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Use of a tropical bay in southeastern Brazil by juvenile and subadult *Micropogonias furnieri* (Perciformes, Sciaenidae)

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The white croaker *Micropogonias furnieri* is a commercially important marine fish that uses bays and other semi-closed coastal areas early in its life. A sampling programme, using beach-seine and otter trawl, was carried out in Sepetiba Bay (22°54′–23°04′S, 43°34′–44°10′W), southern Brazil, from October 1998 to September 1999, with the objective of assessing the patterns of temporal and spatial usage of the bay by white croaker during its early life. Early recruits (total length, TL, 10–50 mm) appear off beaches of the inner bay between October and December, move away from them during late summer and early autumn (January–April), and are caught by trawl offshore from May to September at a TL of 70–150 mm. From May to August, new recruits (10–50 mm) are again found inshore. Fish grow from 10–40 mm to 70–150 mm during the first year of life in the shallows of the bay, before moving offshore. They cross the deeper waters of the bay as they migrate towards the open ocean. Juveniles (TL 70–150 mm) are most abundant in the inner bay, and subadults (TL 150–200 mm) in the outer and central bay. *M. furnieri* use semi-closed coastal areas as nursery grounds, before moving out over the continental shelf, where they spawn.

Keywords: Brazil, *Micropogonias furnieri*, recruitment, Sciaenidae, size structure.

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Introduction

The white croaker *Micropogonias furnieri* is one of the most abundant sciaenids in the waters of southeastern Brazil; it has a wide distribution in the western Atlantic, from the Caribbean (20°N) to Argentina (41°S; Vazzoler, 1991). It has been reported over sandy and muddy substrata, mostly shallower than 60 m (Vazzoler, 1975; Menezes and Figueiredo, 1980). It is an important resource of the artisanal and industrial fisheries along the southern and southeastern coast of Brazil; an estimated 20 000 tonnes are caught annually in southeastern Brazil and sometimes even more in southern Brazil (Ibama, 1998). In Sepetiba Bay, the species ranks third, its landings constituting approximately 10% of all fisheries. The size of the fishable population over a calendar year varies as a result of immigration and emigration from bays and estuaries to the open sea of the continental shelf (Castello, 1986; Giannini and Paiva Filho, 1990; Haimovici and Umpierre, 1996). The movements are related to phases of the life cycle; young fish live and feed in semi-closed areas and migrate to the open ocean to spawn.

Movements of *M. furnieri* have been reported to and from the estuarine zones of the Patos Lagoon (Castello, 1986) and Cananéia (Vazzoler and Phan, 1981). Also, Giannini and Paiva Filho (1990) found seasonal and spatial variations in abundance in Santos Bay (São Paulo) and, in the Bay of Cienfuegos, Cuba, González-Sansón *et al.* (1996) found that recruits and subadults migrate from shallow areas of the estuary to deeper waters as they grow. The last author also showed a constant year-round influx of recruits into the bay.

Sepetiba Bay (22°54′–23°04′S, 43°34′–44°10′W) is an increasingly eutrophic semi-closed area near the outskirts of Rio de Janeiro. It has an area of 520 km^2 and a watershed of approximately 2500 km^2 (Figure 1). In the outer bay, the substratum is predominantly coarse and sandy, and rocky islands are common. In the inner bay the substratum is mostly muddy, and the beaches are rocky, sandy and muddy, in places fringed with mangrove formations that are

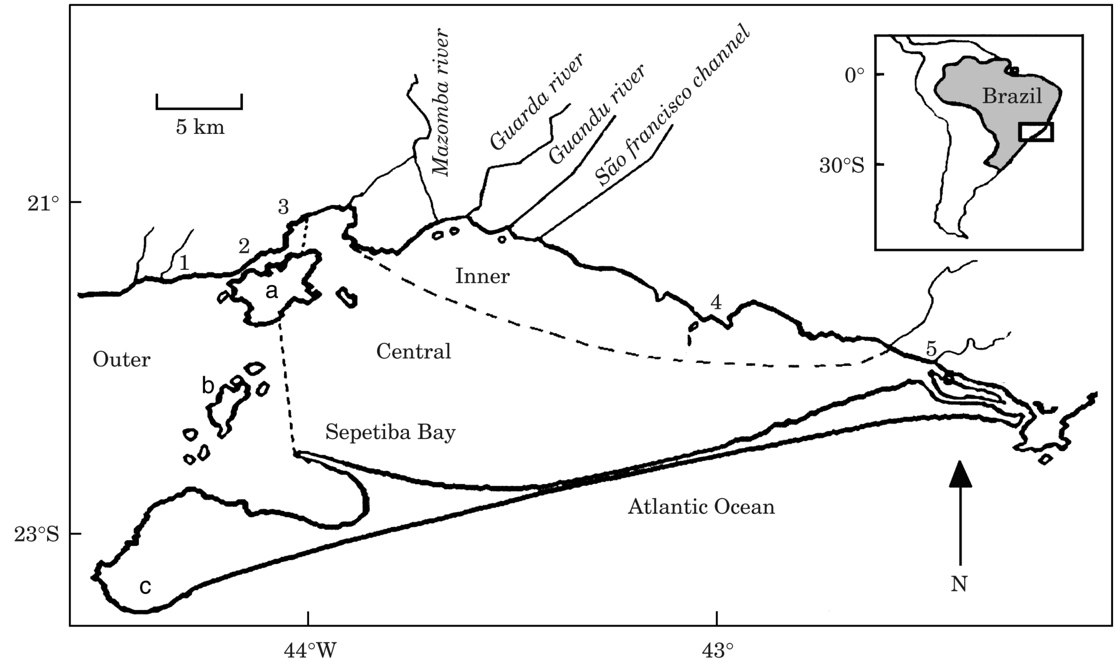

Figure 1. Sepetiba Bay, showing the three zones sampled by otter trawl (outer, central and inner) and the sites sampled by beach-seine (sites 1, 2 and 3—outer zone; sites 4 and 5—inner zone). (a) Itacuruçá Island; (b) Jaganum Island; (c) Marambaia Island.

