

Larval fish in the surf zone of Pontal do Sul beach, Pontal do Paraná, Paraná, Brazil

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ABSTRACT. A total of 6,575 larvae in the preflexion, flexion and post-flexion stages of 15 families, 26 genera and 29 species were captured in the surf zone of Pontal do Sul beach, Paraná, Brazil. Samples of the families Gerreidae and Scianidae predominated and larvae of *Eucinostomus argenteus* (Baird & Girard, 1854), *Micropogonias furnieri* (Desmarest, 1823), *Eucinostomus gula* (Cuvier, 1830), *Menticirrhus americanus* (Linnaeus, 1758) and *Anchoa tricolor* (Agassiz, 1829) were the most dominant species. Greater abundance of larvae was observed during the summer, followed by winter and in a less extent during spring and autumn. The number of species was greater in the summer, and there were no significant differences in the rest of the seasons.

KEY WORDS. Ichthyoplankton, surf zone, Brazil

The movement of larvae from the spawning areas to the coast of fish recruited to estuarine areas, occurs initially by passive drift (ROSENBERG 1982; MILLER *et al.* 1984), with the majority of larvae being in the planktonic stage. After the aggregation of larvae in coastal areas, such as beaches, a migration towards the estuaries occurs (ROSENBERG 1982; MILLER *et al.* 1984), generally in advanced stages near or after metamorphose, as was observed in different orders of fish (WEINSTEIN *et al.* 1980).

Despite the importance of studies on ichthyoplankton in the south-southeast Brazilian coast, these were for the most part performed on the continental shelf, being a fairly limited number of works in coastal areas. Concerning the beach environment, recognized as nursery areas, information on fish larvae is practically non-existent. This is due in part to the fact that in the majority of surveys on the ichthyofauna of the surf zone the nets design and mesh did not allow the sampling of this important part of the local fish assemblage. Therefore this study reports the abundance, diversity and seasonability of the fish larvae of the surf zone at Pontal do Sul beach, a sandy beach situated in the Galheta Inlet of Paranaguá Bay (25°34'20"S, 48°20'48"W), southern Brazil.

MATERIALS AND METHODS

Samples were obtained from the surf zone at Pontal do Sul beach, between May 1993 and April 1994, through bi-monthly collections in high and low tides (daytime and nighttime) of the new and full moon. Sixteen monthly tows were performed, eight with a conical plankton net (mesh size 300 µm and a mouth

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diameter of 60 cm) and eight with a beach seine (mesh size of 1 mm, 18 m in length and 2 m in height), in the same direction as the current, at a depth which never surpassed 1.70 m along a 100 m strip parallel to the beach. Data of salinity and surface water temperature were collected at the same time.

Samples were preserved in the field with 4% buffered formalin. All fish larvae were sorted, identified to the lowest possible taxon and classified according to their development stage (AHLSTRON & BALL 1954). The seasons were defined in the following way: September to November=spring; December to February=summer; March to May=autumn and June to August=winter.

RESULTS

Conical Plankton Net

A total of 649 fish larvae were captured, comprising 9 families, 13 genera and 12 species. The Sciaenidae and Gobiidae families were the most numerous in terms of species (three species each), followed by the Gerreidae (two species). Considering only the identified larvae, the families Gerreidae, Gobiidae and Sciaenidae dominated numerically, while the rest represented only 9.59%. Regarding the species composition, 85.5% (555 individuals) was not identified as genera, 11.9% was made up by *Eucinostomus argenteus* (Baird & Girard, 1854), *Gobionellus* spp. and *Micropogonias furnieri* (Desmarest, 1823), and *Elops saurus* (Linnaeus, 1766), *Anchoa tricolor* (Agassiz, 1829), *Paraexocoetus brachypterus* (Richardson, 1846), *Eucinostomus gula* (Cuvier, 1830), *Menticirrhus littoralis* (Holbrook, 1860), *Menticirrhus* spp., *Umbrina coroides* (Cuvier, 1830), *Bathygobius soporator* (Valenciennes, 1837), *Microgobius* spp., *Mugil curema* (Desmarest, 1831), *Etropus crossotus* (Jordan & Gilbert, 1882) and *Achirus lineatus* (Linnaeus, 1758) contributed only with 2.6% of the total (Tab. I). Larvae in the post-flexion stage occurred in all the identified species while the pre-flexion stage was present in non-identified larvae and in *M. furnieri*, and the flexion stage occurred only in *A. tricolor*.

