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DISTRIBUTION AND ABUNDANCE OF PLEURONECTIFORMES LARVAE OFF SOUTHEASTERN BRAZIL

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ABSTRACT

The objective of this study was the description of the composition, abundance and density in horizontal and vertical distribution of Pleuronectiformes larvae on the southeastern Brazilian continental shelf. The samples were collected with bongo nets and a Multi Plankton Sampler (MPS), both in summer and winter 2002. A total of 352 flatfishes larvae were collected in summer and 343 in winter, representing three families and a total of 13 taxa: Paralichthyidae (*Citharichthys cornutus*, *C. spilopterus*, *Citharichthys sp.*, *Cyclosetta chittendeni*, *Syacium spp.*, *Etropus spp.* and *Paralichthys spp.*), Bothidae (*Bothus ocellatus* and *Monolene antillarum*) and Cynoglossidae (*Symphurus trewavasae*, *S. jenynsi*, *S. plagusia* and *S. ginsburgi*). The most abundant taxa were *Etropus spp.*, *Syacium spp.* and *Bothus ocellatus*. *Etropus spp.* occurred mainly as far out as the 200 m isobath and *Syacium spp.* from 100 m. *B. ocellatus* was present mainly in the oceanic zone between Ubatuba and Rio de Janeiro as from the 200 m isobath. The greatest average densities of these species occurred in the strata from 0 to 20 m depth in summer and between 20 and 40 m in winter.

RESUMO

O objetivo deste estudo foi descrever a composição, abundância, densidade, distribuição horizontal e vertical das larvas de Pleuronectiformes ao longo da plataforma continental Sudeste brasileira. As amostras foram coletadas na plataforma continental sudeste com redes bongô e Multi Plankton Sampler (MPS), no verão e inverno de 2002. Um total de 352 larvas de linguado foi coletado no verão e 343 no inverno, representadas por três famílias e totalizando 13 táxons: Paralichthyidae (*Citharichthys cornutus*, *C. spilopterus*, *Citharichthys sp.*, *Cyclosetta chittendeni*, *Syacium spp.*, *Etropus spp.* e *Paralichthys spp.*), Bothidae (*Bothus ocellatus* e *Monolene antillarum*) e Cynoglossidae (*Symphurus trewavasae*, *S. jenynsi*, *S. plagusia* e *S. ginsburgi*). Os táxons mais abundantes foram *Etropus spp.*, *Syacium spp.* e *Bothus ocellatus*. *Etropus spp.* ocorreram principalmente até a isóbata de 200 m e *Syacium spp.* a partir de 100 m. *B. ocellatus* esteve presente principalmente na zona oceânica entre Ubatuba e Rio de Janeiro a partir da isóbata de 200 m. As maiores densidades médias dessas espécies ocorreram nos estratos de 0 a 20 m de profundidade, no verão, e entre 20 a 40 m, no inverno.

Descriptors: Fish larvae, Temporal variation, Horizontal distribution, Vertical distribution, Flatfishes.
Descritores: Larvas de peixes, Variação temporal, Distribuição horizontal, Distribuição vertical, Linguados.

INTRODUCTION

Much of our knowledge of fish ecology comes from studies on species of commercial interest or which are otherwise abundant in coastal waters; however, few studies focus on the initial stages of the life-cycle of the Pleuronectiformes. The larger part of the available information relates to the species of the Northern Hemisphere, particularly to the adult phase of those which are commercially important (MARQUES et al., 2009; MUNROE; ROSS, 2010).

Recent studies have concentrated particularly on the cultivation of *Paralichthys olivaceus* in China and Japan (OHNO et al., 2008; SHIROZU et al., 2008; YAMAGUCHI; KITANO, 2008; CHEN et al., 2009; HUANG et al., 2010; SUN et al., 2010).

In Brazil, studies on flatfish, based on adults, deal with various aspects: morphology (MENEZES; BENEVEGNÚ, 1976); occurrence, distribution and abundance (LEMA; OLIVEIRA, 1977; LEMA et al., 1980; PAIVA-FILHO et al., 1989; ALMEIDA; VASCONCELOS FILHO, 1997; MENDONÇA;

ARAÚJO, 2002), reproductive dynamics (CHAVES; VENDEL, 1997; PAIVA et al., 2001; MENDONÇA; ARAÚJO, 2002; DIAS et al., 2005); feeding (WAKABARA et al., 1982; CHAVES; SERENATO, 1998; LUNARDON-BRANCO; BRANCO, 2003; GUEDES et al., 2004); occurrence of parasites (ROBALDO et al., 2002; THATCHER; PEREIRA Jr., 2004; ABREU et al., 2005; CARDENAS; LANFREDI, 2005; VELLOSO et al., 2005), and genetic characterization (AZEVEDO et al., 2005, 2007).

Recent work on the larvae of the Pleuronectiformes has dealt mainly with *P. olivaceus* and has been undertaken in China and Japan (TANAKA et al., 2005; SAKAKURA, 2006; ISHIBASHI et al., 2007; SHIMADA; SEIKAI, 2008a, 2008b; TOMIYAMA et al., 2008). In Brazil studies have focused more on transport (ARAÚJO-LIMA; OLIVEIRA, 1998), reproductive aspects (SAMPAIO et al., 2007) and aquiculture (LANES et al., 2008). Kurtz and Matsuura (1994) conducted an in-depth study on the Cynoglossidae. On the other hand, in other studies, such as those of Castro et al. (2005), Katsuragawa and Dias (1997), flatfish larvae have been analyzed more superficially, as they focused on the total ichthyoplankton population. This brings out the need for more detailed studies on this group with a view to increasing knowledge of the initial phases of their life-cycle, as also to contributing to our understanding of the flatfish ecology and population dynamics on the southeastern coast of Brazil. This study aims to describe the composition, abundance and density in horizontal and vertical distribution of flatfishes larvae in southeastern Brazilian waters.

