Rev. bras. oceanogr., 48(1):1-7, 2000

Temporary use of a coastal ecosystem by the fish, *Pomadasys corvinaeformis* (Perciformes: Haemulidae), at Guaratuba Bay, Brazil[1]

Paulo T. C. Chaves[2] & Carlos E. Corrêa[2]

Universidade Federal do Paraná, Departamento de Zoologia
(Caixa Postal 19020, 81531-990, Curitiba, PR, Brasil).
poissons@cce.ufpr.br

- ***Abstract:*** *Pomadasys corvinaeformis* is one of the most abundant species found in Guaratuba Bay, an Atlantic coastal, estuarine ecosystem in Paraná, Brazil. We tested whether this species comprises a resident or migratorial population. Abundance, size distribution, and gonad development of individuals captured during the year show that pre-adults enter the system when salinities are greater (autumn and early winter). During this time, they are mostly associated with mangroves and adjacent areas. When salinities begin to fall (late spring and summer) these now maturing individuals return to the sea where they spawn. Thus, *P. corvinaeformis* is migratorial and estuarine-dependent and uses this area prior to sexual maturity. During the period in this bay, *P. corvinaeformis* presents a great plasticity of feeding habits, that include mainly Crustacea, Mollusca and Thaliacea.

- ***Resumo:*** *Pomadasys corvinaeformis* é uma das espécies de maior representatividade na ictiofauna da Baía de Guaratuba, litoral do Estado do Paraná. Este trabalho investigou se a espécie compõe ali uma população permanente, residente no sistema, ou se é migratória, freqüentando-o apenas em épocas determinadas. Resultados de 12 meses sobre variações de abundância, distribuição de tamanho e aspectos reprodutivos indicam que indivíduos subadultos ingressam no sistema quando a salinidade é maior (outono, começo de inverno). Nesta época, os indivíduos utilizam a área de manguezal e suas adjacências. Quanto a salinidade começa a cair (final de primavera, verão), estes indivíduos agora em maturação gonadal retornam para o mar, onde desovam. *P. corvinaeformis* é, portanto, uma espécie migratória e estuarino-dependente que utiliza a Baía em período anterior ao de maturidade gonadal. Ali, apresenta uma dieta muito variada, constituída basicamente de Crustacea, Mollusca e Thaliacea.

- ***Descriptors:*** Migration, Fish, Estuaries, Feeding habits, Haemulidae, Pomadasyidae.

- ***Descritores:*** Migração, Peixes, Estuários, Alimentação, Haemulidae, Pomadasyidae.

Introduction

Most species that inhabit estuarine systems are occasional visitors or migrants through these systems. This tendency for fish to migrate through, rather than reside in, estuarine systems has been attributed to the wide fluctuation in environmental conditions (Amanieu & Lasserre, 1982). In spite of variable environmental conditions, some migrant populations can reach greater abundance and biomass than that of other resident populations. In the mangroves of Guaratuba Bay, southern Brazil (28°52'S;48°39'W), some of the most common fish species (*Bairdiella ronchus*, *Isopisthus parvipinnis*, three *Eucinostomus* spp.; Chaves, 1996; Chaves *et al.*, 1998; Chaves & Otto, 1999) temporarily utilize the estuary as a "nursery area".

One of the most abundant of these species in the area is the roughneck grunt ("corcoroca"), *Pomadasys corvinaeformis* (Steindachner, 1868) (Haemulidae=Pomadasyidae), a small, schooling species (Chaves & Bouchereau, 1999). Individuals

(1) Contr. number 1159 of the Department of Zoology/UFPR, Financial grants: CNPq and FUNPAR/UFPR.
(2) Fellowships of CNPq.

usually occur in Guaratuba Bay within the range of sizes previously reported for this species: juveniles=40 mm (Costa *et al.*, 1995) and maximum=250 mm (Menezes & Figueiredo, 1980). Corcoroca have no commercial importance in this region, but they take part in the food dynamic of the fish assemblage. They apparently leave the mangroves during spring and summer (cf. Chaves, 1998), but it is unknown whether they a) remain inside the Bay and spawn, or; b) leave the Bay, moving to the ocean, to spawn. Studies of other populations of this species report its occurrence in estuaries (Araújo *et al.*, 1998) and along coastal oceanic beaches (Costa *et al.*, 1995). Here, spatial and temporal occurrences of *P. corvinaeformis* are examined in the Guaratuba Bay, near the mangroves studied by Chaves (*op. cit.*). We also examined the dietary habits and compared with work outside of estuaries (Fortaleza beach, Brazil – Costa *et al.*, *op. cit.*).

