

# MOON, TIDAL AND DIEL INFLUENCES ON CATCH COMPOSITION OF FISHES IN THE SURF ZONE OF PONTAL DO SUL BEACH, PARANÁ

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**ABSTRACT.** Fishes were sampled by beach seine during the day and night at the high and low syzygy tides, on a sandy beach at the southeast coast of Brazil. The quantitative results appear to indicate a larger concentration of fish in the surf zone of this beach, in low tides at the start and end of the day. Only eight from the 17 most abundant taxa, appeared to have been influenced singly or in combination by the factors of the moon, day, night and tide.

**KEY WORDS.** Brazil, diel changes, fishes, sandy beach, tidal changes

Few studies of the fish communities on Brazilian beaches have been performed. Those that do exist have shown a community composed of up to 79 species, mainly in the juvenile stage and with a numerical dominance of a few species (PAIVA-FILHO *et al.* 1987; MONTEIRO-NETO *et al.* 1990; GRAÇA LOPES *et al.* 1993; SAUL & CUNNINGHAM 1995).

No study has been designed to investigate the changes in abundance of fishes on a Brazilian sandy beach over tidal and diel cycles. The present work analyzes the possible effects of moon, time of the day and tidal stage on abundance of fishes in the surf zone of the beach at Pontal do Sul, Paraná.

## MATERIAL AND METHODS

Samples were obtained in the surf zone of the beach at Pontal do Sul, Paraná State (Fig. 1), with a beach seine (mesh of 1mm, 18m in length and 2m in height), between May 1993 and April 1994, on a bimonthly bases, during the day and the night at the high and low syzygy tides. The collections were made in the same direction as the current, at a depth which never surpassed 1.70m along a 100 mt. strip paralel to the beach.

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In order to evaluate the influence of the moon, tide and time of day on the mean values of the captures in numbers of species, number of individuals and weight, as well as the mean capture estimated from the density data log (x+1) transformed from the 17 most abundant taxa, the three-way variance analysis (Model I), with three fixed factors was used. Posteriorly, the least significant difference test (LSD), a post hoc comparisons of means was performed (SOKAL & ROHLF 1981).

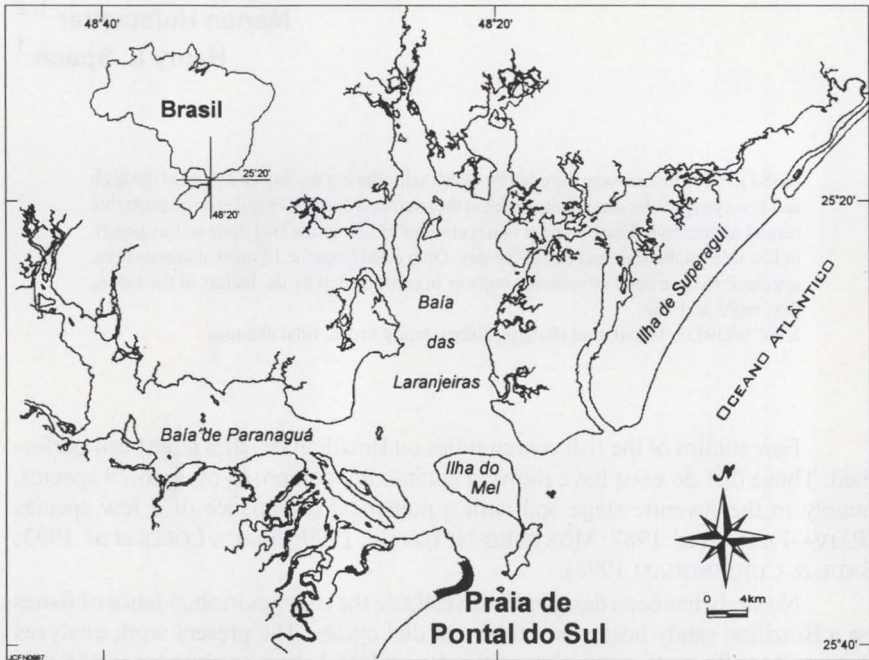


Fig. 1. Paranaguá's estuary, showing the location of the sample site.