MATERIAL AND METHODS

The samples analyzed were collected on two oceanographic cruises undertaken in 2002, establishing a total, in summer, of 72 stations distributed on 14 transects and, in winter, of 66 stations on 13 transects. The study area extended from the coast as far out as the oceanic region, being limited to the north by the São Tomé Cape and to the south by São Sebastião Island (Fig. 1). This area was subdivided into three regions in accordance with their respective depths: coastal zone (out to the 100 m isobath), intermediate zone (between the 100 and 200 m isobaths) and the oceanic zone (beyond the 200 m isobath).

Hydrographic data were obtained with the help of a CTD (Conductivity, Temperature, and Depth Sensor). T-S diagrams were traced for the purpose of identifying the water masses by means of the thermohaline indices described by Sverdrup et al. (1942), Emilsson (1961) and Miranda (1985). The 10m depth temperature was used to try to explain the horizontal distribution of larvae. This depth was in the range (0-20m) where the greatest abundance of ichthyoplankton is observed.

The samples were obtained on oblique trawls with a bongo net with a 60 cm diameter mouth and an MPS (Multi Plankton Sampler) with 1 m² mouth area, both with 333 µm mesh size. Whenever, possible the bongo net gathered samples from the surface down to 200 m depth (SMITH; RICHARDSON, 1977). The MPS composed of five nets with an opening and closing system, operated on strata of 20 m down to 100 m depth, on alternate transects. Mechanical flowmeters were coupled to all the nets to estimate the volume of water filtered (SMITH; RICHARDSON, 1977).

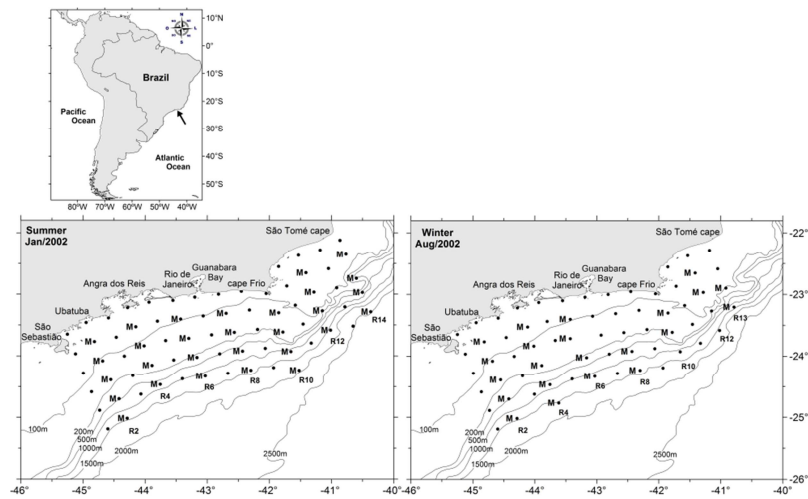


Fig. 1. Map of sampling stations of summer and winter 2002. All stations were sampled with bongo net and, the marked one with M, with MPS in alternating radial (R)

The identification of some species was carried out by development series such as Aceves-Medina et al. (1999) and Saldierna-Martinez et al. (2010). Larvae of the genera *Etropus* and *Syacium* underwent the process of clearing and staining techniques (POTTHOFF, 1984) to show meristic characteristics that would make the identification to species level possible.

The estimate of larval abundance at each station was arrived at by means of the expression $Y = \frac{d \times x}{v}$, where Y is the number of larvae per m^2 , d the depth at which the collection was made (m), x the number of individuals collected at the station, and v the volume of water filtered (m^3). From the samples obtained with the MPS net, the density of the larvae at each station and on each stratum was estimated by means of the expression $N = \frac{x}{v}$, where N is the number of larvae per m^3 , x the number of individuals from one of the strata at the collection station, and v the volume of water filtered (m^3) on that same stratum.

Mann-Whitney's non-parametric analytical test (ZAR, 1999) was used to ascertain significant differences between biological data such as larval density and abundance and relation to collection period (summer and winter).

RESULTS

Oceanographic Conditions

The Brazil Current transports two water masses southward: Tropical Water (TW) near the shelf break in the upper layer of 200 m depth with

temperature and salinity higher than 20°C and 36.40 respectively (CASTRO; MIRANDA, 1998); South Atlantic Central Water (SACW) at 200-500m depth with salinity and temperature lower than those of TW. Another water mass, Coastal Water (CW), is derived from mixing of shelf and continental origin waters resulting in low salinity water (SILVEIRA et al., 2000).

It may be observed, on the basis of the scattered T-S diagram, in both the periods studied TW, that SACW and CW occurred in the water column sampled. The periods presented variations by virtue of the mixing of the water masses in the upper part of the water column. In summer the TW predominated on the shelf, while in winter a larger contribution of the CW was observed (Fig. 2). Upwelling was present in summer, when SACW was observed on the shelf, whereas in winter this water mass was evident as from the intermediate zone, corresponding to the middle shelf.