Material and methods

Fish were collected monthly from May 1998 to April 1999 in three areas along an east-west transect of approximately 12 km, from the Guanxuma river (area 1) to the proximity of the sea (area 3) (Fig. 1). We towed an otter trawl with a 20mm mesh monthly for seven minutes in waters 3-4m (depth) in each area. Bottom water salinity, pH and temperature (except in June and October) were also measured using a Van Dorn bottle.

Fish specimens were weighed, measured (total length, TL) and dissected to assess reproductive stage and sample stomach contents. Sex and maturation stage were evaluated by visual examination of gonads, using a four stage classification (immature, maturing, mature and spent; Vazzoler, 1996). Next, stomachs with food items were immediately fixed in a 10% formalin solution for later examination with a stereoscopic microscope. Contents were analyzed in two ways: 1) frequency of occurrence (**FO**), defined as the proportion of stomachs that contained a given food item, and 2) proportional abundance (**P**), measured as the number of points covered by each item on a grid of points spaced 4 mm, divided by the total number of points occupied by the contents. Items were ranked using these two methods based on the Preponderance Index (**PI**; Juras & Yamaguti, 1985):

$$\mathbf{PI}_i = (\mathbf{FO}_i.\mathbf{P}_i) / \sum_{i=1\rightarrow n}(\mathbf{FO}_i.\mathbf{P}_i).100,$$

where "$_i$" is each one of the "n" identified items.

All variables used in statistical analysis were tested for normality, and when appropriate, parametric or non-parametric analyses were used. The abiotic characteristics in the three study areas were compared using ANOVA. These were compared monthly and for the entire study period. A five-year record (1993-1998) of monthly rainfall collected nearby (Morretes IAPAR station, 30 km from Guaratuba Bay) explains salinity variation in the estuary (Fig. 2). Voucher specimens are deposited in Museu de História Natural Capão da Imbuia collection, Curitiba, Brazil (MNHCI 8260 to 8262).

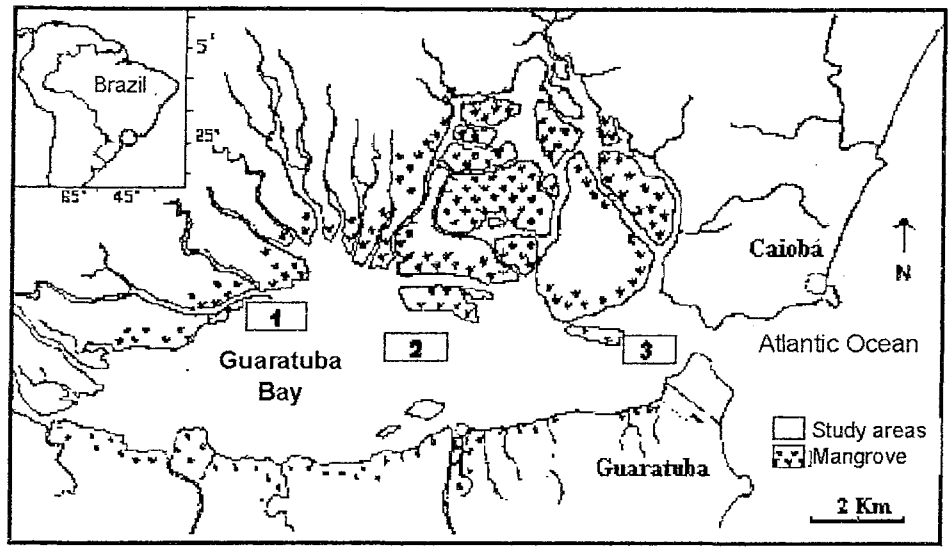

Fig. 1. Map of Guaratuba Bay, Southern Brazil, showing positions of study areas (1,2,3) relative to the sea and rivers entering the bay, as well as the mangrove zone (northern region) studied by Chaves (1998).