Considering the seasonal occurrence, larvae of *M. littoralis*, *Menticirrhus* spp., *U. coroides*, *Microgobius* spp. and *E. crossotus* were caught over the winter, while *E. saurus*, *E. gula*, *M. curema* and *A. lineatus* occurred only in the summer and *P. brachypterus* only in spring. Other taxa were represented in more than one season as was the case of *E. argenteus*, captured since the beginning of summer until the beginning of winter, *M. furnieri*, which occurred in winter, spring, and summer, *Gobionellus* spp., recorded during autumn and winter, *A. tricolor*, present in spring and summer, and *B. soporator*, collected during winter and summer (Tab. I).

Larvae of *A. tricolor*, *B. soporator*, *Gobionellus* spp., *E. crossotus* and *M. furnieri* were present in water with salinity between 27 and 35, while *E. argenteus* occurred in a greater range of salinity. Larvae of *M. furnieri* and *E. argenteus* were captured in water with a greater range of temperature, while *A. tricolor*, *B. soporator*, *Gobionellus* spp. and *E. crossotus* were caught over a smaller range of temperature (Tab. I).

Table I. General data on fish larvae capture with plankton conical net in the surf zone of the beach at Pontal do Sul, between May 1993 and April 1994. (Y) Yolk-sac larvae, (PRF) preflexion, (F) flexion, (PF) post-flexion.

Taxon	Number individuals	Capture (%)	Stage	Season	Temperature range	Salinity range (‰)
Elopidae						
<i>Elops saurus</i>	1	0.15	PF	Summer	26.0	30.0
Engraulidae						
<i>Anchoa tricolor</i>	3	0.46	F / PF	Spring, Summer	22.0 - 25.0	27.0 - 34.0
Exocoetidae						
<i>Paraexocoetus brachypterus</i>	1	0.15	PF	Spring	21.5	28.5
Gerreidae						
<i>Eucinostomus argenteus</i>	51	7.8	PF	Summer, Autumn, Winter	18.0 - 26.0	21.0 - 34.0
<i>Eucinostomus gula</i>	1	0.15	PF	Summer	26.0	30.0
Sciaenidae						
<i>Menticirrhus littoralis</i>	1	0.15	PF	Winter	16.0	33.0
<i>Menticirrhus</i> spp.	1	0.15	PF	Winter	21.0	29.0
<i>Micropogonias furnieri</i>	8	1.23	PRF / PF	Spring, Summer, Winter	16.0 - 26.0	30.0 - 35.0
<i>Umbrina coroides</i>	1	0.15	PF	Winter	15.0	29.00
Gobiidae						
<i>Bathygobius soporator</i>	3	0.46	PF	Summer, Winter	21.0 - 25.0	29.0 - 34.0
<i>Gobionellus</i> spp.	18	2.77	PF	Autumn, Winter	20.0 - 23.0	29.0 - 34.0
<i>Microgobius</i> spp.	1	0.15	PF	Winter	20.0	34.0
Mugilidae						
<i>Mugil curema</i>	1	0.15	PF	Summer	26.0	30.0
Paralichthyidae						
<i>Etropus crossotus</i>	2	0.30	PF	Winter	20.0 - 21.0	29.0 - 35.0
Achiridae						
<i>Achirus lineatus</i>	1	0.15	PF	Summer	28.0	31.0
Not identify	555	85.51	Y / PRF / PF	All seasons	16.0 - 31.0	23.0 - 35.0

Beach Seine Net

A total of 5,926 fish larvae in the post-flexion stage of 12 families, 20 genera and 25 species were captured. A greater number of species occurred in the family Sciaenidae, represented in the samples by seven species. The capture was comprised, for the most part, by Gerreidae (81.68%) and Sciaenidae (13.98%) with the other families comprising only 4.34% of the total. The most abundant species were *E. argenteus* (66.88%), *M. furnieri* (6.22%), *E. gula* (4.23%), *M. americanus* (3.98%) and *A. tricolor* (2.00%) with the 20 remaining species corresponding to only 16.67% of the total (Tab. II).