At 10 m depth, the highest temperatures were recorded in the south of the study area and also beyond the 200 m isobath (Fig. 3). Colder waters were observed in the coastal zone between Cape Frio and Guanabara Bay and in the region of Cape São Tomé. In winter the range of temperature variation was smaller (Fig. 3). An upwelling promoted by the intrusion of SACW, could be observed in the Cape Frio region and with greater intensity in summer. When the summer salinity results were analyzed the water column was seen to be homogeneous throughout. In winter, however, the salinity varied more than in summer (Table 1). The lowest average values were found at 10 m, in the coastal zone near São Sebastião and Angra dos Reis. Values above 37 were only observed beyond the 500 m isobath, between the depths of 10 and 50 m.

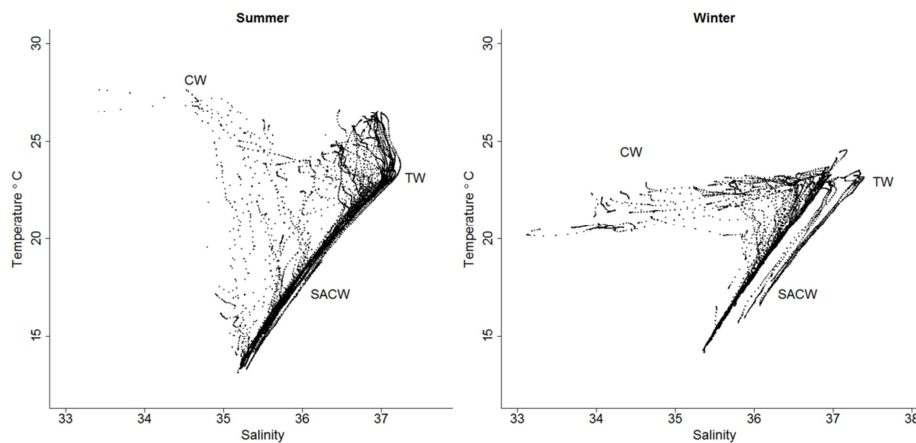


Fig. 2. T-S diagrams of the total oceanographic stations realized during the summer and winter cruises. (TW - Tropical Water mass; SACW - South Atlantic Central Water mass; CW - Coastal Water mass).

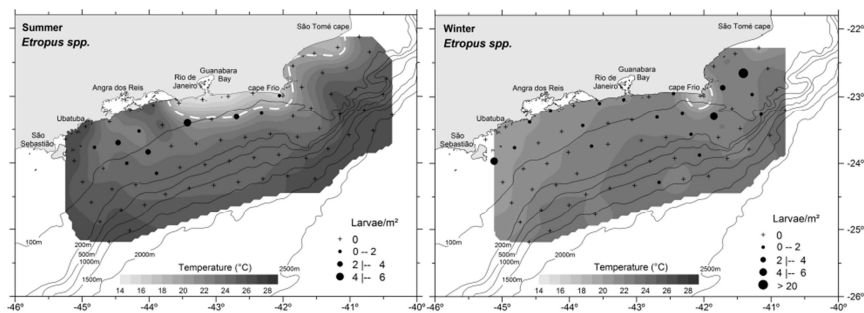


Fig. 3. Horizontal distribution of *Etropus spp.* during the summer and winter 2002. The abundance is expressed in larvae/m². Horizontal section of temperature at 10 m depth. The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

Table 1. Temperature (°C) and salinity registered by depth during the summer and winter 2002 (sd - standard deviation).

	depth	Temperature (°C)				Salinity			
		mean	sd	maximum	minimum	mean	sd	maximum	minimum
summer	10 m	23.79	2.86	27.08	14.88	36.08	0.69	37.01	34.67
	30 m	21.84	3.64	26.36	14.27	36.38	0.57	37.18	35.19
	50 m	20.97	3.61	25.91	13.74	36.46	0.61	37.12	35.24
	100 m	19.00	3.19	23.35	13.55	36.23	0.64	37.18	35.25
winter	150 m	17.77	2.80	22.33	13.35	35.99	0.53	36.95	35.23
	10 m	22.38	1.20	24.44	16.50	35.55	0.95	37.09	33.79
	30 m	22.34	1.50	24.45	14.64	36.17	0.78	37.09	34.18
	50 m	21.56	1.78	24.41	17.61	36.47	0.50	37.17	34.35
	100 m	18.85	2.40	22.69	14.83	36.14	0.42	36.85	35.45
	150 m	17.29	1.58	19.35	14.60	35.85	0.27	36.21	35.42

Horizontal Distribution

A total of 579 flatfishes larvae were collected, 282 of them in summer (2.34 ± 2.68 larvae/m²) and 297 in winter (1.64 ± 3.49 larvae/m²). In both periods the families Paralichthyidae (*Citharichthys cornutus*, *C. spilopterus*, *Citharichthys sp.*, *Cyclosetta chittendeni*, *Syacium spp.*, *Etropus spp.* and *Paralichthys spp.*), the most abundant (36% of the total of the order in summer and 51% in winter),

Bothidae (*Bothus ocellatus* and *Monolene antillarum*) and Cynoglossidae (*Symphurus trewavasae*, *S. jenynsi*, *S. plagusia* and *S. ginsburgi*) were identified (Table 2). The most abundant taxa, *Etropus spp.*, *Syacium spp.* and *Bothus ocellatus*, accounted, in summer, for 36% of the total flatfishes larvae captured and, in winter, for 50%. *Syacium spp.* (U-test, $p = 0.0117$) and *B. ocellatus* (U-test, $p = 0.0352$) were more abundant in summer.