coming under increasing pressure from industrial and municipal pollution from the city. The bay also contains a long and conspicuous sandbank formed by sedimentation from the prevailing currents. Maximum depth is 30 m, close to the island at the western side of the bay, near the open sea, but for about 40% of the whole area, and especially close inshore, the average depth is <5 m. Water temperature ranges from 20 to 26°C and salinity from 25 to 33. Araújo *et al.* (2002) classified the bay into three zones according to environmental characteristics: an outer, deeper (>10 m) zone, with salinity >30 and Secchi transparency >3 m; an inner, shallower (<5 m) zone, with salinity 25–30 and transparency <2 m; and a central zone with environmental conditions intermediate between the inner and the outer zones. The bay is used as a nursery ground by several species of fish, mainly the families Sciaenidae, Ariidae, Engraulidae, Mugilidae and Carangidae (Araújo *et al.*, 1998).

The size structure of a population can be used to investigate the growth of a species. It is influenced not only by a species' biology, but also by external environmental factors. Consequently, relative growth rates can be used as an indicator of fish condition; fast growth can indicate abundant food and a suitable environment. Seasonal food availability can also determine the life history strategy for certain species, as they seek to use resources and energy only when conditions are favourable.

The focus of this work was to determine the pattern of usage of Sepetiba Bay by *M. furnieri*, based on the size structure of the population. Spatial and temporal distributions of early life history stages in the bay were analysed with the objective of contributing to the understanding of the life cycle of the species, in terms of ecology and as an economic resource in southern and southeastern Brazil.

Material and methods

Samples were taken monthly between October 1998 and September 1999. Beach-seines were used at five sites to collect recruits (<70 mm total length, TL): outer zone, sites 1, 2 and 3; inner zone, sites 4 and 5 (Figure 1). An otter trawl was deployed to collect juveniles (70–150 mm TL) and subadults (>150 mm TL) in three zones: outer, central and inner bay.

Beach-seines (10 m long, 2.5 m high, 7 mm mesh) were towed about 30 m offshore, parallel to the beach at depths <1.5 m. Otter trawls (8 m mouth width, 12 mm mesh near the codend) were towed for 20 min at a speed of 2 knots, so covering a distance of some 1.5 km. A small boat 12 m long was used for the purpose. Three replicates were performed for both beach-seines and otter trawls at each station at which they were deployed. The catch per unit effort (cpue) unit used for the study was the total number and mass of fish caught per tow. All fish were preserved in 10% formalin, counted, measured to the nearest 1 mm, and weighted to the nearest 0.1 g.

Spatial distribution was analysed on the basis of the cpue (number and weight) in each zone, and the seasonality was specified as the months of occurrence in the seasons spring (October–December), summer (January–March), autumn

(April–June) and winter (July–September). Length frequency distributions were drawn by grouping the number of fish caught into 5-mm size-class intervals. Two-way ANOVA was used to perform spatio-temporal comparisons; the assumptions of normality and homoscedasticity were met by a $\log_{10}(x + 1)$ transformation of the raw data. Tukey's multiple range test was used to determine differences in the mean values following ANOVA (Zar, 1984).

Results

In all, 830 white croaker were caught during 180 beach-seine hauls (5 sites × 12 months × 3 replicates), and 2017 during 108 otter trawl tows (3 zones × 12 months × 3 replicates).

Size structure

Individual fish TL ranged from 10 to 300 mm. In beach-seines they were captured at a length of 10–70 mm (recruits), and in otter trawls at a length of 70–300 mm (juveniles, subadults, and adults). Three size classes were observed during the study, according to length frequency distributions, coinciding with the age/size classification of Vazzoler (1991) and Reis and Castello (1996): recruits (TL<70 mm) during two periods (R1 and R2), juveniles (J) less than 1 year old (TL 70–150 mm), and subadults (SA) or adults (TL>150 mm) older than 1 year (Figure 2).

Recruits were caught by beach-seine in the inner zone during all seasons except summer. Fish of TL>130 mm were captured by otter trawl in all parts of the bay.

Temporal and seasonal distribution

In beach-seines, no fish were caught in the outer zone (1–3), except for three fish (TL 20–30 mm) at site 1 in November. In contrast, white croaker was common in the inner zone (sites 4 and 5), and more abundant at site 4 than at site 5. Abundance was greatest ($p < 0.01$) by both number and weight in August and November; no *M. furnieri* were caught by beach-seine in summer or early autumn (Figure 3). Catch rates in May and June were intermediate between these two extremes, but did not differ significantly from those in August and November.

In otter trawls, the distribution of *M. furnieri* over the three bay zones was wider, more being caught in the inner zone, fewer in the central zone, and least in the outer zone (Figure 3). Catch rate in the inner zone (45.5 fish per sample) was significantly higher ($p < 0.01$) than in the central and outer zones (6.5–6.8 fish per sample; Table 1). Temporally, abundance was greatest in December, July, August, and September in the inner zone, but there was no significant difference ($p > 0.01$) between the catch rates (number or weight) for those months. The trend was for abundance in the inner zone to be greater from October to January and from May to September, especially when compared with catch rates in the other two zones. In February and March, abundance decreased in the inner zone, and catch rates were comparatively highest in the central and outer zones. These trends of decreased abundance in the inner zone and increased abundance in the central and outer zones in February and March coincided with a period of absence of recruits (<70 mm TL) from beach-seine catches. From November to March only few fish were captured in the outer zone; these fish tended to be larger, indicating that they were subadults and/or adults (>150 mm TL; Figures 2 and 3).

