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DISTRIBUTION AND RECRUITMENT OF MOJARRAS (PERCIFORMES, GERREIDAE) IN THE CONTINENTAL MARGIN OF SEPETIBA BAY, BRAZIL

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ABSTRACT

Fishes of the family Gerreidae are an important resource in tropical and sub-tropical coastal lagoons. They ranked among the top abundant species in Sepetiba Bay (305 km^2), a Brazilian lagoon communicating with the sea in Rio de Janeiro State. Monthly fish sampling with a beach seine, between July 1993 and June 1994, at five fixed sites, revealed seasonal and spatial trends in their relative abundance and early life cycles. Two of the five species recorded, *Diapterus rhombeus* and *Gerres aprion*, occurred at all sites at some time and contributed approximately 95% of the total gerreids caught. Highly variable in their occurrence by both month and site, these species tended to be more abundant in the shallow mid-continental margin of the Bay, during the Autumn. This high abundance coincided with decreasing temperature and stable salinity and transparency. For *G. aprion* there were indications of an ample period of recruitment, from November to June, while *D. rhombeus* showed multiple influxes of juveniles, mainly from February to May. Post recruitment both species move early in their development to deeper areas in the Bay.

Members of the family Gerreidae are very abundant in tropical and sub-tropical coastal lagoons and make an important contribution to commercial fisheries. The ecology of gerreids has been investigated world-wide (Waldinger, 1968; Austin, 1971; Charles, 1975; Aguirre-León et al., 1982; Cyrus and Blaber, 1984; Aguirre-León and Yáñez-Arancibia, 1986; Sarre et al., 1997), with some information for coastal lagoons for Rio de Janeiro (Santos et al., 1997). However, there remains a lack of information on the early distribution, recruitment and spawning patterns of gerreids. A number of species are known to spawn throughout the year, and recruitment into the nursery grounds may occur in phases. Overall, gerreids spend part of their life cycles in estuaries or inshore coastal waters which may offer safe areas for first-time spawners and nurseries for fry.

Gerreids rank among the top abundant fish species in the Sepetiba Bay, a 305 km^2 coastal lagoon with a wide communication with the sea in Rio de Janeiro State, Brazil (22°54′ and 23°04′S, 43°34′ and 44°10′W). They contribute 33.2% of all fish catches by beach seine (Araújo et al., 1997). The high primary productivity typically found in the Bay provides excellent conditions for the recruitment and growth of juveniles and a coexistence strategy must have developed to maintain the high abundance at several species in the area.

This paper adds to the knowledge of the life cycles of two species of mojarras, *Gerres aprion (*Baird and Girard, 1854) and *Diapterus rhombeus* (Cuvier, 1829) in the continental margins of the Sepetiba Bay, focusing on early patterns of recruitment and distribution.