## RESULTS

A total of 14,516 fish, for the majority in the juvenile and larval stages, were captured, comprising 32 families, 51 genera and 70 species. The analysis revealed that the capture in number of species, appeared to have been influenced only by the tide, with means per throw significantly greater in the low tide in comparison with the high tide. In relation to the number of individuals, significant differences between the mean values per throw could be observed in comparison between the tides and between daytime and nighttime, the larger means being at low tide and during the day. Also, with respect to the mean weight of the capture, the differences between the means were significant only in comparison between the daytime and nighttime samples, with the higher weights occurring during the daytime (Tab. I).

Table I. Results of variance analysis evaluating the effect of different sampling conditions on the mean number of species, fish and total mean weight of the captures obtained with beach seine at Pontal do Sul, between May, 1993 and April, 1994. (NM) New moon, (FM) full moon, (D) daytime, (N) nighttime, (L) low tide, (H) high tide, (\*) significant  $p < 0,05$ , (NS) non-significant.

Sampling conditions	Variance analysis							
	NM x FM	D x N	L x H	NMD x NMN x FMD x FMN	NML x NMH x FML x FMH	LD x PD x LN x HN	NMDL x NMDH x NMNL x MNNH x FMDL x FMDH x FMNL x FMNH	
	F	F	F	F	F	F	F	
Number of species	1.09 NS	2.47 NS	8.73 *	0.6600 NS	1.60 NS	0.12 NS	0.0005 NS	
Number of fish	0.37 NS	4.51 *	5.37 *	0.0005 NS	1.94 NS	0.22 NS	0.5700 NS	
Weight (g)	2.10 NS	8.45 *	0.55 NS	0.0300 NS	2.68 NS	0.40 NS	0.5400 NS	

The abundance means of each of the selected species, with the exception of *Anchoa lyolepsis* (Evermann & Marsh, 1902), *Anchoa parva* (Fowler, 1976), *Xenomelaniris brasiliensis* (Quoy & Gaimard, 1824), *Trachinotus carolinus* (Linnaeus, 1766), *Eucinostomus* spp., *Menticirrhus americanus* (Linnaeus, 1758), *Micropogonias furnieri* (Desmarest, 1823), *Umbrina coroides* (Cuvier, 1830) and *Mugil gaimardianus* (Desmarest, 1831), appeared to have been influenced singly or in combination by the factors of the moon, day, night and tide (Tab. II). *Harengula clupei* (Cuvier, 1829) was collected in a significantly higher mean abundance in the daylight period in comparison with the nighttime. At low tide the mean abundance of the species *Sardinella brasiliensis* (Steindachner, 1789) was significantly greater than that in the high tide. In the species *Anchoa tricolor* (Agassiz, 1829) considerable differences between the means were present between the daytime and the nighttime samples and between the tides, being on the average, greater during the daytime and at low tide. Concerning the species *Hyporhamphus unifasciatus* (Ranzani, 1842), statistical differences were present in the combination of the daytime and nighttime factors with the tide, with greater mean values not significantly different from each other in the nighttime high tide and the daytime and nighttime low tide, the latter not differing significantly from the mean value of the daytime high tide. In *Oligoplites saurus* (Bloch & Schneider, 1801), only in the combined conditions between the factors of the moon and time of day, were the differences between the means significant, with greater and similar mean values in the daytime new moon and daytime and nighttime full moon, the last two not differentiating significantly from the means that were obtained in the nighttime period of the new moon. In the species *Eucinostomus argenteus* (Baird & Girard, 1854) higher mean captures were obtained at the low tide in comparison with the high tide, the same having been observed for the species *Eucinostomus gula* (Cuvier, 1830). In *Menticirrhus* spp. the mean abundance was significantly greater in the nighttime (Tab. II).

## DISCUSSION

Correlations between the diversity and biomass in number and weight, with the tide and time of day, were observed in various studies performed on the ichthyofauna associated with the beaches. The greater diversity in the low tide

catches, independent of the time of day, observed at Pontal do Sul, was also present in the collections of DELANCEY (1989) on the American East coast. While the ichthyofauna of Pontal do Sul, apparently, maintains between daytime and nighttime species composition, in other beaches this species composition appears to change between these periods (LASIAK 1984; GIBSON *et al.* 1993).

Table II. Results of variance analysis evaluating the effect of different sampling conditions on the mean abundance of main species captured with beach seine net at the beach of Pontal do Sul, between May, 1993 and April, 1994. (NM) New moon, (FM) Full moon, (D) daytime, (N) nighttime, (L) low tide, (H) high tide, (LSD) least significant difference, (\*) significant  $p < 0,05$ , (NS) non-significant.