Recruits (<70 mm TL) and juveniles (70–150 mm TL) were caught close to the beaches through most of the year, except between January and April. Recruitment was inferred when the *M. furnieri* were smallest (TL < 70 mm, mostly 10–40 mm). On this basis, recruitment peaked from October to December and from May to August (Figure 2). This dual period of recruitment, one in spring (R1) and the other in autumn/winter (R2), is clear from the length frequency distributions (Figure 2): small fish 15 mm long grew to some 25 mm 3 months later (R1), or to 35 mm after 5 months (R2). Juveniles (70–150 mm) were abundant from June to September, and fish >150 mm were caught mainly from October to May (Figure 2).

Two modes were observed between June and September, the first reflecting an influx of recruits and the second a group of juveniles; a third size class of larger size probably represented juveniles more than 1 year old. Subadults were caught from October to May. The length frequency distributions in Figure 2 suggest recruitment in the bay from May to August. Between June and September, juveniles dominate and increase in size, and another set of recruits appears between October and December.

Two size classes of white croaker were caught, recruits captured by beach-seine, and juveniles >1 year old and subadults captured by otter trawl. Recruits (<70 mm) were more abundant in spring and autumn/winter, and juveniles (70–150 mm) in winter. A third class of larger fish (150–200 mm), presumably subadults, was recorded throughout the year (Figure 4).

Spatial distribution

Only three fish were captured by beach-seine in the outer zone (site 1) during the study period, but in the inner zone 396 were captured at site 4 and 335 at site 5. Clearly, *M. furnieri* is strongly associated with the inner bay. The three fish caught by beach-seine in the outer zone were smaller (TL 10–20 mm) than those caught in the inner zone at site 5 (25–30 mm) and site 4 (30–40 mm; Figure 5).

Fish caught by otter trawl (TL 20–300 mm) in the inner zone had modes between 70 and 130 mm, in the central zone at 130–170 mm, and in the outer zone at 130–170 mm, at 190 and at 220 mm, indicating a size increase from the inner to the outer bay zone (Figure 6). Small fish of TL

