (1957).

net with 200 µm mesh size, 2 m length and 0.50 m mouth diameter and equipped with a General Oceanic flowmeter. The samples were fixed with 4 % buffered formaldehyde for further analysis.

In the laboratory, samples were divided with the Folsom splitter into ½, ¼, $^1/_8$ and $^1/_{16}$ subsamples. Decapoda and Stomatopoda larvae were sorted under stereomicroscope. Up to 100 Brachyura zoeae were obtained among others. Most of the larvae were identified as morphotypes within the family level. Numbers of larvae were expressed as individuals.m^{-3}.

Surface water temperature and salinity were also measured during sampling with an LF1 Schott Gerate handylab. Analysis of variance (one-way ANOVA) was used to investigate weather salinity and temperature differences and also to verify the hypotheses that the concentration and richness of Decapoda and Stomatopoda larvae were significantly different across different sites and months. Density data were transformed with log (x+1).

Cluster analysis was used to evaluate the occurrence of similarities between Decapoda and Stomatopoda association sites and months using the Bray Curtis index. Clusters were determined using ranked similarities and weighted by group average sorting. The analysis was conducted with 28 cases and 50 larval taxa.

RESULTS

Temperature ranged from more than 27°C in January to 17°C in July, a difference of 10º C. Salinity ranged from 29.55 psu in July to 35.18 psu in May. The low salinity found in July was not expected in the area and it might be attributed to a sampling error. ANOVA revealed significant variations in temperature and salinity only across months (Tab. I, Fig. 2).

Thirty-nine morphotypes, 11 genus and 4 species were identified, from which only two were morphotypes of Stomatopoda larvae and the remainder were Decapoda larvae (Tab. II).

Decapod larvae densities ranged from 1 to 129 ind.m^{-3}. The mean concentration varied from 7 ind.m^{-3} in September to 67 ind.m^{-3} in April.

Brachyuran zoeae were the most abundant groups among the decapod and stomatopod larvae (mean concentration of 12.75 ind.m^{-3}) and they were well represented by Portunidae zoeae (mean concentration of 7.61 ind.m^{-3}). Xanthidae, Pinnotheridae, Majidae and Leucosiidae occurred frequently at the sample sites. Leucosiidae zoeae, represented by *Persephona* sp., were one of the most frequent taxa. Grapsidae and Ocypodidae occurred at low concentration and contribution (0.06 ind.m^{-3}, 32.14%, and 0.19 ind.m^{-3}, 7.14% respectively).

Lucifer sp. mysis and Caridea zoeae were the most abundant non-brachyuran taxa (mean concentration of 2.60 and 2.28 ind.m^{-3}, respectively). Processids and alpheyds represented 73.77% of mean carideans concentration.

Stomatopoda zoeae and postlarvae occurred with intermediate frequency (32.14% each) but low concentration (mean of 0.13 and 0.06 ind.m^{-3}, respectively).

ANOVA revealed significant effects of spatial-temporal factors on taxa concentration and richness (Tab. III). April was the month with the highest mean larvae concentration, followed by May and November. April and May were the months with the highest taxa richness (Fig. 3). Therefore, larvae were mainly concentrated in autumn and spring.

Spatial analysis showed that Saco das Balas and Baía do Farol, both on the south side of the island, had the highest taxa concentration and richness. In contrast, the north island sites, Rancho Norte and Saco d'Água, exhibited the lowest values.

Cluster analysis revealed three distinct groups of samples (Fig. 4), distinguished by water temperature and salinity and crustacean taxa concentration and richness. In group A, water temperature and salinity indicated the presence of Coastal Water with influence from Tropical Water. The richness and the concentration of taxa were low (mean of 15.5 taxa and 1.80 ind.m^{-3}). Additionally, this group was characterized by the scarcity of Brachyura zoeae in all sites (mean of 0.95 ind.m^{-3}).

Group B comprised all sites during May and April, three in January and two in November**.** Temperature and salinity data indicated the presence of Coastal Water under influence of the Tropical Water. This group exhibited high taxa richness and concentration at all sampling sites (mean of 25.13 taxa and 36.15 ind.m^{-3}). There was abundance of Brachyura zoeae, Penaeoidea and

Table I. Analysis of variance of the effects of months and sites on temperature and salinity in the Arvoredo Island, from May 2002 to April 2003.