Table 2. Data participation (N %) of each species in the total number of larvae collected from each family, mean abundance (larvae/m²) with standard deviation and frequency of occurrence (F.O. %) during the summer and winter 2002.

Family	Genus/Species	N (%)	Summer		Winter		
			Abundance (larvae/m ²)	F.O. (%)	Abundance (larvae/m ²)	F.O. (%)	
Paralichthyidae	<i>Etropus spp.</i>	32.7	0.29 ± 0.89	13.9	88.0	0.66 ± 2.73	30.3
	<i>Syacium spp.</i>	38.6	0.33 ± 0.57	31.9	8.0	0.07 ± 0.27	7.6
	<i>Citharichthys cornutus</i>	7.9	0.07 ± 0.27	8.3	-	-	-
	<i>Citharichthys spilopterus</i>	4.0	0.04 ± 0.25	2.8	-	-	-
	<i>Citharichthys sp.</i>	2.0	0.01 ± 0.09	2.8	-	-	-
	<i>Cyclosetta chittendeni</i>	-	-	-	0.7	0.003 ± 0.03	1.5
	<i>Paralichthys spp.</i>	3.0	0.03 ± 0.22	2.8	3.3	0.04 ± 0.22	4.5
	Paralichthyidae N.I.	11.9	0.06 ± 0.26	6.9	-	-	-
Bothidae	<i>Bothus ocellatus</i>	37.5	0.32 ± 0.76	25.0	57.14	0.04 ± 0.21	4.5
	<i>Monolene antillarum</i>	31.3	0.21 ± 1.11	9.7	14.29	0.01 ± 0.10	1.5
	Bothidae N.I.	31.3	0.25 ± 0.90	13.9	28.57	0.01 ± 0.04	3.0
Cynoglossidae	<i>Symphurus trewavasae</i>	25.0	0.02 ± 0.13	4.2	22.7	0.03 ± 0.16	4.5
	<i>Symphurus jenynsi</i>	16.7	0.02 ± 0.11	2.8	-	-	-
	<i>Symphurus plagusia</i>	8.3	0.003 ± 0.03	1.4	-	-	-
	<i>Symphurus ginsburgi</i>	-	-	-	72.7	0.15 ± 0.73	7.6
	Cynoglossidae N.I.	50.0	0.03 ± 0.12	6.9	4.5	0.005 ± 0.04	1.5

Etropus spp. was the second most abundant taxon in summer, accounting for 33% of the total of Paralichthyidae larvae captured and occurring at 14% of the stations sampled; in winter it was the most abundant of the family accounting for 88% of the larvae collected at 30% of the stations sampled. Its occurrence in summer was limited to the 200 m isobath, having its greatest frequency and abundance (F.O. = 25%; 0.53 ± 1.14 larvae/m²) in the intermediate zone. In winter it was more widespread and occurred from the coast as far out as near to the 1500 m isobath, though more frequent and abundant in the coastal zone (F.O. = 44%; 1.21 ± 4.12 larvae/m²), specially in the Cape Frio region. There was no statistically significant difference in abundance as between the periods (U-test, $p = 0.0767$) (Fig. 3).

Syacium spp. In summer, the larvae of *Syacium spp.* were the most abundant (0.33 ± 0.57 larvae/m²), both as regards the Paralichthyidae larvae and among the Pleuronectiformes. The greatest abundances were found in the intermediate zone (0.61

± 0.70 larvae/m²). In winter, in lesser abundance (0.07 ± 0.27 larvae/m²), they only occurred at five stations (F.O. = 8%) (Fig. 4).

Bothus ocellatus. During the summer, with abundance of 0.32 ± 0.76 larvae/m² and frequency of occurrence of 25%, this species occurred mainly in the oceanic area between the 500 and 1500 m isobaths; in winter it presented low abundance (0.04 ± 0.21 larvae/m²) and occurrence (4 larvae at 3 stations) (Fig. 5).

Other species. The larvae of *Paralichthys spp.*, *Monolene antillarum* and *Symphurus trewavasae* occurred in both periods, the first two in the intermediate zone and *S. trewavasae* mainly in the coastal zone. The species of the genus *Citharichthys* (*Citharichthys sp.*, *C. spilopterus* and *C. cornutus*) and *Symphurus jennynsi* only occurred in summer in the coastal zone between the region of Angra dos Reis and Cape São Tomé. *Symphurus ginsburgi* only occurred in winter, in the intermediate zone off Angra dos Reis and Cape Frio.

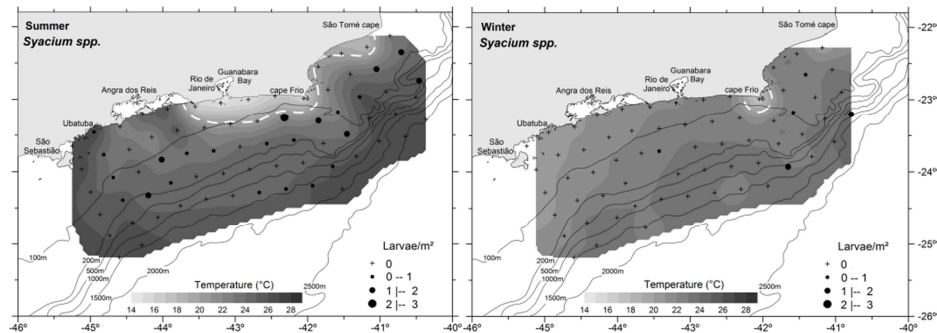


Fig. 4. Horizontal distribution of *Syacium spp.* during the summer and winter 2002. The abundance of larvae is expressed in larvae/m². Horizontal section of temperature at 10 m depth. The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