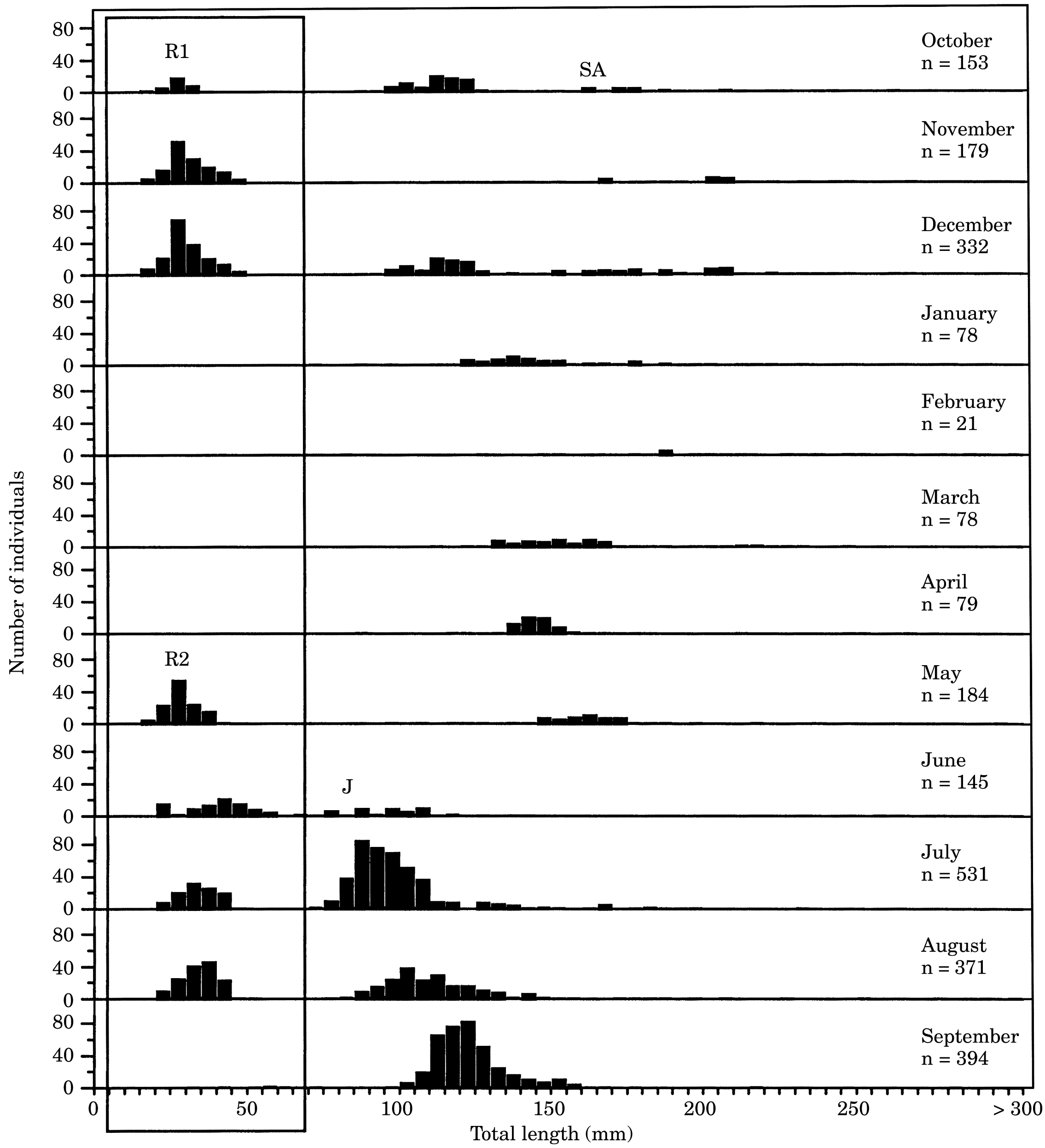

Figure 2. Monthly length frequency distribution of *M. furnieri* in Sepetiba Bay between October 1998 and September 1999. n, number of fish; R1, first recruitment; R2, second recruitment; J, juveniles at the end of their first year of life, SA, subadults. Rectangle indicates beach-seine catches, and non-delineated frequencies are catches by otter trawl.

70–100 mm, likely almost 1 year old, were abundant only in the inner zone, whereas larger fish (>130 mm), likely more than 1 year old and subadult, were abundant in all three of the zones trawled, the biggest fish concentrating in the central and outer zones. There are indications of spatial separation into groups according to size within the zones, mainly in the inner and in the central plus outer zone, because the modes in the last two zones are comparable. Overall, the smallest fish caught by trawl (TL 70–120 mm) were mainly in the inner zone, and the largest (>120 mm) were in the central and outer zones (Figure 6).

Discussion

Based on the analysis of size distributions, *M. furnieri* displays a well-defined spatial pattern of use of Sepetiba

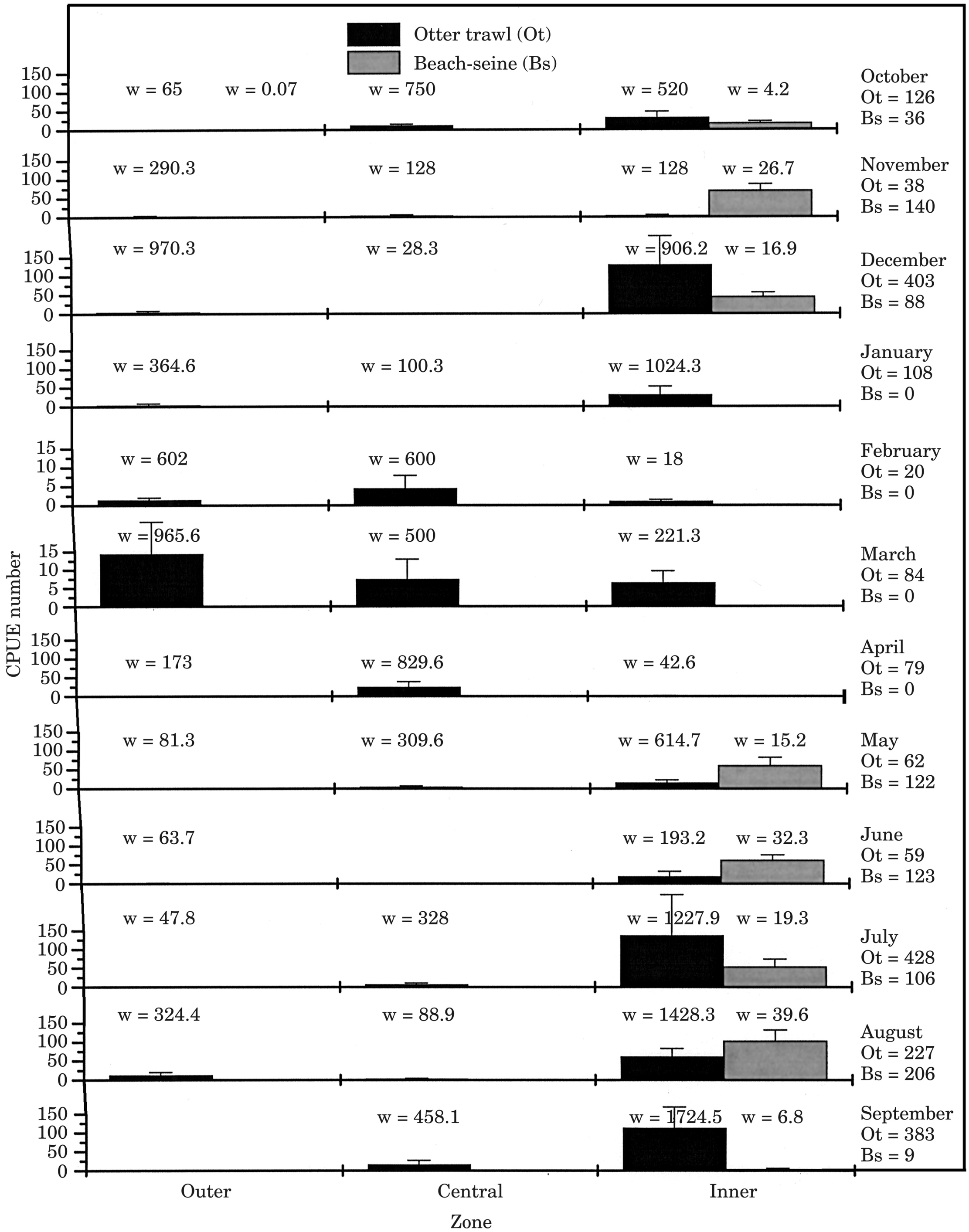

Figure 3. Spatial and temporal variation in catch rate (fish per sample) in Sepetiba Bay between October 1998 and September 1999. The abbreviations Ot and Bs indicate the number of fish caught by otter trawl and beach-seine, respectively. Vertical lines represent the mean standard error, and w is the average weight.