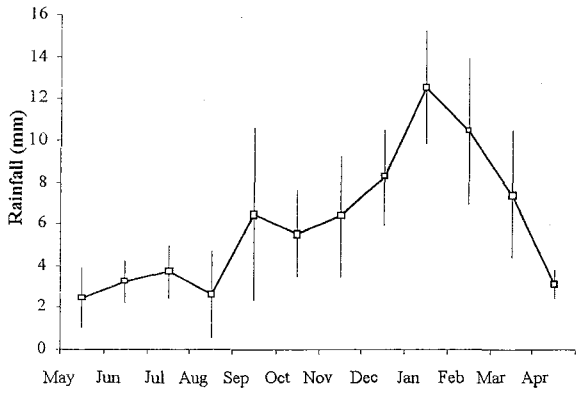

Fig. 2. Rainfall (mean, standard deviation), from measurements taken at Morretes IAPAR (Instituto Ambiental do Paraná) Station, January 1993 to October 1998.

Results

Salinity, pH, Temperature - Average salinity was significantly greater in area 3 than in areas 1 and 2 ($F=16.9$; d.f.=2; $p<0.01$), which had similar salinity levels. January had the lowest salinity levels in all three areas (Tab. 1), and differences between areas were not significant ($F=1.5$; d.f.=9; $p>0.05$). Rainfall was greatest during summer months resulting in the lower salinities (Fig. 2). Area 3 had the greatest average pH ($X^2=10.14$; d.f.=2; $p<0.01$), but no monthly trends in pH were observed ($X^2=15.71$; d.f.=9; $p>0.05$) (Tab. 1). Water temperatures were not statistically different among the areas ($X^2=0.84$; d.f.=2; $p>0.05$), but did vary among months ($X^2=25.9$; d.f.=9; $p<0.01$), with highest temperatures during summer (January-March) and lowest during winter (July-September) (Tab. 1).

Fish - A total of 520 individuals were netted, most between June and December (Fig. 3). Mean TL of these fish ranged from a minimum of 66 mm in February to a maximum of 140 mm in December (Fig. 4a). The largest individuals were found at the highest temperatures and the lowest salinities (Figs 4b,c). No "corcoroca" were netted in January, March, April or May. During the other months, they were only netted in area 3, nearest of the sea, except December, when they were also taken in area 2 ($n=64$; $111 \leq TL \leq 140$ mm, the largest of the two areas – Fig. 4d).

Reproductive data - Sex ratio was 48% male : 52% female for 406 specimens. Fish in the "maturing" phase ($n=27$; $115 \leq TL \leq 140$ mm) were only found in area 2, in December (Tab. 2). All other specimens ($n=379$; $83 \leq TL \leq 135$ mm) were immature, and were found in areas 2 and 3. "Mature" or "spent" phase individuals were never captured.

Stomach contents - All specimens collected in February had empty stomachs. Thus, stomach contents are only compared for specimens ($n=256$) collected between June and December. The monthly abundance in the diet for the most common items, based on Preponderance Index values, varied widely (Fig. 5). Thaliacea, Gastropoda, Amphipoda, Copepoda and plants were the most common food items (Tab. 3). Polychaeta, Crustacea larvae and Diatomacea were also common, presenting frequency of occurrence greater than 10% and proportional abundance greater than 4%.

Table 1. Bottom salinity, pH and temperature values by month and sampling area (1 to 3) in Guaratuba Bay, during survey period. X: mean; S: standard error.