Source	DF	p	F calc
Temperature	4.23	0.05	0.06
Month	5.22	0.05	590.03**
Station			
Salinity			
Month	5.22	0.05	45.27**
Station	4.23	0.05	0.12

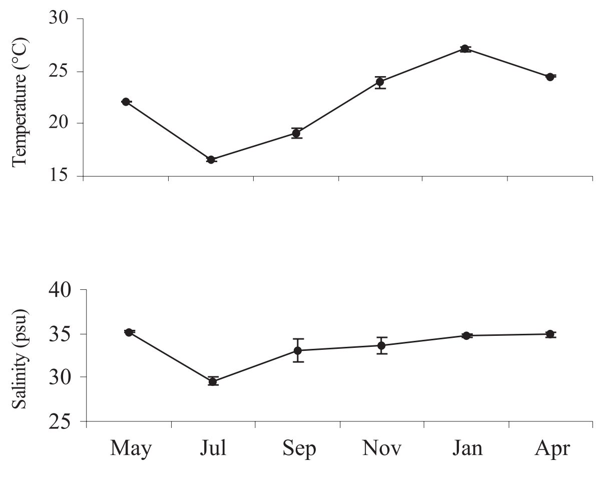


Fig 2. Mean surface water temperature and salinity at Arvoredo Island, SC, Brazil from May 2002 to April 2003.

Table II. Decapoda and Stomatopoda larvae identified in plankton samples; mean concentration (ind.m^{-3}) and percentage of occurrence of each larva in the Arvoredo Island from May 2002 and April 2003.

Taxa	ind.m^{-3}	%	Taxa	ind.m^{-3}	%
ORDER DECAPODA			INFRAORDER BRACHYURA		
SUPERFAMILY PENAEOIDEA			Brachyura postlarvae	0.33	67.86
Pleoticus muelleri Bate, 1888	0.24	32.14	FAMILY PORTUNIDAE		
Protozoea III Penaeoidea	0.14	35.71	Portunidae 5	2.13	78.57
Protozoea II Penaeoidea	0.08	28.57	Portunidae 1	2.07	64.29
Artemesia longinaris Bate, 1888	0.07	17.86	Portunidae 4	1.57	96.43
Protozoea I Penaeoidea	0.06	25.00	Portunidae 6	1.35	85.71
Trachypenaeus sp.	0.03	14.29	Portunidae 3	0.36	35.71
Penaeus sp.	0.03	28.57	Portunidae 2	0.12	25.00
Penaeoidea 2	0.005	7.14	Total	7.61	
Penaeoidea 1	0.004	7.14	FAMILY XANTHIDAE		
Total	0.68		*Menippe nodifrons* Stimpson, 1859	1.27	50.00
SUPERFAMILY SERGESTOIDEA			Panopeinae	0.56	67.86
Lucifer sp.	2.60	82.14	Xanthidae 2	0.38	57.14
Protozoea III Sergestoidea	0.94	57.14	*Pilumnus* sp.	0.14	28.57
Protozoea I Sergestoidea	0.79	50.00	Xanthidae 1	0.03	10.71
Acetes sp.	0.48	60.71	*Hexapanopeus schmitti* Rathbun, 1930	0.01	10.71
Protozoea II Sergestoidea	0.15	25.00	Total	2.38	
Peisos sp.	0.08	28.57	FAMILY PINNOTHERIDAE		
Total	5.05		*Pinnixa* sp.	0.87	85.71
INFRAORDER CARIDEA			Pinnotheridae	0.28	64.29
Processidae	1.16	89.29	Total	1.15	
Alpheidae	0.52	67.86	FAMILY MAJIDAE		
Hippolytidae 1	0.15	32.14	Majidae 2	0.47	35.71
Pandalidae	0.12	50.00	Majidae 1	0.38	57.14
Hippolytidae 2	0.12	21.43	Total	0.85	
Carideans unidentified	0.09	32.14	FAMILY LEUCOSIIDAE		
Leptochela sp.	0.05	17.86	*Persephona* sp.	0.50	96.43
Lysmata sp.	0.04	17.86	FAMILY OCYPODIDAE		
Palaemonidae	0.03	21.43	Ocypodidae	0.19	7.14
Total	2.28		FAMILY GRAPSIDAE		
INFRAORDER THALASSINIDEA			Grapsidae	0.06	28.57
Thalassinidea 1	1.30	67.86	*Sesarma* sp.	0.01	3.57
Thalassinidea 2	0.05	32.14	Total	0.07	
Total	1.35				
INFRAORDER ANOMURA			ORDER STOMATOPODA		
Porcelanidae	0.32	54.29	Stomatopoda zoea	0.13	32.14
Hippidae 1	0.20	28.27	Stomatopoda postlarvae	0.06	32.14
Paguridae	0.11	60.71	Total	0.19	
Diogenidae	0.10	64.29			
Albuneidae	0.02	7.14			
Hippidae 2	0.01	10.71			
Total	0.76				