Table 1. Values of *F* from ANOVA for fish abundance (cpue) and Tukey test for differences in beach-seine and otter trawl catches in Sepetiba Bay, October 1998–September 1999.

Cpue	Months (M)	Zones (Z)	Interaction (M×Z)	Tukey test for differences
Number (beach-seine)	5.99*	93.54*	5.95*	Jan.–Apr.; Sep. < Aug.; Nov. outer < inner
Weight (beach-seine)	4.25*	66.84*	4.26*	Jan.–Apr. < Aug.; Nov. outer < inner
Number (otter trawl)	n.s.	10.34*	n.s.	Central, outer < inner
Weight (otter trawl)	n.s.	n.s.	n.s.	–

n.s., not significant. *$p < 0.01$.

Bay during its first year of life, with recruits concentrating off beaches of the inner zone. Such beaches are predominantly of muddy substratum. The organic loading brought into the bay by channels and municipal drainage may favour young fish by increasing primary and secondary productivity in the area (Coelho and Carvalho, 1973). *M. furnieri* is essentially omnivorous and prefers a diet of the small crustaceans that inhabit muddy substrata, e.g. brachyuran crabs, carid shrimps, and penaeid prawns, as well as tanaidaceans, polychaetes, and organic matter (Figueiredo and Vieira, 1998). Its generalist/opportunist feeding habit allows it to take dietary advantage of the high productivity of the shallows. Such a preference may also contribute to its commonness in an area prone to fluctuating (usually decreasing) water quality, in contrast with the more stable conditions in the outer zone, which is more influenced by the open sea. The productive nature of the shallow (<2 m) zones of the bay generates favourable conditions for recruitment and growth of the species, to the extent that *M. furnieri* has developed strategies to maintain its abundance there. Beaches also offer protection against predators owing to their turbidity and shallowness (Blaber and Blaber, 1980). Several authors include *M. furnieri* in a category of marine fish with high dependence on semi-closed coastal areas, such as estuaries and bays (Giannini and Paiva Filho, 1990; Vieira and Castello, 1997). In general, they inhabit the shallows as recruits, juveniles and subadults, and migrate to the deeper waters of the continental shelf as they grow (Castello, 1985; Vazzoler, 1991). According to Vieira and Castello (1997), *M. furnieri* in their first year of life live in the shallows of the inner Patos Lagoon, seeking shelter from predators. After

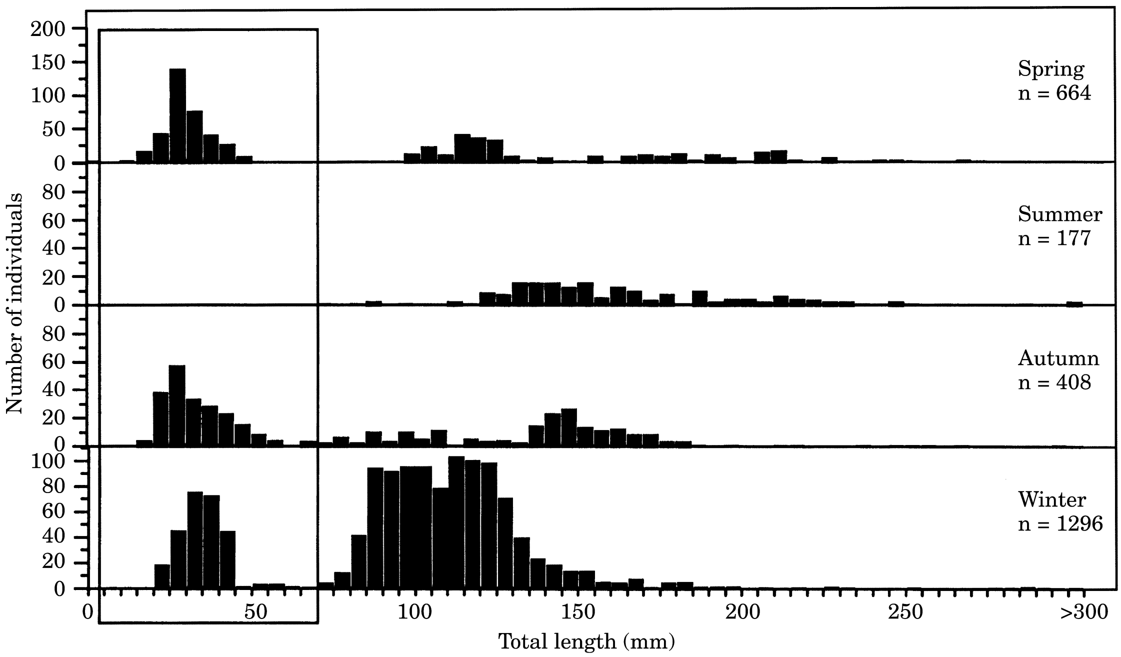

Figure 4. Seasonal length frequency distribution of *M. furnieri* in Sepetiba Bay between October 1998 and September 1999. *n*, number of fish. Rectangle indicates beach-seine catches, and non-delineated frequencies are catches by otter trawl.