	SALINITY (‰)					pH					TEMPERATURE (°C)				
AREA	1	2	3	**X**	**S**	1	2	3	**X**	**S**	1	2	3	**X**	**S**
May/98	12.1	18.1	22.2	**17.5**	**5.1**	7.8	8.1	8.2	**8.0**	**0.2**	23.0	23.0	24.0	**23.3**	**0.6**
July	7.8	11.6	21.5	**13.6**	**7.1**	7.4	8.1	8.7	**8.1**	**0.6**	20.0	20.0	20.0	**20.0**	**0.0**
August	19.3	19.3	23.2	**20.6**	**2.2**	7.0	7.1	7.1	**7.1**	**0.1**	20.0	21.0	20.0	**20.3**	**0.6**
September	12.0	12.0	18.0	**14.0**	**3.5**	7.7	7.9	8.1	**7.9**	**0.2**	20.0	21.0	20.0	**20.3**	**0.6**
November	2.0	4.0	30.0	**12.0**	**15.6**	7.4	7.5	8.5	**7.8**	**0.6**	20.0	21.0	21.0	**20.7**	**0.6**
December	5.0	11.0	26.0	**14.0**	**10.8**	7.4	8.0	8.4	**7.9**	**0.5**	26.0	26.0	25.0	**25.7**	**0.6**
January/99	0.0	0.0	16.0	**5.3**	**9.2**	5.9	5.7	7.8	**6.5**	**1.2**	25.0	25.0	28.0	**26.0**	**1.7**
February	0.0	4.0	18.0	**7.3**	**9.4**	6.8	7.1	8.0	**7.3**	**0.6**	27.0	28.0	28.0	**27.7**	**0.6**
March	4.0	6.0	30.0	**13.3**	**14.5**	6.0	6.4	7.5	**6.6**	**0.8**	26.0	26.0	28.0	**26.7**	**1.1**
April	5.0	6.0	20.0	**10.3**	**8.4**	7.8	7.8	8.4	**8.0**	**0.3**	20.0	21.0	22.0	**21.0**	**1.0**
X	**6.7**	**9.2**	**21.5**			**7.2**	**7.4**	**8.1**			**23.0**	**23.2**	**23.6**		
S	**6.2**	**6.3**	**4.2**			**0.7**	**0.8**	**0.5**			**3.0**	**2.8**	**3.5**		

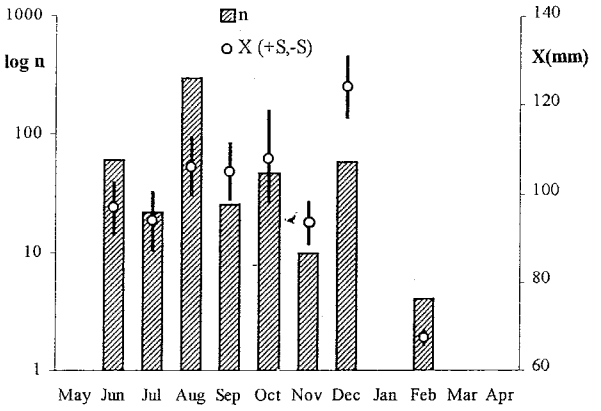

Fig. 3. Number (n), average length (X) and standard error (S) of individuals caught monthly during the study period in Guaratuba Bay.

Discussion

Because we never found mature or spent fish and corcoroca were primarily netted from June to December, we conclude that *P. corvinaeformis* comprises a migratory population at Guaratuba Bay. During their time of inhabiting the bay, they are most common in two regions: the mangrove (Chaves, 1998) and the estuarine zone near the entrance to the sea (present results). In the mangroves, generally, larger individuals are found than in the second one. Abiotical parameters vary between the study areas and so perhaps the population distribution can be explained by the continental and marine influences that occur in each area. Salinity is minimal when rainfall is maximal (January) in the tributaries feeding into the bay (late spring and summer). This corresponds to the time when *P. corvinaeformis* leaves the Bay and goes to the sea. Conversely, when