Table III. Analysis of variance of the effects of months and sites on concentration and richness on Decapoda and Stomatopoda larvae in Arvoredo Island, from May 2002 to April 2003.

Source	DF	p	F calc.
Concentration			
Month	5.22	0.05	2.9*
Sites	4.23	0.05	5.84**
Richness			
Month	5.22	0.05	3.46*
Sites	4.23	0.05	5.65**

Sergestoidea protozoeae and mysis, Processidae and Alpheidae zoeae.

Temperature and salinity data for group C indicated the presence of Coastal Water with influence from South Atlantic Central Water (SACW), especially in July. Taxa richness and concentration values were intermediate (mean of 18.75 taxa and 8.39 ind.m^{-3}). Once more Brachyura zoeae were the larvae with the greatest concentration (mean of 5.46 ind.m^{-3}). During both months comprising this group, Caridea zoeae, Penaeoidea and Sergestoidea protozoeae and mysis were found.

Moreover, the cluster analysis showed that the north sites, Rancho Norte and Saco d'Água, were very similar in terms of taxa composition and concentration, in most cases with great similarity.

In relation to the seasonal distribution of the most abundant taxa (Fig. 5), Penaeoidea and Sergestoidea protozoeae were mainly present in May 2002 and April 2003, following the general trend for crustacean larvae. Their mysis were also abundant in May 2002 and April 2003 but there was an input of *Pleoticus muelleri* (Bate, 1888) in September 2002. Thalassinideans and carideans larvae were well represented throughout the year, with high concentrations in November, January and April. Paguroideans and porcellanids were also found throughout the year and hippids were very abundant in July 2002. Among the brachyuran zoeae, *Persephona* sp. and pinnotherids occurred from May to September, increased in November and decreased again in January and April. Majids also occurred all year, with higher concentration in November and April. Portunidae and Xanthidae were the brachyuran families with highest abundance and frequency, occurring during all sampled months, especially in November and April.

As a general tendency, the southern sites Saco das Balas and Baía do Farol were the most abundant ones (Fig. 6). Rancho Norte and Saco do Batismo exhibited medium larval concentration. Rancho Norte had high concentrations of portunids and xanthids and, as Saco do Batismo, high concentration of *Pleoticus muelleri*, thalassinideans and carideans zoeae. Saco d'Água was the site with the lowest concentration of larvae.