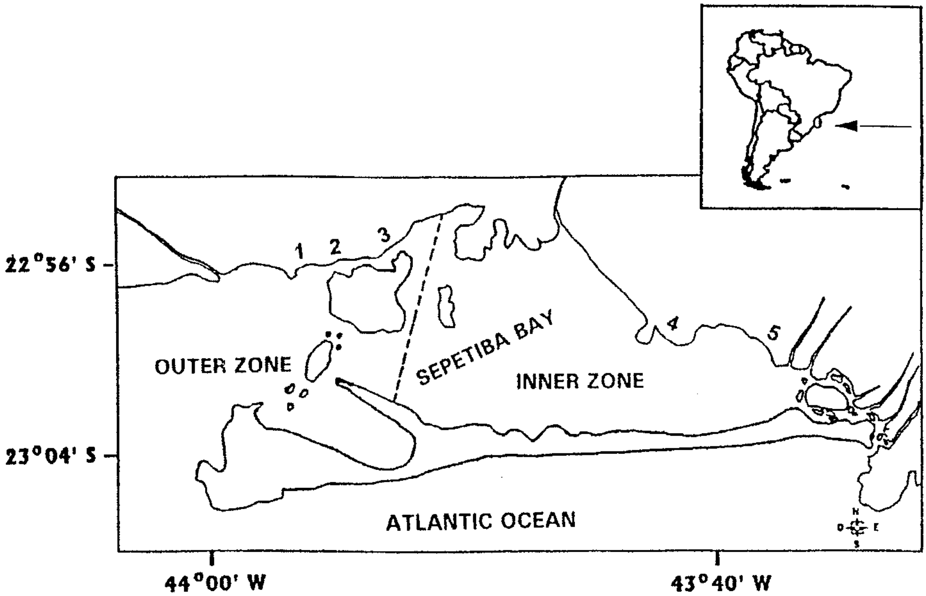

Figure 1. Study Area — Sepetiba Bay, Rio de Janeiro, Brazil, with indications of the five sampling stations. Scale 1: 425,000.

Materials and Methods

Fishes were collected monthly, at five stations in the continental margin of Sepetiba Bay, between July 1993 and June 1994, which differed in location (Fig. 1) and substrates. Station 1 had a sandy mud bottom and was close to the sea limit. Further in Station 2 had a shelly mud substrate and Station 3 had a sandy bottom located within a protected area of the outer Bay. Station 4 had a shelly mud substrate and was representative of the central, internal part of the Bay, whilst the innermost Station 5, had a heavy mud bottom. Overall the outer stations, 1–3, had moderately organic substrates and inner Bay stations, 4–5, had highly organics muddy bottoms.

A total of 60 samples (5 sites× 12 mo) were carried out in this study. Fish were collected with a beach seine 10 m × 2 m and a 5 mm mesh. On each occasion the net was pulled far about 50 m parallel to the shore covering an area of 500 m^2 in water up to 1 m in depth. This procedure was replicated twice at each sampling site. Fish were preserved in 10% formaldehyde and subsequently identified to species and counted. Individuals were measured for total length (TL), and then the total weight of the pooled sample of each species was taken. All fish were measured except two exceptionally high samples in April and May for *D. rhombeus* (above 500 fishes), from which approximately one sixth of individuals were measured. Identification followed Andreata (1988, 1989). Water temperature, salinity, using a refractometer, and turbidity using a Sechi disk, were measured on every sampling visit.

A two-way ANOVA (Model I; $P < 0.05$) was used to determine whether the densities (individuals 500 m^{-2}) of the two species *G. aprion* and *D. rhombeus* differed between stations and seasons. Seasons were defined as Winter: July and August; Spring: September, October and November; Summer: December, January and February; and Autumn: March, April and May. For the purposes of the study, data from samples taken in each of the 3 mo representing a quarterly season were taken as replicates for the ANOVA analyses. Raw abundance data were $\log_{10}(x+1)$ transformed to fulfil the homoscedasticity and normality requirements for ANOVA. The Student-Newman-Keuls multiple range test was used to determine differences in mean values following ANOVA.

Results

PHYSICAL-CHEMICAL CHARACTERISTICS.—Water temperature showed a seasonal cycle, with an minimum average of 21.3°C in August, and a maximum of 31.4°C in February (Fig. 2). Monthly temperature differences between sites did not exceeded 1.5°C.

Seasonal salinity changes were not conspicuous. The lowest average of 23.8‰ in October, compared with the highest of 30.2‰ in February (Fig. 2). Spatially, there was a slight trend of increasing salinity from the inner to the outer stations of the Bay, but the maximum change observed was only 3.5‰.

Transparency as an index of turbidity (Fig. 2) ranged from a mean of 0.5 m between December and January, to 0.8 m, between June and August. Spatially, stations 1–2 located in the outer Bay showed maxima of 0.9 m compared with stations located in the inner Bay, with a minimum value of 0.4 m at site 4.

RELATIVE ABUNDANCE.—Among a total of 55 fish species recorded in 60 samples, gerreids contributed 59.3% by number and 47.5% by weight (Table 1). Five species found in Sepetiba Bay were in order of decreasing numerical abundance: *D. rhombeus, G. aprion, Gerres gula, Gerres lefroyi* and *Gerres melanopterus.* Of these, the first two species were the most abundant, and present year-round, contributing 72.4% and 22.4% by number, and 46.8% and 44.8% by weight to the catch of the family Gerreidae.