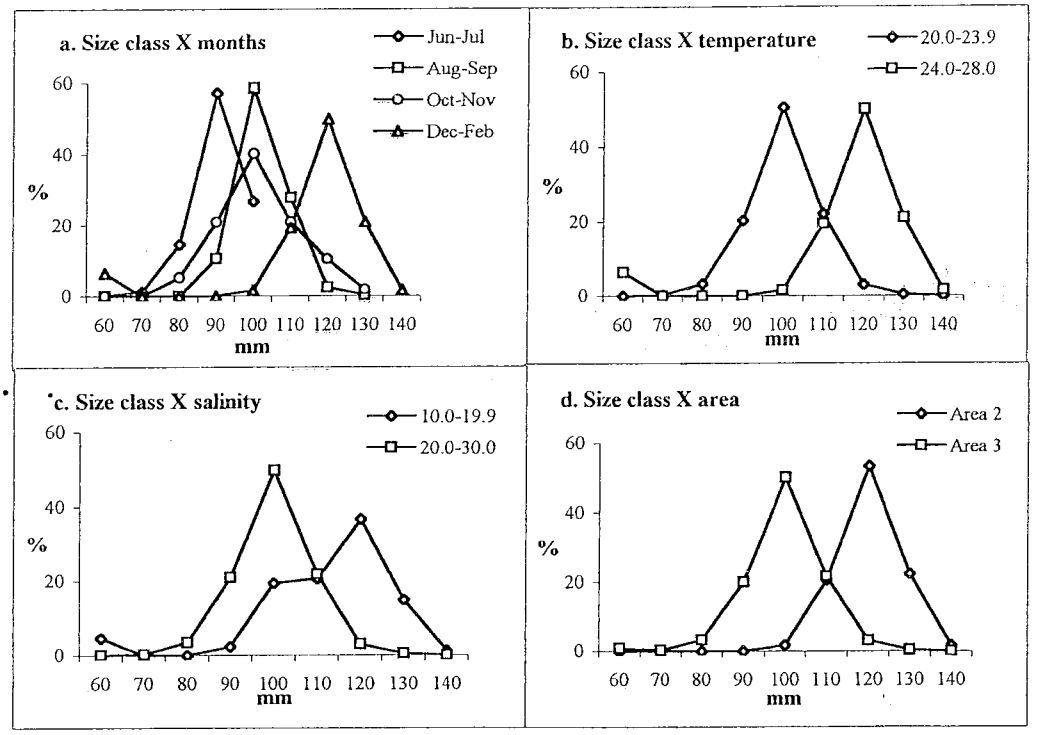

Fig. 4. Size class distributions of individuals (n=520) according to the: a) months of sampling; b) temperature (°C); c) salinity of the bottom water; and d) study area.

Table 2. Percentage of immature and maturing *P. corvinaeformis* individuals in each month. December: area 2; other months: area 3; n: number of observations.

	n	Immature (%)	Maturing (%)
June	8	100	0
July	5	100	0
August	267	100	0
September	26	100	0
October	37	100	0
November	10	100	0
December	53	48	52

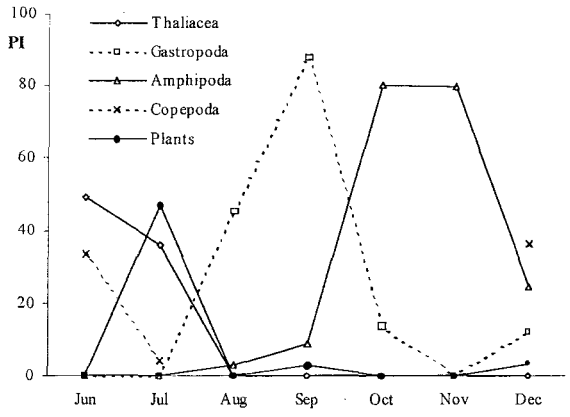

Fig. 5. Preponderance Index values distribution of the main food items of *P. corvinaeformis* in Guaratuba Bay, between June and December 1998. Size and number of specimens are in Table 3.

the rainfall is minimal (autumn/early winter), salinity is higher due to the increased marine influence in the bay. During this time, the pre-adults (and probably also juveniles) enter the estuary. This suggests that Guaratuba Bay is used during growth of individuals and acts as nursery area, as has been shown for other estuarine systems (Yáñez-Arancibia *et al.*, 1993). Earliest phases were not collected, probably because small, planktonic individuals are not netted at these depths and with the mesh size used. However, even during this time of suitable conditions for the fish, individuals never reach the inner areas of the Bay, but rather stay in and near area 3 (and very rarely to area 2), where marine conditions (greater salinity) is greatest. *P. corvinaeformis* does not appear to tolerate lower salinities. Another *Pomadasys* species, *P. commersonnii*, also does not tolerate lower salinities, due to variation in the water conductivity associated with pH levels rather than avoidance of elevated flows (Ter-Morshuizen *et al.*, 1996). *P. corvinaeformis* is most abundant along coastal areas of north-west Brazil (Fortaleza) during the rainy season, when salinities are low (Costa *et al.*, 1995). Conversely, inside Guaratuba Bay during similar conditions of high rainfall, the population size is minimal or non-existent. Thus, *P. corvinaeformis* enters the bay during periods of higher salinities and leaves the bay when salinities decline. Appearance in Guaratuba Bay (Fig. 6), therefore, seems to be influenced primarily by salinity.