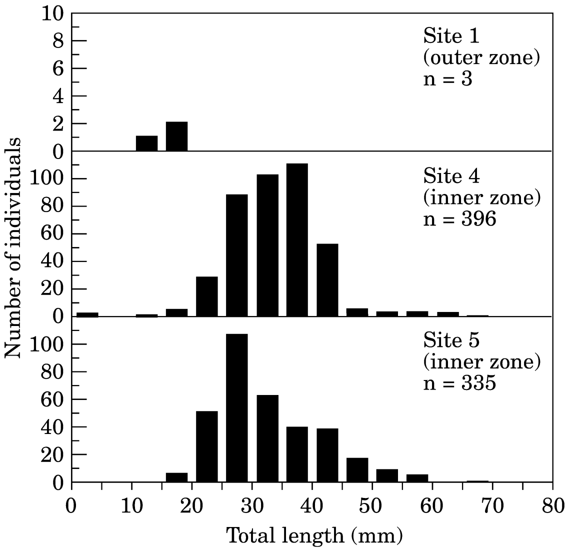

Figure 5. Length frequency distribution of *M. furnieri* caught by site by beach-seine in Sepetiba Bay, October 1998–September 1999. n, number of fish.

spawning, which takes place in deeper open-sea areas over the continental shelf, the estuarine Patos Lagoon is used as a nursery ground where the young *M. furnieri* feed and grow in comparative safety in the shallow, turbid water, which is clearly important in the adaptative evolution of the species (Chao *et al.*, 1986).

The use of shallows or sandbanks by recruits (TL 30–70 mm) can also be associated with food availability (Gonçalves *et al.*, 1999). It is during the recruitment phase that *M. furnieri* change their feeding preference from zooplanktophagous to microbenthofagous. According to Gonçalves *et al.* (1999), larvae and juveniles penetrate the Patos Lagoon estuary throughout the water column and recruit into the shallows, where conditions are favourable for survival; they then migrate deeper as they grow. Castello (1986) suggests that fish >100 mm move from the shallows out to deeper water, creating a broad distribution throughout the Patos Lagoon estuary. Giannini and Paiva Filho (1990), in their research in Santos Bay, discovered that *M. furnieri* use several types of habitats in the shallows, as well as occupying the water column and moving deeper as they grow.

The documented migration pattern of young white croaker described above agrees with the results of the present work, in which recruits and juveniles were recorded close to the beach, where transparency, depth, and salinity are relatively low. The abundance in the inner zone suggests that recruits (TL < 70 mm) target this zone as they penetrate the bay. The scarcity of recruits and juveniles in the outer zone is probably a reflection of unfavourable habitat in an area where the influence of

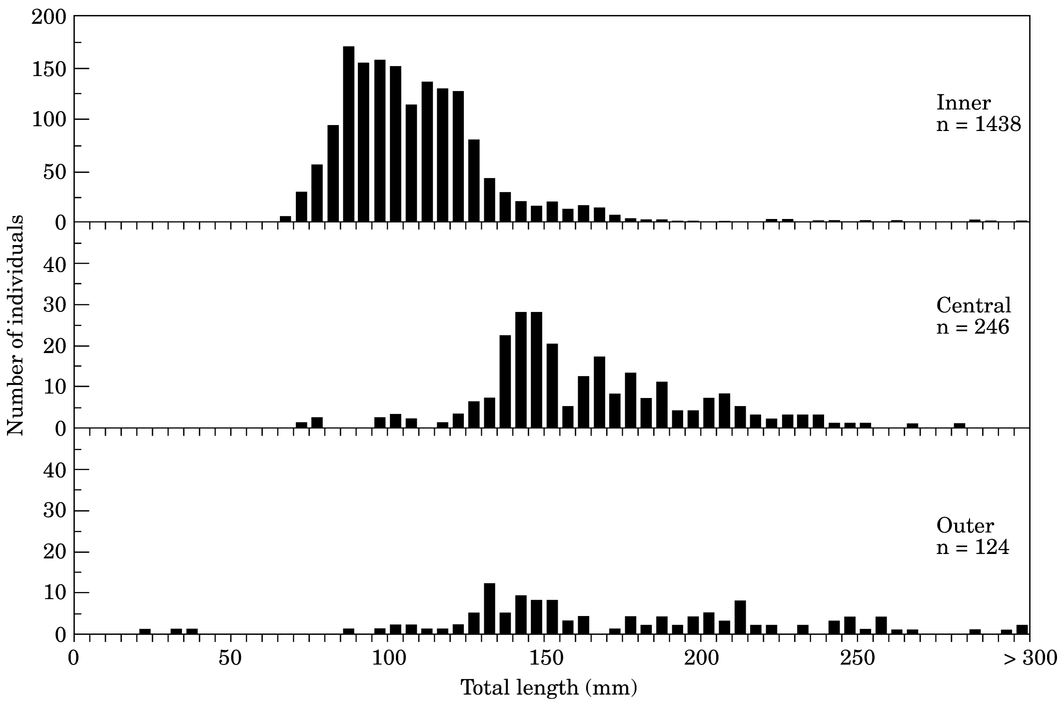

Figure 6. Length frequency distribution of *M. furnieri* caught by site by otter trawl in Sepetiba Bay, October 1998–September 1999. n, number of fish.

currents is stronger. It could also be related to a need for white croaker to avoid competition with species such as engraulids that recruit into such areas in large numbers (Silva and Araújo, 1999), and also to the greater transparency of the water, that would favour predators.

In Sepetiba Bay recruits are common throughout much of the year, suggesting a long spawning period of the species, although they are scarce in late summer and early autumn. Recruitment influx to the bay peaks during spring and between late autumn and early winter. Such a long period of recruitment contrasts with the shorter period documented for more-southern populations in the Patos Lagoon, where recruitment is limited to late spring and early autumn (Vazzoler, 1991). The higher latitude of the Patos Lagoon may well be the reason for this difference in recruitment duration in the same species; other species in the Patos Lagoon also have a more curtailed recruitment than stocks of similar species to the north. Vazzoler (1991) has already suggested that there may be two geographically isolated populations of *M. furnieri* in southeastern and southern Brazil, with differences in growth rate, reproductive cycle and recruitment period. He named the stock found between 23 and 29°S, which includes the present study area, population I, and described it as having a long reproductive season, but with a break in recruitment during summer. The other stock, found between 29 and 33°S, he named population II, and described it as having a shorter reproductive season, mainly spring and summer.