SPATIAL AND TEMPORAL DISTRIBUTION.—Significant differences in abundance were found between the sites and seasons for *D. rhombeus* and *G. aprion* according to the ANOVA F-values (Table 2). Neither species was recorded at site 1, nearest to the sea limit, in any season (Fig. 3). *G. aprion* seems to be more widespread at sites 2 to 5, mainly in Winter,

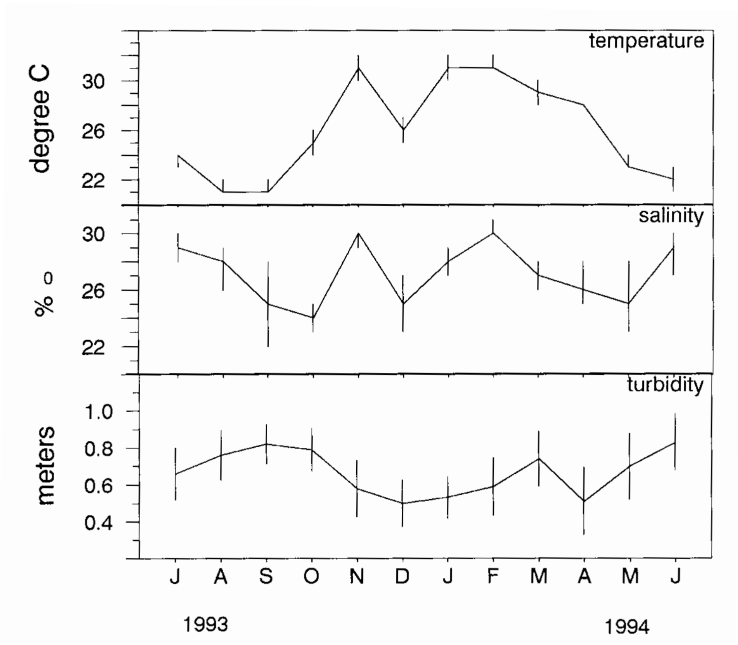

Figure 2. Water temperature, salinity and turbidity in the Sepetiba Bay, 1993–1994. Overall average of five sampling sites plus ± 1 SE (vertical bars).

Table 1. Total number (N), weight (W, in g), % (in number and weight), rank among the total fish catches (R), and frequency of occurrence (FO) of Gerreidae fish in Sepetiba Bay in 1993– 1994.

	N	%N	W	%W	R	FO
Diapterus rhombeus	4,425	42.9	1,357.3	21.3	1	26.7
Gerres aprion	1,368	13.3	1,418.3	22.2	2	48.3
Gerres gula	165	1.6	188.0	2.9	8	10.0
Gerres lefroyi	129	1.3	38.4	<1.0	10	3.5
Gerres melanopterus	27	<1.0	26.4	<1.0	21	3.1
All Gerreidae	6,114	59.3	3,028.4	47.5	–	–
All fish	10,304	100	6,379.1	100	–	–

Table 2. Significance and F-values from two-way ANOVA on densities of *Gerres aprion* and *Diapterus rhombeus*.

Parameter	df	*G. aprion*	*D. rhombeus*
Stations	4	7.2**	4.3*
Seasons	3	3.4**	8.8**
Interaction	12	1.8	2.2