Table 3. Preponderance Index of the stomach contents (except sand and non-identified material) of *P. corvinaeformis* by month, between June and December 1998. n: number of observations; TL: total length. Mysidacea and Non-Brachyura Decapoda were combined.

	Jun n=57 86≤TL ≤108mm	**Jul** n=17 78≤TL ≤100mm	**Aug** n=64 91≤TL ≤126mm	**Sep** n=20 95≤TL ≤120mm	**Oct** n=36 92≤TL ≤138mm	**Nov** n=6 88≤TL ≤100mm	**Dec** n=56 111≤TL ≤140mm
Polychaeta	< 0.1	2.1	50.4		0.8		0.2
Fish	1.8		0.2				10.8
Copepoda	33.5	4.3	0.5				36.3
Decapoda Brachyura							1.4
Non-Brachyura Decapoda and Mysidacea		3.4			2.9		4.7
Amphipoda			2.8	9.0	80.6	80.0	24.5
Tanaidacea			0.7				
Other Crustacea/larvae		2.1				20.0	5.0
Gastropoda			45.4	88.0	13.9		12.4
Bivalvia					0.4		1.0
Thaliacea	49.3	36.0					
Vitellogenic eggs					1.4		
Diatomacea Centrales	4.53						
Other Diatomacea	5.34						
Plants	< 0.1	43.9		3.0			3.5
Nematoids	5.49	8.1					

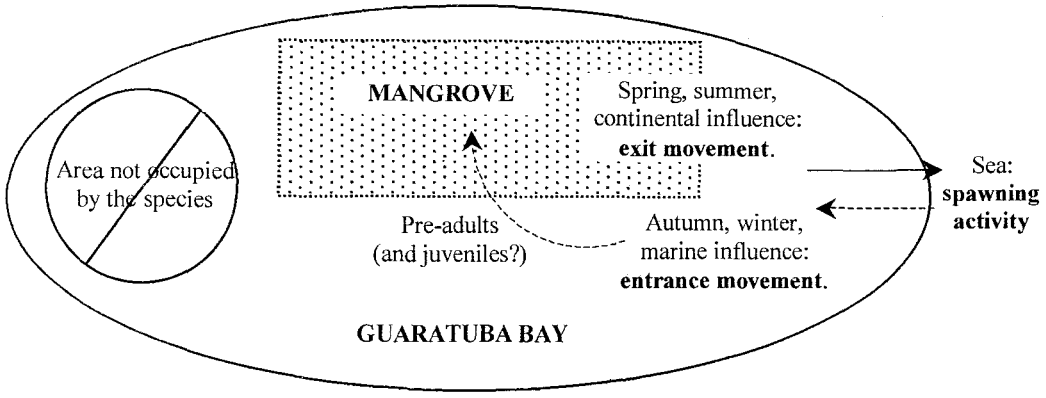

Fig. 6. Model depicting movements of *P. corvinaeformis* in Guaratuba Bay, as suggested by the results presented herein.

Gonad maturation of *P. corvinaeformis* occurs just prior to entry and during exit from the bay. Thus, these fish probably spawn at sea during summer, when salinities are lower in the bay. Another *Pomadasys* species, *P. jubelini* from the eastern Atlantic, may spawn in estuaries, but also has permanent populations in estuaries as well as in the ocean (Albaret, 1994). Size at first maturation is unknown. In *P. jubelini* from the eastern Atlantic, size at first maturation is estimated at 130 mm (males) and 160 mm (females), while all individuals are mature at 150 and 170 mm, respectively (Albaret, 1994). These results suggest that individuals found in Guaratuba Bay are probably juveniles and maturing adults. Mature adults are unlikely to return to the bay after spawning.