Larvae of *Albula vulpes* (Linnaeus, 1758), *Anchoa parva* (Fowler, 1976), *Adenops dissimilis* (Carvalho, 1956), *E. gula*, *Bairdiella ronchus* (Cuvier, 1830) and *Polydactylus virginicus* (Linnaeus, 1758) were present in the summer, while *Opisthonema oglinum* (Lesueur, 1818) and *Oligoplites saurus* (Bloch & Schneider, 1801) appeared in autumn. *Cynoscion leiarchus* (Cuvier, 1830) and *Polydactylus oligodon* (Günther, 1860) were exclusively caught during the winter, and *Hyporhamphus unifasciatus* (Ranzani, 1842) and *M. littoralis* during the spring. Larvae of *Glossanodon pygmaeus* (Cohen, 1958), *Trachinotus carolinus* (Linnaeus, 1766), *Umbrina canosai* (Berg, 1895), *U. coroides*, *Harengula jaguana* (Poey, 1865), *Sardinella brasiliensis* (Steindacner, 1789), *E. argenteus*, *M. curema* and *Mugil gaimardianus* (Desmarest, 1831) were observed in two seasons of the year. *A. tricolor*, *M. americanus* and *M. furnieri* occurred throughout the seasons, the former being more abundant in the summer and the latter two more abundant in the winter (Tab. II).

Larvae of *E. saurus*, *A. tricolor*, *E. argenteus*, *M. americanus*, *M. furnieri*, *U. coroides* and *M. gaimardianus* were captured in water with great variation in salinity and temperature. Larvae of *H. jaguana*, *E. gula* and *M. curema* were caught in water with great variation in salinity but not in temperature (Tab. II).

Table II. General data on fish larvae capture with beach seine in the surf zone of the beach at Pontal do Sul, between May 1993 and April 1994 (PF) Post-flexion.

Taxon	Number individuals	Capture (%)	Stage	Season	Temperature range	Salinity range (‰)
Elopidae						
<i>Elops saurus</i>	21	0.300	PF	Spring, Summer, Winter	15.0 - 27.0	25.0 - 35.0
Albulidae						
<i>Albula vulpes</i>	20	0.300	PF	Summer	26.5 - 27.0	31.0 - 32.0
Engraulidae						
<i>Anchoa parva</i>	2	0.003	PF	Summer	25.0 - 26.5	31.0 - 32.0
<i>Anchoa tricolor</i>	119	2.000	PF	All seasons	20.0 - 30.0	28.0 - 34.0
Clupeidae						
<i>Brevoortia</i> spp.	1	0.001	PF	Autumn	22.0	32.0
<i>Harengula clupeiola</i>	29	0.400	PF	Summer, Autumn	25.0 - 27.0	19.0 - 31.0
<i>Opistonema oglinum</i>	2	0.003	PF	Autumn	22.0 - 27.0	29.0 - 32.0
<i>Sardinella brasiliensis</i>	3	0.050	PF	Summer, Autumn	25.0 - 27.0	29.0 - 31.0
Argentiniidae						
<i>Glossanodon pygmaeus</i>	3	0.005	PF	Spring, Summer	22.0 - 25.0	28.0 - 31.0
Atherinidae						
<i>Adenops dissimilis</i>	1	0.010	PF	Summer	25.0	34.0
Exocoetidae						
<i>Hyporhamphus unifasciatus</i>	3	0.050	PF	Spring	22.0 - 23.5	28.0 - 29.0
Carangidae						
<i>Oligoplites saurus</i>	1	0.001	PF	Autumn	25.0	27.0
<i>Trachinotus carolinus</i>	2	0.020	PF	Spring, Summer	22.0 - 25.0	30.0 - 31.0
Gerreidae						
<i>Eucinostomus argenteus</i>	3965	66.880	PF	Summer, Autumn	25.5 - 28.0	25.0 - 32.0
<i>Eucinostomus gula</i>	251	4.230	PF	Summer	25.0 - 27.5	25.0 - 32.0
<i>Eucinostomus</i> spp.	627	10.570	PF	Summer, Autumn	22.0 - 27.5	19.0 - 34.0
Sciaenidae						
<i>Baidiella ronchus</i>	3	0.050	PF	Summer	26.0	25.0
<i>Cynoscion leiarchus</i>	2	0.030	PF	Winter	15.0	29.0
<i>Menticirrhus americanus</i>	234	3.980	PF	All seasons	15.0 - 26.0	26.0 - 34.0
<i>Menticirrhus littoralis</i>	8	0.130	PF	Spring	23.0	30.0
<i>Menticirrhus</i> spp.	208	3.509	PF	Spring, Summer, Winter	15.0 - 25.0	29.0 - 35.0
<i>Micropogonias furnieri</i>	369	6.220	PF	All seasons	15.0 - 25.0	28.0 - 35.0
<i>Umbrina canosai</i>	2	0.020	PF	Spring, Summer	23.0	30.0
<i>Umbrina coroides</i>	3	0.005	PF	Summer, Winter	15.0 - 25.0	29.0 - 35.0
Polynemidae						
<i>Polydactylus oligodon</i>	1	0.010	PF	Winter	15.0	29.0
<i>Polydactylus virginicus</i>	1	0.010	PF	Summer	27.0	32.0
Mugilidae						
<i>Mugil curema</i>	8	0.130	PF	Summer, Autumn	26.0 - 27.5	25.0 - 31.0
<i>Mugil gaimardianus</i>	31	0.520	PF	Summer, Autumn	26.0 - 30.0	25.0 - 35.0
<i>Mugil</i> spp.	6	0.100	PF	Summer, Autumn	26.0 - 30.0	23.0 - 35.0