Recruits (TL 15–70 mm) first appear at Sepetiba Bay beaches in October, and remain there until attaining about 70 mm in January. They then disappear from the vicinity of the beaches and probably move offshore into slightly deeper water (about 2–3 m deep), a depth out of reach of both beach-seine (limited to depths <1.5 m) and otter trawl (>3 m). Late summer temperatures at the beaches are comparatively high, and this may stimulate offshore movement. During late autumn and spring, when they reach 1 year of age (TL 70–150 mm), they move to the deeper areas of the bay, where they become available to otter trawls. Figure 7 is a schematic representation of the likely life cycle of the species in and around Sepetiba Bay. Vazzoler (1971) suggested three recruitment periods for population I (southeastern Brazil), one in autumn, another in late winter, and a third in spring, with a short rest period in summer. Based on the length frequency data presented here, we lean towards the hypothesis of a broader recruitment period, with a resting period in summer and early autumn.

The movement towards the outer bay by large fish in summer could be associated with a search for more profitable feeding grounds elsewhere in the bay when these bigger fish would be more capable of competing with other

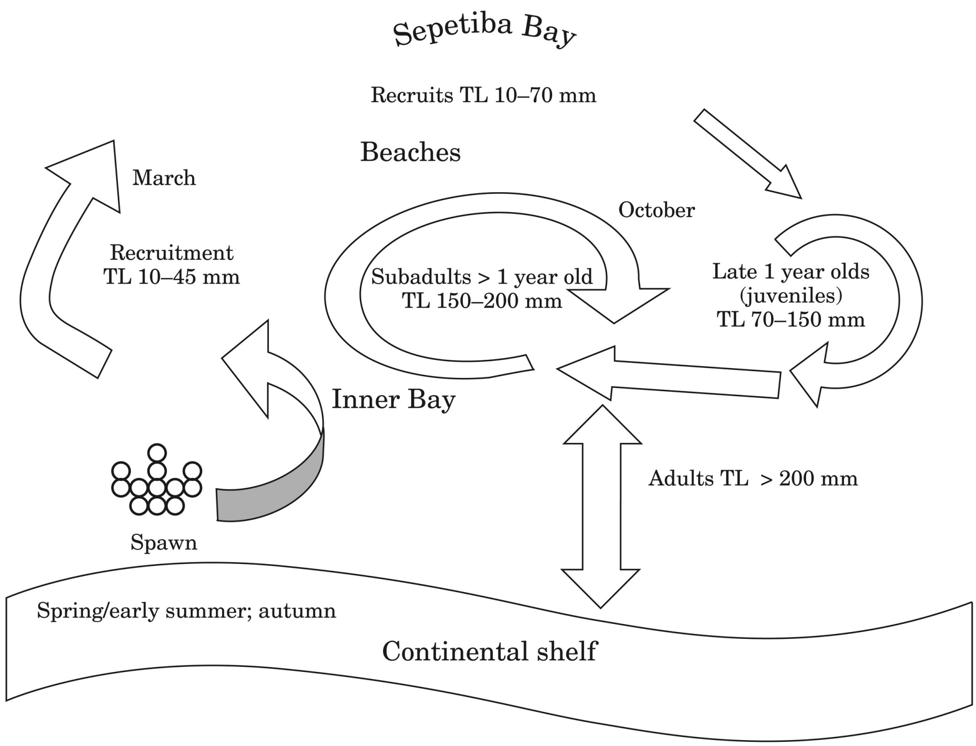

Figure 7. Schematic diagram of the early life history of *M. furnieri* in Sepetiba Bay, Brazil.

(larger) species. Adult white croaker are commonly caught in open-sea areas over the continental shelf (González-Sansón *et al.*, 1996; Reis and Castello, 1996; Carozza *et al.*, 1997). Vazzoler (1991) stated that recruits penetrate the bays and estuaries mainly to feed, moving out to the open sea only when they achieve adulthood.

Sepetiba Bay *M. furnieri* were mostly <200 mm TL, supporting the view that the bay acts as a nursery for the species. The L_∞ of the species in adjacent coastal areas is estimated to be 507 mm TL and the L_{50} to be 250 and 275 mm for males and females, respectively (Vazzoler, 1991). In estuaries and bays, where the species is considered to be relatively slow-growing, some females mature at a TL < 200 mm (Reis and Castello, 1996). One possibility for the smaller relative size at age in bays could be that the fish are forced to utilize some of their energy reserves to withstand pollution and the frequent changes in salinity, so permitting less energy to be directed towards growth. Another possibility is that heavy fishing mortality is simply removing the larger fish from the population in the bay. Juveniles clearly coexist with larger fish, including subadults, a pattern similar to that in other semi-closed areas in southeastern Brazil (Figure 7).

In summary, *M. furnieri* penetrate Sepetiba Bay, probably as eggs and larvae, in incoming currents from the western side, and on the inner muddy beaches find habitats favourable for their early development. Only when they attain a TL > 150 mm do they move deeper inside the bay, and only as subadults and adults do they move out of the bay to live and spawn.

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References

Araújo, F. G., Cruz-Filho, A. G., Azevedo, M. C. C., and Santos, A. C. A. 1998. Estrutura da comunidade de peixes demersais da Baía de Sepetiba, RJ. Revista Brasileira de Biologia, 58: 417–430.