At Guaratuba Bay, *P. corvinaeformis* is omnivorous, preferring invertebrates over plants, algae and fish in its diet. At Fortaleza beach, this species eats, in order of abundance, Crustacea, Polychaeta, fish and algae (Costa *et al.*, 1995). Temporal and spatial variations in frequency of each food type are probably associated to food requirements by each size class, implying a plasticity of habits that is associated with migration movements between different regions.

Acknowledgements

We would like to thank two anonymous reviewers for their suggestions on how to improve the manuscript.

References

Albaret, J. -J. 1994. Les poissons, biologie et peuplements. In: Durand, J. R., Dufour, P., Guiral, D. & Zabi, S. G. F. eds. Environnement et ressources aquatiques de Côte-d'Ivoire, Tome II – Les milieux lagunaires. Paris, Éditions de l'Orstom. p.239-279.

Amanieu, M. & Lasserre, G. 1982. Organisation et évolution des peuplements lagunaires. Oceanologica Acta, n. sp: 201-213.

Araújo, F. G.; Cruz-Filho, A. G.; Azevedo, M. C. C. & Santos, A. C. A. 1998. Estrutura da comunidade de peixes demersais da Baía de Sepetiba, RJ. Rev. Brasil. Biol., 58(3):417-430.

Chaves, P. T. C. 1996. Atividade reprodutiva de *Bairdiella ronchus* (Cuvier) (Pisces, Sciaenidae) na Baía de Guaratuba, Paraná, Brasil. Revta bras. Zool., 12(4):759-766.

Chaves, P. T. C. 1998. Estrutura populacional de *Pomadasys corvinaeformis* (Steindachner) (Teleostei, Haemulidae) na Baía de Guaratuba, Paraná, Brasil. Revta bras. Zool., 15(1):203-209.

Chaves, P. T. C. & Bouchereau, J. -L. 1999. Biodiversité et dynamique des peuplements ichtyiques de la mangrove de Guaratuba, Brésil. Oceanologica Acta, 22(3):353-364.

Chaves, P. T. C. & Otto, G. 1999. The mangrove as a temporary habitat for fish: the *Eucinostomus* species at Guaratuba Bay, Brazil (25°52'S;48°39'W). Braz. Arch. Biol. Technol., Curitiba, 42(1):61-68.

Chaves, P. T. C.; Rickli, A. & Bouchereau, J. -L. 1998. Stratégie d'occupation de la mangrove la baie de Guaratuba (Brésil) par le Sciaenidae prédateur *Isopisthus parvipinnis* (Teleostei, Pisces). Cah. Biol. mar., 39(1):63-71.

Costa, P. S. R.; Santos, M. A. M.; Espínola, M. F. A. & Monteiro-Neto, C. 1995. Biologia e biometria do coró, *Pomadasys corvinaeformis* (Steindachner) (Teleostei: Pomadasyidae), em Fortaleza, Ceará, Brasil. Arq. Ciên. Mar, Fortaleza, 29(1-2):20-27.

Juras, A. A. & Yamaguti, N. 1985. Food and feeding habits of king weakfish, *Macrodon ancylodon* (Bloch & Schneider, 1801) caught in the southern coast of Brazil. Bolm Inst. oceanogr., S Paulo, 33(2):149-157.

Menezes, N. A. & Figueiredo, J. L. 1980. Manual de peixes marinhos do sudeste do Brasil. IV. Teleostei (3). Universidade de São Paulo, Museu de Zoologia. 96p.

Ter-Morshuizen, L. D.; Whitfield, A. K. & Paterson, A. W. 1996. Influence of freshwater flow regime on fish assemblages in the Great Fish River and estuary. South. Afr. J. Aquat. Sci., 22(1-2): 52-61.

Vazzoler, A. E. A. M. 1996. Biologia da reprodução de peixes teleósteos: teoria e prática. Maringá, EDUEM. 169p.

Yáñez-Arancibia, A.; Lara-Dominguez, A. L. & Day Jr, J. W. 1993. Interactions between mangrove and seagrass habitats mediated by estuarine nekton assemblages: coupling of primary and secondary production. Hydrobiologia, 264(1):1-12.

(Manuscript received 07 July 1999; revised 10 November 1999; accepted 24 April 2000)