Species	Variance analysis						
	NM x FM	D x N	L x H	NMD x NMN x FMD x FMN	NML x NMH x FML x FMH	LD x PD x LN x HN	NMDL x NMDH x NMNL x MNNH x FMDL x FMDH x FMNL x FMNH
	F	F	F	F	F	F	F
<i>Anchoa lyolepis</i>	0.2100 NS	1.69 NS	3.07 NS	1.240 NS	0.06 NS	0.48 NS	0.83 NS
<i>Anchoa parva</i>	0.0900 NS	0.16 NS	2.50 NS	0.070 NS	0.01 NS	2.33 NS	0.02 NS
<i>Anchoa tricolor</i>	0.8600 NS	6.76 *	19.09 *	1.670 NS	0.01 NS	1.50 NS	0.47 NS
<i>Harengula clupeiola</i>	0.9100 NS	17.65 *	2.50 NS	0.004 NS	1.93 NS	1.65 NS	3.49 NS
<i>Sardinella brasiliensis</i>	0.7700 NS	0.58 NS	7.36 *	0.070 NS	0.94 NS	0.03 NS	0.12 NS
<i>Xenomelaniris brasiliensis</i>	0.4600 NS	3.38 NS	0.71 NS	1.510 NS	0.34 NS	1.95 NS	1.50 NS
<i>Hyporhamphus unifasciatus</i>	0.1000 NS	0.38 NS	3.85 NS	0.050 NS	0.08 NS	6.79 <sup>*2</sup>	0.15 NS
<i>Oligoplites saurus</i>	0.0008 NS	1.00 NS	1.65 NS	4.970 <sup>*1</sup>	0.41 NS	0.37 NS	2.51 NS
<i>Trachinotus carolinus</i>	0.0200 NS	1.31 NS	1.76 NS	0.210 NS	2.00 NS	0.72 NS	0.70 NS
<i>Eucinostomus argenteus</i>	2.2400 NS	0.24 NS	7.09 *	0.010 NS	0.67 NS	0.97 NS	0.13 NS
<i>Eucinostomus gula</i>	2.7700 NS	0.58 NS	6.27 *	0.080 NS	2.77 NS	0.58 NS	0.08 NS
<i>Eucinostomus</i> spp.	1.7100 NS	1.42 NS	3.11 NS	0.090 NS	0.06 NS	1.05 NS	0.23 NS
<i>Menticirrhus americanus</i>	2.9100 NS	3.32 NS	1.73 NS	2.190 NS	0.03 NS	0.09 NS	0.17 NS
<i>Menticirrhus</i> spp.	0.1600 NS	4.17 *	0.61 NS	0.370 NS	1.06 NS	0.32 NS	1.54 NS
<i>Micropogonias furnieri</i>	0.1300 NS	0.41 NS	3.47 NS	0.330 NS	0.56 NS	0.06 NS	0.03 NS
<i>Umbrina coroides</i>	0.0200 NS	3.70 NS	3.70 NS	0.130 NS	0.07 NS	1.96 NS	0.06 NS
<i>Mugil gaimardianus</i>	0.1800 NS	0.04 NS	0.97 NS	0.190 NS	0.48 NS	1.04 NS	0.04 NS

(\*<sup>1</sup>) LSD: NMD FMD FMN NMN; (\*<sup>2</sup>) LSD: LD HN LN HD

A greater efficiency in the early morning low tide capture occurred, not only in this work, but also in the samplings performed by LASIAK (1984). In other areas, despite the absence of correlation with the tide, again a greater number of individuals were present in the early morning catches (MODDE & ROSS 1981; ROSS *et al.* 1987). On the other hand, large captures at the low tide, nighttime, was characteristic of a Scottish beach (GIBSON *et al.* 1993).

The variations of weight biomass with the tide cycle, were not significant in the surf zone of the the beach at Pontal do Sul, however, on the average, the weight biomass was greater during the daytime collections. This result differed from those obtained by LASIAK (1984) and GIBSON *et al.* (1993), who observed higher weight biomass during the low tide nighttime. These results appear to indicate, for the studied area, a greater concentration of fish in the surf zone at the beginning of the morning and night.

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