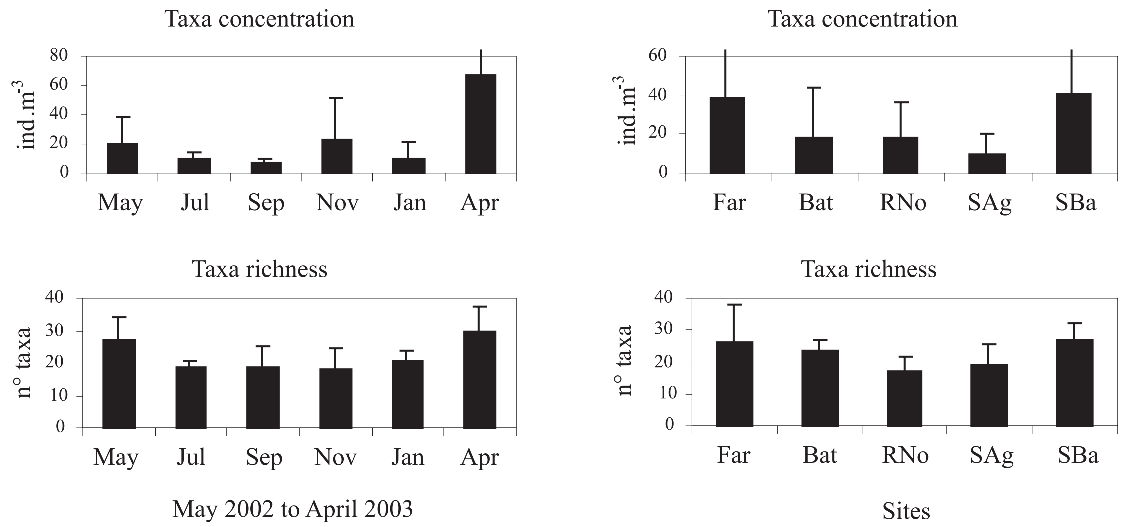
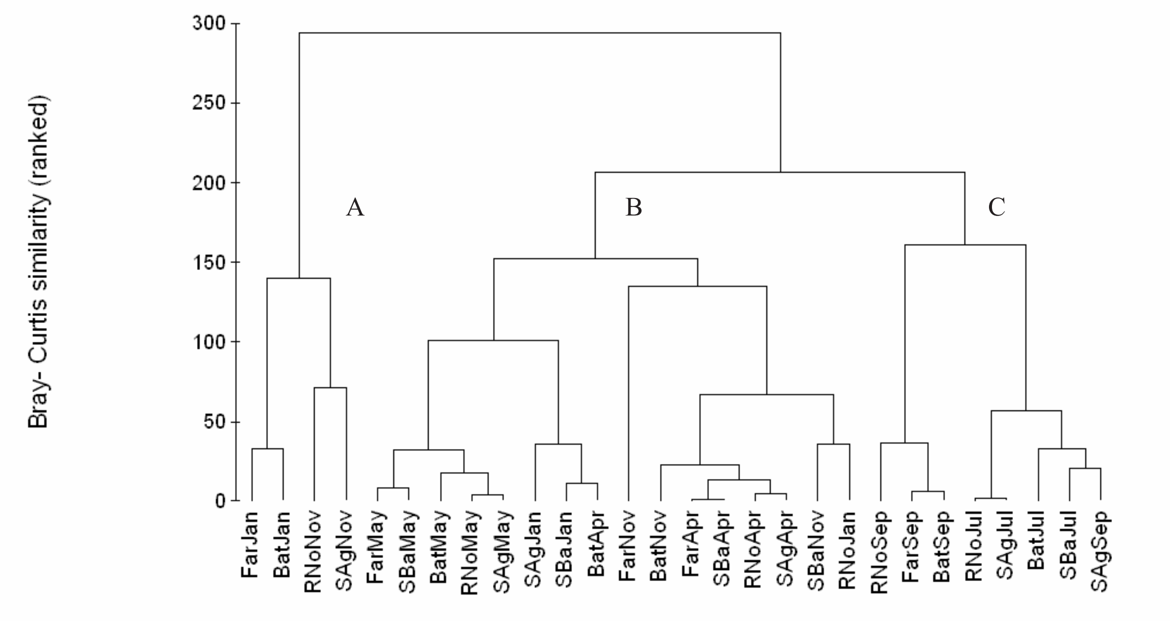


Fig. 3. Crustacean larvae taxa concentration (mean ind.m^{-3}) and richness (number of taxa) for each month of sampling from May 2002 to April 2003 and at sampling sites around Arvoredo Island (Bat, Saco do Batismo; Far, Baía do Farol; RNo, Rancho Norte; SAg, Saco d'Água; SBa, Saco das Balas).