* = P < 0.05; ** = P < 0.01; df = degree of freedom

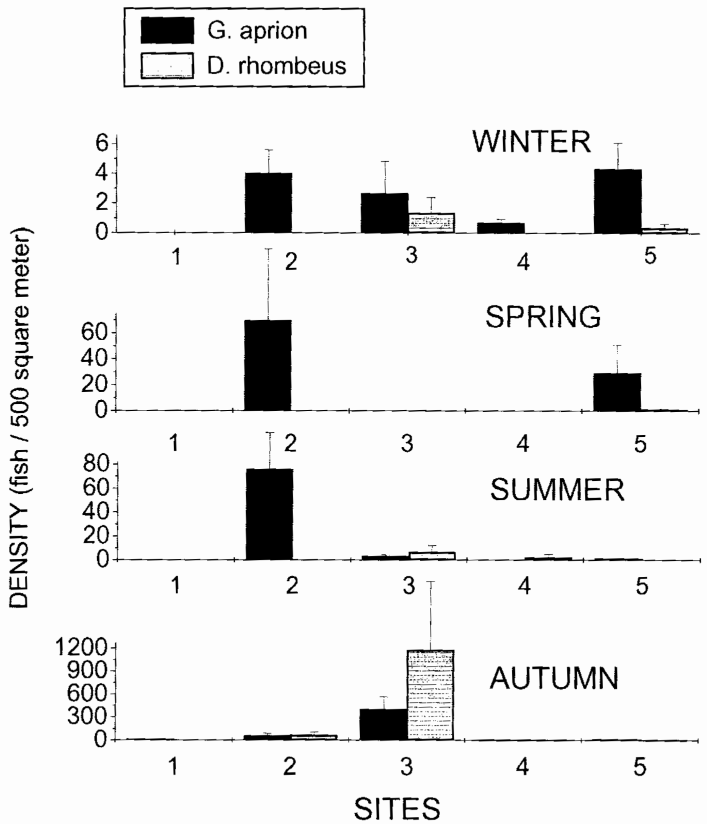

Figure 3 .Spatial and temporal variation in the densities (± 1 SE) of *Gerres aprion* and *Diapterus rhombeus* in the Sepetiba Bay, RJ, 1993–1994.

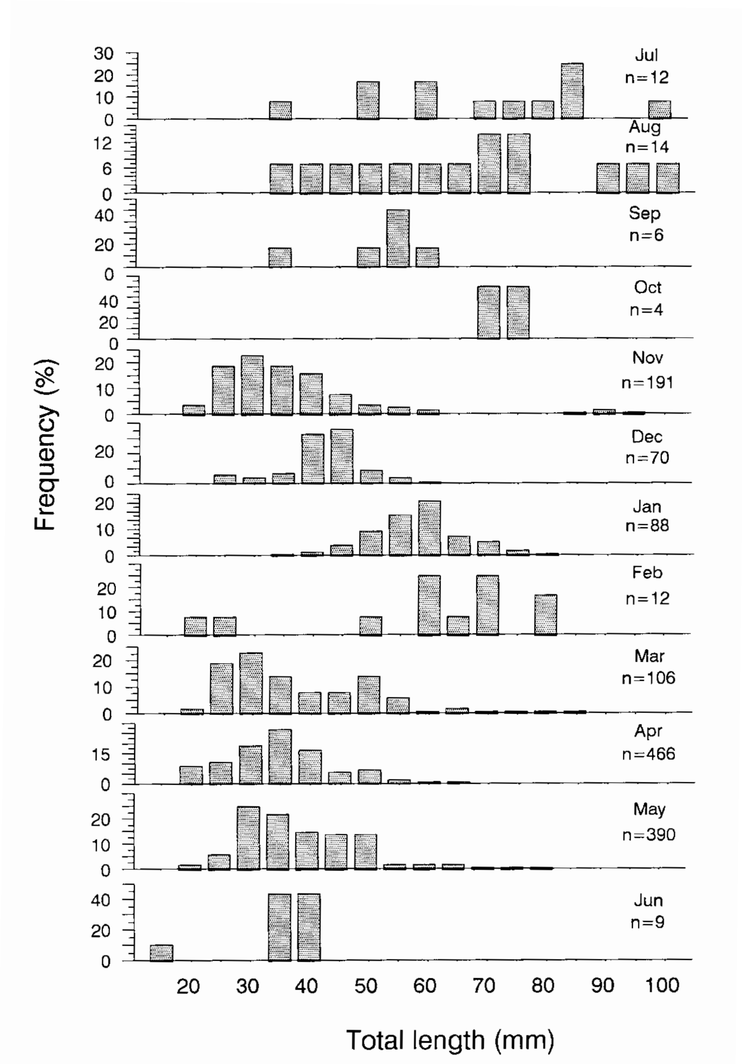

Figure 4. Monthly length-frequency distribution of *Gerres aprion*, in the Sepetiba Bay, RJ, 1993–1994.

when abundances are lowest, while *D. rhombeus* was concentrated at site 3. Both species exibited clear peaks of abundance in Autumn which is the chief recruitment period.