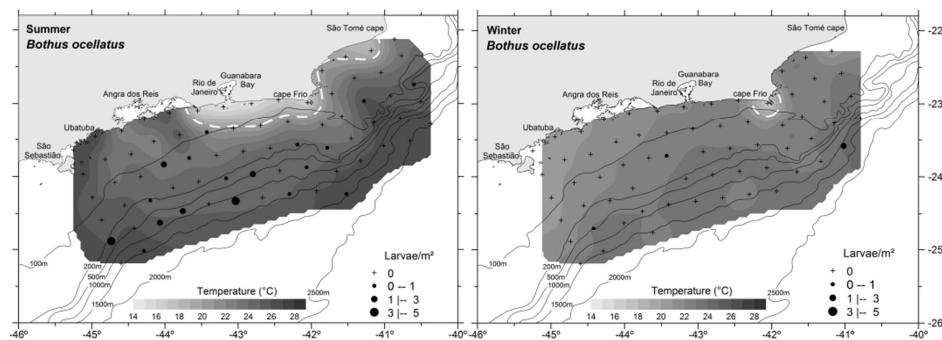


Fig. 5. Horizontal distribution of *Bothus ocellatus* during the summer and winter 2002. The abundance of larvae is expressed in larvae/m². Horizontal section of temperature at 10 m depth. The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

There was just one occurrence each of *Cyclopsetta chittendeni* and *Symphurus plagusia* - that of the former species was recorded in the region of Ubatuba, in winter, and that of the latter, in summer, to the north of Cape Frio, both near the coast.

Vertical Distribution

A total of 116 flatfishes larvae were collected with MPS, 70 in summer, with an average density of 2.24 ± 5.61 larvae/100 m³, and 46 in winter with 1.28 ± 5.35 larvae/100 m³. With this net, of the taxa collected with the bongo net, no specimens of *Citharichthys* sp., *C. spilopterus*, *Cyclopsetta chittendeni*, or *Paralichthys* spp. were found.

Etropus spp. In summer the larvae of *Etropus* spp. occurred mainly in the surface stratum (1.45 ± 4.75 larvae/100 m³), whereas in winter they

were more widely scattered, occupying the first three strata, although with their greatest density in the 20-40 m layer (2.56 ± 8.36 larvae/100 m³). The larvae of *Etropus* spp. occurred mainly in association with TW, with temperatures varying between 14.9° and 26.5°C and average salinity of 35.7 ± 0.3 (Fig. 6).

Syacium spp. The larvae of this group were more abundant in summer. In terms of vertical distribution they were collected in the first two strata, the greatest abundance being observed between 0 and 20 m, both in summer (1.13 ± 2.86 larvae/100 m³) and in winter (0.41 ± 1.08 larvae/100 m³). In summer they occurred in the deepest stratum at just one station. The variation of temperature and salinity in which the larvae were sampled was between 16.1° and 25.8°C and 35.2 and 37.1. Their occurrence was limited to TW and the mixing zone between TW and SACW (Fig. 7).