Temperatura (°C)	23.94 - 27.10	22.10 - 27.10	16.58 - 19.10
Salinity (psu)	33.64 - 34.76	33.64 - 35.18	29.55 - 32.98

Fig. 4. Cluster dendrogram based on similarities of 28 samples collected in Arvoredo Island from May 2002 to April 2003. Samples were clustered by Bray Curtis similarity based on log (x+1) transformed densities of 50 taxa. Water temperature and salinity range of each group (Bat, Saco do Batismo; Far, Baía do Farol; RNo, Rancho Norte; SAg, Saco d'Água; SBa, Saco das Balas).

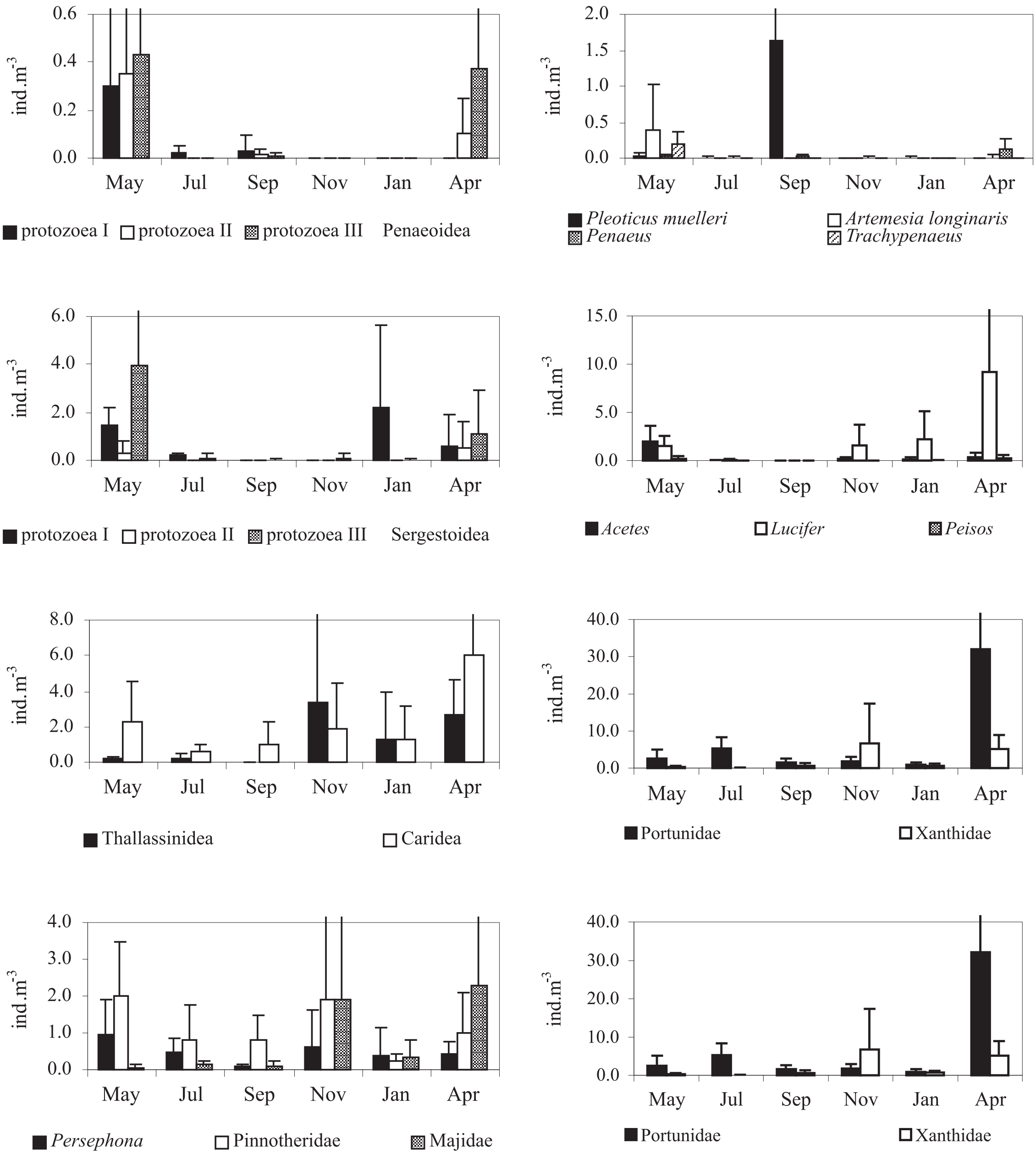


Fig. 5. Temporal distribution. Mean larvae concentration (ind.m^3) of the main decapod taxa from May 2002 to April 2003, in Arvoredo Island, SC, Brazil.