DISCUSSION

This was the first study on beach ichthyoplankton in the south and southeast Brazilian coast. In the studied area, 35 taxa were captured, namely, 26 genera and 29 species of 15 families of fish larvae. In the post-flexion stage, these are new citations for the area: *E. saurus*, *A. vulpes*, *A. parva*, *Brevoortia* spp., *O. oglinum*, *G. pygmaeus*, *A. dissimilis*, *T. carolinus*, *E. argenteus*, *E. gula*, *B. ronchus*, *C. leiarchus*, *M. littoralis*, *U. canosai*, *U. coroides*, *P. oligodon*, *P. virginicus*, *M.*

curema, *M. gaimardianus*, *P. brachypterus*, *B. soporator*, *Gobionellus* spp., *Microgobius* spp. and *E. crossotus*. Except for the genera *Gobionellus* and *Microgobius* and the species *U. canosai*, the other taxa had not previously been cited in the larval stage in the southern Brazilian coast.

A review of the available literature on the subject showed that, up to the present time, it has been cited for the Paraná coast 14 species of fish larvae in the region of the continental shelf (MATSUURA 1977; MATSUURA & SATO 1981; MATSUURA & KATSURAGAWA 1981; VALENTIN *et al.* 1994) and 16 species in the estuarine region (CARVALHO 1945; SINQUE 1989; ALMEIDA & SPACH 1992). The obtained results of this work represent an increase of 48% in the number of species of identified larvae in the Paraná coast as a whole. This contribution is even more significant when we consider separately the sectors of the shelf and of the estuary, in both cases the number is superior to 60%.

SINQUE *et al.* (1982) and SINQUE (1989), studying the ichthyoplankton of Paranaguá Bay, observed greater abundance of eggs and fish larvae in spring and summer, followed by autumn, and smaller abundance in winter. This same seasonal pattern of numerical dominance of eggs and fish larvae was observed in the Galheta Inlet, just in front of the sampled beach and in the Laranjeiras and Guaraqueçaba Bays, in the northern portion of the Paranaguá estuary (SPACH per.com). In this study, the summer capture represented more than 80% of the total, with *E. argenteus* and *E. gula* contributing with more than 90% of the summer capture and around 75% of the total sampled larvae for this study. Different from the precited works, in the surf zone of the beach at Pontal do Sul the spring along with autumn showed the smaller number of individuals, while in the winter it was observed the second greatest abundance. As was the case in the summer, in which the majority of larvae were from one specie, in the spring *M. furnieri* represented more than 90% of the total, and in winter *M. americanus* and *M. furnieri* contributed with more than 75% of the capture.

MUELBERT & WEISS (1991), studying the abundance and distribution in the area of the inlet to the Lagoa dos Patos estuary, found larvae throughout the year, however, with greater abundance and diversity in the spring and summer seasons. A greater diversity in spring and summer was also observed in the surf zone of the Northern Gulf of Mexico Barrier Island (RUPLE 1984). SENTA & KINOSHITA (1985), in a survey of 55 points on the Japanese coast, observed differences between larval ichthyofauna of beach habitat and other close biotypes, especially in relation to the coastal region. They also observed a greater diversity in spring and summer. In the present work, the diversity was greater in the summer, but there was no significant difference between the other seasons of the year.

With the exception of yolk-sac larvae, sampled with the plankton net, which were probably transported outside and inside the estuary by currents, the majority of sampled larvae at Pontal do Sul beach were in the post-flexion stage, therefore, in an advanced larval development stage, which corresponds to what would be expected for an area located at the entrance of an estuary. In the majority of larval species in the post-flexion, the fins were already formed permitting an active locomotion.

The principle of natural selection makes it possible to state that the objective of an individual is to maximize the production of its offspring. Although differences exist between this work and literature in general, it was observed that, similar to the majority of other studies of the area, there is a preference for hatching in warmer periods. In warmer seasons of the year, the presence of more favorable alimentary conditions in the estuarine region as well as in the coast, favors gonadal maturing of the fish and the feeding of the larvae.

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