G. aprion was recorded mainly at sites 2, 3 and 5 (Fig. 3) with lowest densities in Winter. Highest concentrations occurred at site 2 in Spring and Summer, and at site 3 in Autumn. Highly significant differences (P< 0.01; ANOVA) were found between the high densities at sites 3 and 2 and the low densities elsewhere.

D. rhombeus was not recorded in Spring and only in low densities in Winter and Summer (Fig. 3). On the other hand, it was the most abundant gerreid in Autumn, showing a markedly seasonality in the study area. Significant differences (P < 0.05, ANOVA) were shown between the Autumn densities and those of the other seasons. Found chiefly at site 3, the density of *D. rhombeus* was signficantly differed to other sites (P < 0.01, ANOVA).

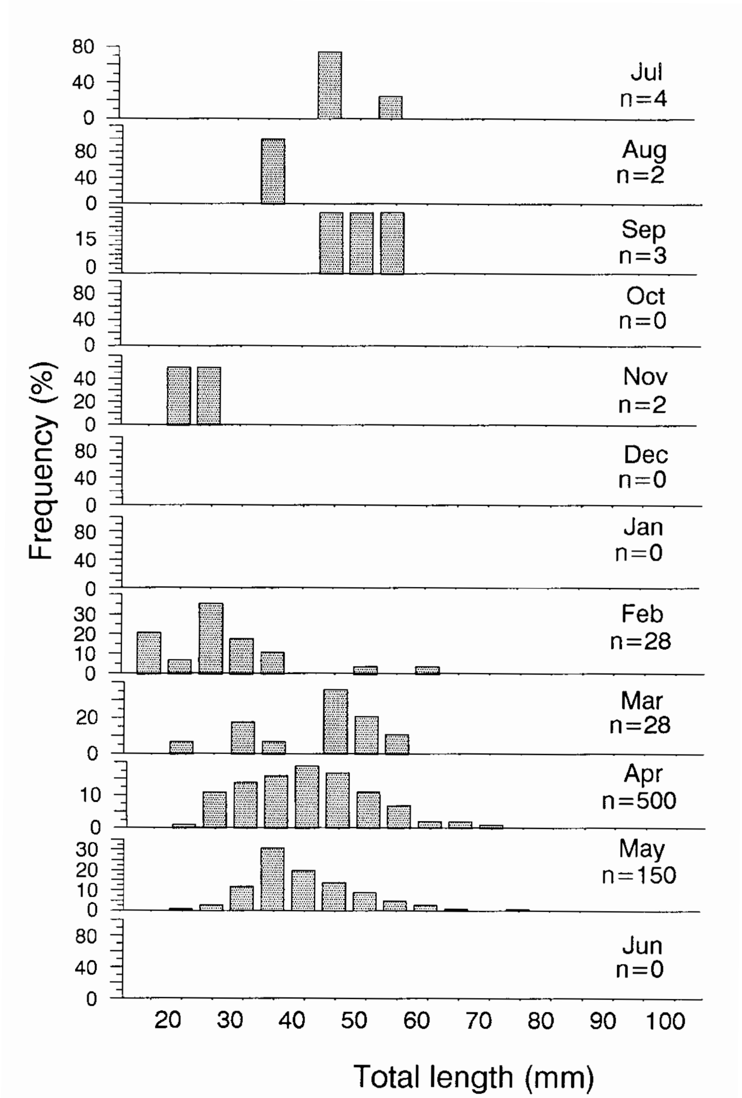

Figure 5. Monthly length-frequency distribution of *Diapterus rhombeus*, in the Sepetiba Bay, RJ, 1993–1994.