DISCUSSION

Temperature seasonality and the influence of subtropical, tropical and coastal waters had been expected in this subtropical area of the Brazilian coast.

Figures for decapod mean density were similar to those found in the surf zone of south Brazil (J. G. Bersano, unpublished data). Mean decapod larvae concentrations ranged from 2 ind.m^{-3} in February to 114 ind.m^{-3} in December. However, estuarine systems show a tendency to higher decapod concentrations. In Guanabara Bay, decapod densities ranged from 1.3 to 612 ind.m^{-3} in summer and from 0.4 to 788 ind.m^{-3} in winter, with brachyuran zoea frequently representing more than 90% of total (FERNANDES *et al.*, 2002). In the Itamaracá estuarine system, mean decapod concentration was of 784.7 ind.m^{-3}, with brachyurans zoeae representing approximately 90.86% (SCHWAMBORN, 1997). In Arvoredo Island, brachyuran zoeae were less dominant than in these estuarine systems, reaching a maximum of 67% in July.

Brachyura zoeae, Caridea zoeae and *Lucifer* sp. mysis were the most abundant larvae in the study area, agreeing with results from Itamaracá estuary and Sepetiba Bay (SCHWAMBORN, 1997; COELHO-BOTELHO *et al.,* 1999) and similar to those observed in Guanabara Bay except by the Caridea larvae absence (FERNANDES *et al.*, 2002).