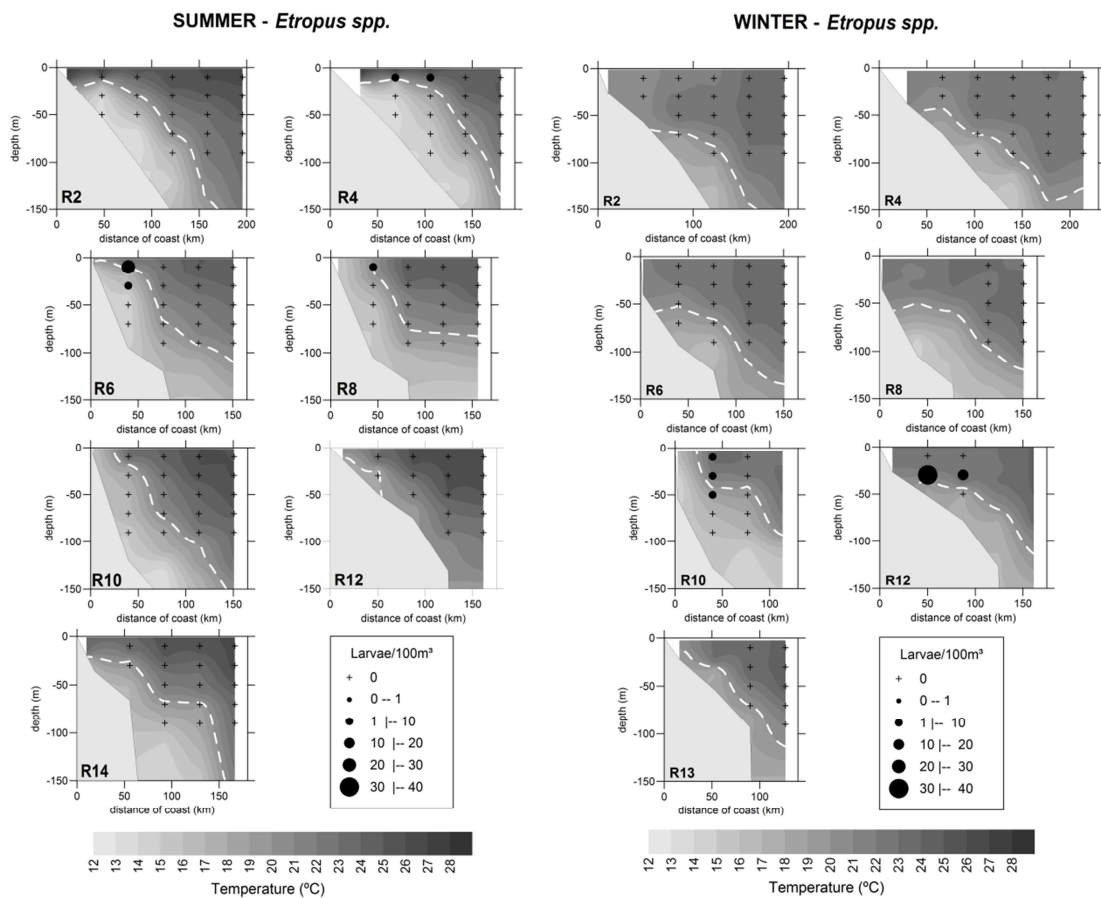


Fig. 6. Vertical profiles of temperature (°C) and vertical distribution of *Etropus* spp. larvae during the summer and winter 2002. The density is expressed in larvae/100 m³. The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

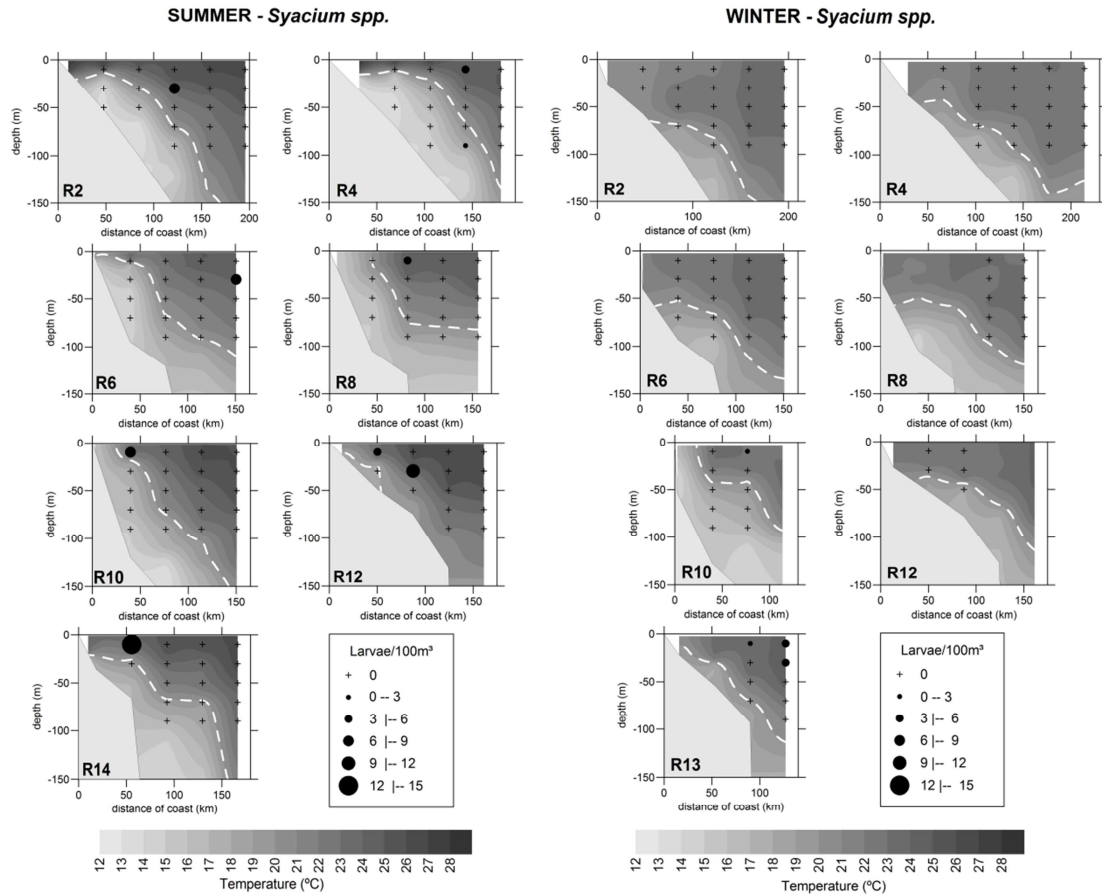


Fig. 7. Vertical profiles of temperature ($^{\circ}\text{C}$) and vertical distribution of *Syacium spp.* larvae during the summer and winter 2002. The density is expressed in larvae/100 m^3 . The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

Bothus ocellatus. Larvae of *Bothus ocellatus* only occurred in summer and in the first three strata, with their greatest average density (1.61 ± 3.85 larvae/100 m^3) in the surface layer. They were found in regions with temperatures varying between 21.8° and 25.8°C , and salinity of between 35.2 and 36.9. Their occurrence was limited to TW and the mixing zone between TW and SACW (Fig. 8).

Other species. Only one larva of each of the following species was sampled: *Cyclopssetta chittendeni*, *Monolene antillarum*, *Symphurus trewasasae*, *S. plagusia* and *S. jenynsi*. Both *C. chittendeni* and *M. antillarum* were sampled in summer, the former in the 40-60 m layer, and the latter in the surface stratum. The larvae of the genus *Symphurus* only occurred in winter, *S. trewasasae* and *S. plagusia* only in the surface stratum and *S. jenynsi* only in the 20-40 m stratum.