LENGTH-FREQUENCY DISTRIBUTIONS.—Monthly length-frequencies for *G. aprion* (15–100 mm TL) indicate that there are small fish (15–30 mm TL) recruiting to the shallows throughout the period November-June (Fig. 4). Young-of-the-year appearing in November (TL<30 mm) are recorded in variables numbers until June and did not appear thereafter. When they reach 60–70 mm TL (Fig. 4), they are recorded only in very small numbers.

The monthly length-frequency distribution of *D. rhombeus* (15–75 mm TL) (Fig. 5) shows recruitment from November (TL < 25 mm) with only two fish being recorded, then an increasing influx of small fish from February, reaching high records in April/May, before leaving the study area. Only low numbers of fish bigger than 75 mm TL were recorded.

Discussion

High abundances and diversity of gerreid fishes have been described in several tropical coastal lagoons (Aguirre-León et al., 1982; Aguirre-León and Yáñez-Arancibia, 1986; Silva, 1994). Vieira (1991) states that the Gerreidae is one of the most abundant families in the coastal ecosystems in Northeast and Southeast of Brazil and Stoner (1986) found them to be the most abundant of fishes in Laguna Joyuda at Puerto Rico. According to Oliveira (1979), nine species occur in the estuaries of Northeast Brazil (4–20°S). Species diversity appears to fall with increasing latitude. Giannini (1994) recorded four species of Gerreidae near São Paulo coast (24°S) while Chao et al. (1982) recorded only two species in Lagoon dos Patos (33°S).

In this study, the influence of environmental variables on fish abundances was not marked, but the highest densities coincided with decreasing Autumn temperatures and stable salinity and turbidity. Both species showed high and low abundances independently from the small variations obtained for these environmental parameters. Overall, the Bay showed a remarkable year round stability in salinity and turbidity. According to Santos et al. (1997) *D. rhombeus* is the only gerreid which occurrs in higher abundances in lower salinity waters in the continental margin of Sepetiba Bay.

There is some indication that juvenile gerreids prefer the less turbid regions with shelly mud and sandy substrates and moderate organic matter in the middle reaches of the Sepetiba Bay. The high abundances of early juveniles of *D. rhombeus* and *G. aprion* in samples notably concentrated at sites 2–3 suggests that this part of the continental margin of Sepetiba Bay is used as a nursery ground for these species.

G. aprion shows a wide period of recruitment. In spite of the lack of small fish in January, low records in December, February and June indicate that there is influx of small fish (TL < 30 mm) during the whole period November–June. This suggests an ample spawning period, peaking from late Spring/Summer. Recruits use the continental margin until June, before moving away from the sampling area. Cyrus and Blaber (1984) and Sarre et al. (1997) found that gerreids typically spawn throughout the year, with one or more peaks during the 12 mo period.

D. rhombeus recruits use the continental margin for a shorter period (mainly February to May). Juveniles remain in the area until late Autumn and then move to other zones outside the sampled areas. Two specimens (TL = 20–25 mm) were recorded in November, which also indicates an ample spawning period. Bertoldo (1996) found *D. rhombeus* in Sepetiba Bay with mature gonads and a high gonadosomatic index (GSI) between November and March, suggesting an ample period of spawning. Elsewhere in Brazil, Silva (1994) similarly reported Autumn-Winter as being the recruitment period at Itaipu-Piratininga coastal lagoon, Rio de Janeiro State, for five gerreids species and Alcântara (1989) recorded *D. rhombeus* juveniles (55–60 mm TL) in Sergipe river estuary between April and October, suggesting a longer period of spawning and recruitment in this more tropical region.

Overall, the recruitment of *G. aprion* and *D. rhombeus* in the middle reaches of Sepetiba Bay, and their subsequent movement toward the inner Bay suggests that spawning occurs in deeper areas of the Bay or outside in the adjacent coastal zone, and that the young-of-the-year use the shallow margin of the Bay during early development before moving toward the deeper water.

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