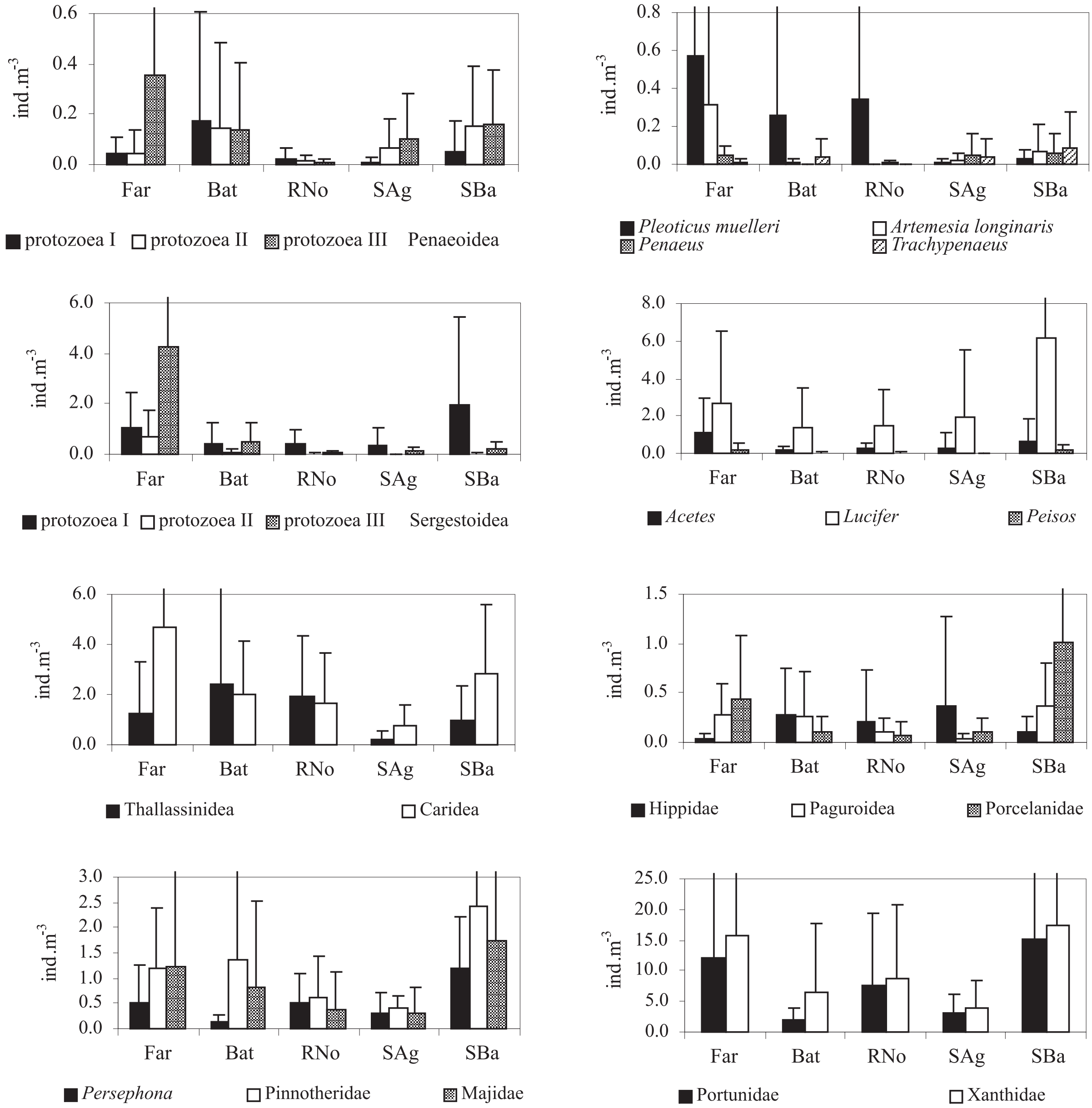


Fig. 6. Spatial distribution. Mean larvae concentration (ind.m^3) of the main taxa around Arvoredo Island, SC, Brazil, from May 2002 to April 2003 (Bat, Saco do Batismo; Far, Baía do Farol; RNo, Rancho Norte; SAg, Saco d'Água; SBa, Saco das Balas).

Portunid larvae were the most abundant brachyuran zoea, occurring all year, but peaking in spring. There are no seasonal distribution data available for brachyuran zoeae along the Brazilian coast. Reproductive studies with portunid crabs showed that reproduction is mainly constant, with peaks in summer and autumn (LUNARDON-BRANCO & BRANCO, 1993; MANTELLATO & FRANSOZO, 1998). Nevertheless, there is little research on the abundance and composition of Brachyura larvae in estuarine systems and coastal areas.

Portunidae zoeae have a high salinity requirement for complete larval development (EPIFANIO & DITTEL, 1984). As such, exportation to open waters is an ecological strategy aimed at finding optimum development conditions. Additionally, this strategy avoids the high predation rates common in estuaries (MORGAN & CHRISTY, 1997). Portunidae crabs are very common along the Santa Catarina coast (BRANCO *et al*, 1998), contributing to the occurrence of their larvae.

The most abundant larvae in Guanabara Bay were portunids and grapsids (FERNANDES *et al*., 2002). However, in this study grapsids were the least abundant larvae among the brachyurans.

Xanthids were also present during all sampling months, especially during autumn and spring. In the

Itamaracá estuarine system (Schwamborn, 1997), Xanthidae and Grapsidae zoeae were found in estuarine plume and at nearshore shelf stations, but were detected in very low densities on the shelf, when compared to the densities in the estuarine plume. The present study reinforces Grapsidae retention in estuaries. Xanthidae exportation was registered during summer in Guanabara Bay night time ebb tides. In contrast, xanthids were homogeneously distributed throughout the water mass during the winter (Fernandes *et al.,* 2002). Xanthids belong to a large family with species having distinct ecological requirements. The elevated occurrence of xanthids found in this study could be explained by the larval dispersion of estuarine crab species and in particular by larval production in the area, since the dominant adult crabs were xanthids (J. L.Bouzon & A. S. Freire, unpublished data).