Only one larva of *Citharichthys cornutus* was captured in summer, in the 20-40 m stratum, and one in winter, in the surface stratum.

Symphurus ginsburgi occurred in winter at two stations, one in the first stratum and the other in the second, to a total of six individuals.

DISCUSSION

A spatial segregation between *Etropus* species has been observed on the south-southeastern coast of Brazil in several studies. *E. crossotus* lives in shallow waters, especially in bays and estuaries, while *E. longimanus* inhabits coastal areas up to 190 m depth, being more frequent from 40 m (PAIVA-FILHO et al., 1987; GIANNINI; PAIVA FILHO, 1995; ROCHA; ROSSI-WONGTSCHOWSKI, 1998; FIGUEIREDO; MENEZES, 2000; MENDONÇA; ARAÚJO, 2002; ROCHA et al., 2010). The literature

SUMMER - *Bothus ocellatus*

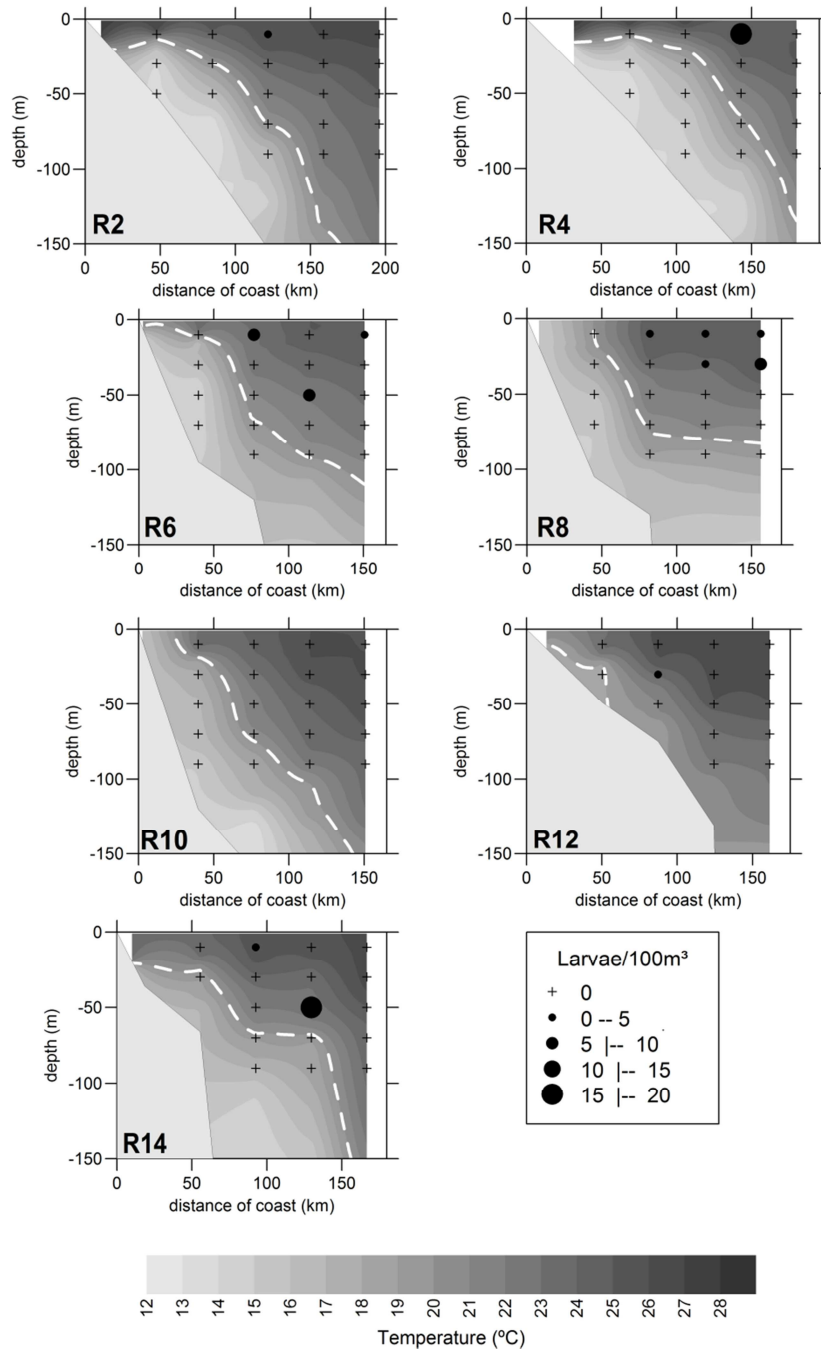


Fig. 8. Vertical profiles of temperature (°C) and vertical distribution of *Bothus ocellatus* larvae during the summer 2002. The density is expressed in larvae/100 m³. The dotted white line represents the characteristic temperature (20°C) of SACW (South Atlantic Central Water mass).

reports that *E. crossotus* spawn near the coast in the estuarine region (REICHERT, 1998) and complete their whole life cycle in this area (OLIVEIRA; FAVARO, 2010). In this present study near Cape Frio, juveniles of two species of *Etropus* were collected. Saad and Fagundes-Netto (1992) observed for *E. longimanus* females of the same region evidence of spawning at depths of less than 60 m, although they did not detect a specific location for the reproduction of this species. Although the *Etropus* larvae found do not have characteristics that allow their identification to species level, it is likely that the larvae present in the oceanic zone, specially where the shelf is wider, are *E. longimanus* that were transported there and then taken to a more coastal zone through oceanographic processes. The dynamics and physical features of this region have been studied by many authors (SILVEIRA et al., 2000; CAMPOS et al., 1995) and it is known that in the oceanic zone of this region the formation of rings and eddies influences the circulation in the shelf area. The circulation of surface water in the area of the present study certainly determines the pattern of the transport and distribution of fish larvae.