Araújo, F. G., Azevedo, M. C. C., Silva, M. A., Pessanha, A. L. M., Gomes, I. D., and Cruz-Filho, A. G. 2002. Environmental influences on the demersal fish assemblages in Sepetiba Bay, Brazil. Estuaries, 25: 441–450.

Blaber, S. J. M., and Blaber, T. G. 1980. Factors affecting the distribution of juvenile estuarine and inshore fish. Journal of Fish Biology, 17: 143–162.

Carozza, C. R., Cotrina, C. P., and Cousseau, M. B. 1997. Muestreo bioestadistico de pescado en el puerto de Mar del Plata. Corvina rubia (*Micropogonias furnieri*). Periodo 1986–1988. INIDEP No. 995, Informe Técnico, 15: 53–79.

Castello, J. P. 1985. La ecología de las comunidades del estuario de la Lagoa dos Patos. *In* Fish Community Ecology in Estuaries and Coastal Lagoons: Towards an Ecosystem Integration, pp. 383–406. Ed. by A. Yañez-Arancibia, UNM Press, México, 654 pp.

Castello, J. P. 1986. Distribucíon, crecimiento e maduracion sexual da la corvina juvenil (*Micropogonias furnieri*) en el estuario de la Lagoa dos Patos, Brasil. Physis, 44: 21–36.

Chao, L. N., Vieira, J. P., and Barbieri, L. R. R. 1986. Lagoa dos Patos as a nursery ground for shore fishes off southern Brazil. Intergovernmental Oceanographic Commission Workshop Report, 44: 144–150.

Coelho, V. M. B., and Carvalho, R. R. 1973. Levantamento sanitário da Baía de Sepetiba e suas possibilidades como corpo receptor de cargas poluidoras da região. Publicaçães avulsas FEEMA, 87 pp.

Figueiredo, G. M., and Vieira, J. P. 1998. Cronologia alimentar e dieta da corvina, *Micropogonias furnieri* no estuário da Lagoa dos Patos, RS, Brasil. Atlântica, Rio Grande, 20: 55–72.

Giannini, R., and Paiva Filho, A. M. 1990. Os Sciaenidade (Teleostei: Perciformes) da Baía de Santos (SP), Brasil. Boletim do Instituto Oceanográfico, São Paulo, 38: 69–86.

Gonçalves, A. A., de Souza, J. A. F., and Vieira, J. P. 1999. Descrição trófica dos primeiros estágios de vida de *Micropogonias furnieri* (Sciaenidae) no estuário da Lagoa dos Patos, RS, Brasil. Atlântica, Rio Grande, 21: 93–103.

González-Sansón, G., Bosch Méndez, A., Guevara Carrió, E., and Aguilar, C. B. 1996. Composición por tallas de las capturas de la corvina *Micropogonias furnieri* (Desmarest, 1823) (Osteichthyes: Sciaenidae) en la Bahia de Cienfuegos, Cuba. Revista de Investigaciones Marinas, 17: 189–195.

Haimovici, M., and Umpierre, R. G. 1996. Variaciones estacionales en la estructura poblacional del efectivo pesquero de corvina blanca *Micropogonias furnieri* (Desmarest, 1823) en el extremo sur de Brasil. Atlântica, Rio Grande, 18: 179–203.

Ibama. 1998. Instituto Brasileiro de Meio Ambiente. Estatística de Pesca – ano 1997. Grandes regiães e unidades da federação. 230 pp.

Menezes, N. A., and Figueiredo, J. L. 1980. Manual dos Peixes Marinhos do Sudeste do Brasil. IV. Teleostei (3). Museu de Zoologia, Universidade de São Paulo, SP. 96 pp.

Reis, E. G., and Castello, J. P. 1996. Growth parameters of white croaker (*Micropogonias furnieri*) derived from length composition. Atlântica, Rio Grande, 18: 101–122.

Silva, M. A., and Araújo, F. G. 1999. Influência dos fatores ambientais na estrutura de população de manjubas (Clupeiformes-Engraulididae) na Baía de Sepetiba, Rio de Janeiro. Acta Biologica Leopoldenisa, São Leopoldo, 21: 229–240.

de Vazzoler, A. E. A. M. 1971. Diversificação fisiológica e morfológica de *Micropogon furnieri* (Desmarest, 1822) ao sul de Cabo Frio, Brasil. Boletim do Instituto Oceanográfico, São Paulo, 20: 1–70.

Vazzoler, G. 1975. Distribuicão da fauna de peixes demersais e ecologia dos Sciaenidade da plataforma continental brasileira, entre as latitudes 29°21′S (Torres) e 33°41′S (Chuí). Boletim do Instituto Oceanográfico, São Paulo, 24: 85–169.

de Vazzoler, A. E. A. M. 1991. Síntese de conhecimentos sobre a biologia da corvina *Micropogonias furnieri* (Desmarest, 1823), na costa do Brasil. Atlântica, Rio Grande, 13: 55–74.

de Vazzoler, A. E. A. M., and Phan, V. N. 1981. Ocorrência de catarata em *Micropogonias furnieri* (Desmarest, 1823), na área

entre Cabo Frio e Torres (23°s 29°s), Brasil: Investigação de causas e estudo eletroforético das proteínas totais dos cristalinos. Boletim do Instituto Oceanográfico, São Paulo, 30: 65–76.
Vieira, J. P., and Castello, J. P. 1997. Environment and biota of the Patos Lagoon estuary: fish fauna. *In* Subtropical Convergence Environments: the Coast and Sea in the Southwestern Atlantic, pp. 56–61. Ed. by U. Seeliger, C. Odebrecht, and J. P. Castello, Springer, Berlin. 308 pp.
Zar, J. H. 1984. Biostatistical Analysis, 2nd ed. Prentice Hall, New Jersey.