Ocypodid larvae exhibited low abundance and frequency, with a small larval input only in November. Schwamborn *et al*. (2001) showed that Ocypodidae zoeae were the most abundant brachyurans in the Itamaracá estuarine system and that the density of zoea of *Uca* spp. and *Ucides cordatus* (Linnaeus, 1763) clearly decreased from the inner estuarine plume towards the outer plume. However, results reported by Fernandes *et al.* (2002) support the hypothesis of ocypodids zoea having a dispersal strategy towards the adjacent coastal waters. *Ucides cordatus* has a similar dispersal strategy from the Paranaguá Bay to adjacent coastal waters (A. S. Freire, unpublished data). The very low concentration and frequency of ocypodids in this study agreed with Schwamborn *et al.* (2001) and the absence of adult ocypodids in the area (J. L. Bouzon & A. S. Freire, unpublished data).

Pinnotheridae, *Persephona* sp. and Majidae zoeae demonstrated continuous reproduction, being present during all sampling months, but their major input occurred during autumn and spring.

The reproductive peak of Sergestoidea and Penaeoidea was registered during autumn, by the presence of a large number of protozoeae. It seems that Sergestoidea and probably Penaeoidea as well, depend on water temperature to spawn, since along the Paraná coast their input occurred during the summer (Fehlauer & Freire, 2002) and, in both studies, the presence of protozoeae was very low or absent during winter. The high concentration of *P. muelleri* in September could indicate another breeding season in spring. This input and even *Artemesia longinaris* Bate, 1888 input in May 2002 was not verified by Calazans (2002), in the nearby southern waters of Rio Grande do Sul (31° S) where *A. longinaris* and *P. muelleri* were well represented throughout the year.

The highest larvae production during autumn among the holoplanktonic decapods *Lucifer* sp. and *Acetes* sp. partially coincided with results reported by Calazans (2002) and Fehlauer & Freire (2002) where the reproductive peak occurred during summer and autumn.

Thalassinidea, Caridea and Anomura larvae had a long reproductive season, but their input in planktonic community was especially important during autumn and spring for thalassinideans and carideans, and winter, spring and autumn for anomurans. This reproductive pattern was verified along the southern coast of Paraná state (Fehlauer & Freire, 2002).

Water temperature and day length are key determinants of larval occurrence, controlling both the reproductive cycle of aquatic invertebrates and the intensity of primary production (Anger, 2001). In a tropical/subtropical environment, continuous reproduction with spawning peaks during major temperature periods seems to be the pattern. The results of this study, demonstrate that most of the decapods reproduced continuously, but larvae input in planktonic community was observed mostly during autumn and spring. Thus, decapod species breeding should also takes place during two periods, the summer and winter.

The spatial distribution of decapod larvae demonstrates that they were well distributed through all sampling sites. However, the southern sites Saco das Balas and Baía do Farol had the highest concentrations and richness of larvae. These results are very important to the area's management program, since Baia do Farol site is not part of the Arvoredo Marine Biological Reserve and the decapod populations are more vulnerable to human impact. Furthermore, since Rancho Norte and Saco d'Água were very similar in terms of the occurrence of larval and adult decapods (J. L. Bouzon & A. S. Freire, unpublished data), one of these places could be chosen as representative of the north of the island.

The diversity of planktonic and benthonic decapods around Arvoredo Island was very different from each other. Thirty-four adult species of the latter were identified, consisting of 25 Brachyura species, 5 Anomura, 1 Caridea, 1 Palinuridea, 1 Penaeidae and 1 Stomatopoda (J. L. Bouzon & A. S. Freire, unpublished data). The greatest numbers of individuals were also representatives of Brachyura species. Xanthidae and Majidae families were the most abundant and frequent of these, whereas Portunidae individuals were scarce. *Menippe nodifrons* (Stimpson, 1859), *Pilumnus* sp. and *Penaeus* sp. were identified in both larval and adult studies. However, decapod spatial variation differed between the two studies since all the adult taxa found at just one benthic sampling site had their larvae distributed all around the Arvoredo Island. Furthermore, carideans larvae were very abundant, diverse and frequent, whereas only one individual collected in the adult study. These comparisons reinforce the idea that ecological and management studies should include adult and larval biology.

Summing up, larval occurrence in the area could be explained by the larval dispersal of coastal and estuarine species, as in the case of portunid crabs, and larval production around the island, as in the case of the xanthids. Sergestid and Caridean larvae production are very important to pelagic food chains. Reproduction is continuous throughout the year with peaks in autumn and spring.

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