Two species of the genus *Syacium* (*S. papillosum* and *S. micrurum*) are known on the western coast of the Atlantic ocean including the south-southeastern coast of Brazil, the former occurring from North Carolina to southern Rio Grande do Sul (35°S) and the latter from Florida to Guarujá (24°S) (FIGUEIREDO; MENEZES, 2000). Souza and Chaves (2007) have recorded the occurrence of *S. micrurum* off Santa Catarina State (27.30°S). Being coastal species, they are captured, respectively, down to about 40 m and 90 m depths. However, in studies of the southeastern coast, the occurrence of juveniles and adults of *S. micrurum* has either not been reported (PAIVA-FILHO et al., 1987; ROCHA; ROSSI-WONGTSCHOWSKI, 1998; MENDONÇA; ARAÚJO, 2002; ZANI-TEIXEIRA, pers. comm¹.) or is low (SOUZA; CHAVES, 2007; ROCHA et al., 2010). This species is more abundant on the northeastern coast (OLIVEIRA, 1972; ROCHA et al., 1998). In the Gulf of Mexico, according to Futch and Hoff Jr. (1971), it is probable that the spawning period of *S. papillosum* extends from early spring through to mid-autumn, with most intense activity in summer. The same result was obtained in studies conducted on adults at Cape Frio (SAAD; FAGUNDES-NETTO; 1992) and on the northern coast of Santa Catarina (SOUZA; CHAVES; 2007). The *Syacium spp.* larvae were more abundant and frequent in summer, which is in accord with these results. Despite these species having coastal habits, their larvae occur particularly as

from the intermediate zone. Further, according to Futch and Hoff Jr. (1971), the spawning of *S. papillosum* in the Gulf of Mexico does not take place near the coast but at depths greater than 20 m. Something similar seems to happen in the study area where only one larva was found near the coast (20 m).

Two species of *Bothus*, *B. ocellatus* and *B. robinsi*, occur in the southeastern region (FIGUEIREDO; MENEZES, 2000). The study area is located near the southern limit of the area of the occurrence of the former species, which extends from New York to the south of the State of São Paulo (25°30'S), down to 100 m depth (FIGUEIREDO; MENEZES, 2000) and it is reef-associated (MACEDO; MONTEIRO-RIBAS, 2006). Only *B. ocellatus* larvae occurred in this present study, these larvae occur predominantly in the summer and in the oceanic zone, the same pattern as that described by Flores-Coto et al. (1991). According to these latter authors, *B. ocellatus* is among the most abundant flatfishes larvae in the Gulf of Mexico. Sanvicente-Añorve et al. (1998), in that same region, in a study undertaken down to the 180 m isobath, found it to be more abundant in the neritic zone. On the southeastern/southern coast *B. ocellatus* belongs to the neritic and oceanic assemblages (KATSURAGAWA et al.; 2006), though it also occurs in the coastal assemblage.

In a study undertaken by Katsuragawa (pers. comm²), *B. ocellatus* larvae were more abundant in mid-autumn than at the end of the spring. When these results and those obtained in this present study are analyzed it may be concluded that this species reproduces throughout the year because its larvae occur in all the seasons, though with more intense reproductive activity in summer-autumn, with a peak in the autumn.

In this present study, flatfish larvae were more abundant in the first 40 m of the water column. A similar pattern has been observed and described for the Pleuronectiformes by many authors such as Weinstein et al. (1980), Tanaka et al. (1989) and Burke et al. (1995). Larvae of *B. ocellatus* were captured in the neustonic layer at the mouth of Guanabara Bay by Bonecker (1997). The occurrence of larvae closer to the surface may be a reflection of the availability of food, which is greater in this stratum (COMYNS; LYCZKOWSKI-SHULTZ, 2004; SABATÉS, 2004).

Although the habitat of the adults of *Syacium spp.* and *B. ocellatus* does not exceed 100 m depth, their larvae are more frequent beyond this

¹ ZANI-TEIXEIRA, M. L. (pers. comm.) (zanit@usp.br) Study conducted from February 1981 to January 1983 at Trapandé Bay – Cananéia, SP, Brazil (25°S; 48°W) (unpublished data).

² KATSURAGAWA, M. (pers. comm.) (mkatsura@usp.br) Study of patterns in larval fish assemblages under the Brazil Current influence, conducted in spring 1997 and autumn 2001 (unpublished data).

isobath, even surpassing the isobath of 1,000 m. The same happens with *Etropus spp.* but their adult habitat reaches a depth of 190 m. In the summer the larvae of these three species occurred outside the area of influence of the SACW. Aceves-Medina et al. (2003) suggest that *Syacium ovale* in the Gulf of California spawn in shallow water, eggs and larvae are transported to deeper waters, probably as a strategy to avoid the high predation in the coastal zone, and juveniles return later to the shallow water areas. *Syacium spp.* and *B. ocellatus* spawn when the intrusion of SACW is more intense. It is probable that the intrusion of this water mass carries the larvae away from the coastal zone where spawning occurs. The processes that bring back the larvae to the coast need to be more fully understood.

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