THE ICHTHYOFAUNA OF THE MARGINAL LAGOONS OF THE SOROCABA RIVER, SP, BRAZIL: COMPOSITION, ABUNDANCE AND EFFECT OF THE ANTHROPOGENIC ACTIONS

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(With 3 figures)

ABSTRACT

The marginal lagoons of the Sorocaba River fulfil important functions in their lotic ecosystems and for its fish communities, providing shelter, food, and area for fish early stages of development. The lagoons are also an escape from the river pollution since the physical-chemical characteristics of their water are more stable than the river water. Nevertheless, these lagoons are under a series of impacts that contribute to reduce their diversity and stability such as water pollution, deforesting and river dumping. These impacts decrease habitat availability, and modify the fish community structure by reducing the number of species in the Sorocaba River, the floodplains and its marginal lagoons.

Key words: fish community, marginal lagoons, diversity, pollution, Sorocaba River.

RESUMO

As comunidades de peixes das lagoas marginais do Rio Sorocaba, SP, Brasil: a estrutura biótica e o efeito de fatores antropogênicos

As lagoas marginais do Rio Sorocaba desempenham importantes funções para o ecossistema lótico que margeiam e para sua comunidade de peixes, fornecendo abrigo, alimentação e local para desenvolvimento dos alevinos. Servem também como refúgios da poluição encontrada no Rio Sorocaba, já que as condições físico-químicas da água das lagoas são mais estáveis que as do rio. Apesar disso, essas lagoas estão sofrendo impactos causados por uma série de perturbações, como poluição da água, desmatamento e assoreamento, que contribuem para diminuir a diversidade e a estabilidade desses ambientes. Tais perturbações reduzem a quantidade de habitats, alterando a estrutura das comunidades de peixes, reduzindo a riqueza de espécies e prejudicando a sobrevivência e a reprodução de inúmeras espécies de peixes que utilizam tanto a calha principal do Rio Sorocaba, como as várzeas e as lagoas marginais.

Palavras-chave: comunidade, lagoas marginais, diversidade, poluição, ictiofauna e planície de inundação.

INTRODUCTION

The importance of marginal lagoons to the fish community and their role on the aquatic ecosystems are little emphasized (Welcomme, 1979; Lowe-McConell, 1975, 1987). Other authors, however, emphasized the relevance of such environment to the commercial fishing (Bonneto, 1985) as being highly productive (Petrere Jr. & Agostinho, 1993) and relevant to the maintenance

of fish species and of the fishing stock itself (Dioni & Reartes, 1975, *apud* Veríssimo, 1994).

The marginal lagoons are formed during the flooding period when the river invades lower areas. These lagoons are essential to fish reproduction considering that it is in the rainy season that millions of eggs and young larvae are carried into them, transforming them in natural fish nurseries. Furthermore, these areas are important to the early stages of fish development due to natural resources of food, especially plankton, and the number of shelters provided by aquatic macrophytes (Veríssimo, 1994).

Deforesting, river dumping and pollution may cause damage to the of marginal lagoons and to their important roles to the fish community. All these hazardous processes occur along the Sorocaba River, contributing to isolate the marginal lagoons from the river, reducing these habitats depth and sometimes leading to their elimination. The objective of this work is to study the composition and structure of fish communities in marginal lagoons of the Sorocaba River, as well as diagnose the environmental hazard to which these lagoons have been submitted.

MATERIAL AND METHODS

The Sorocaba River is the main affluent on the left margin of the Tietê River, which belongs to the Paraná River basin, Brazil, South America. This study was conducted in three areas on the margin of the Sorocaba River (Fig. 1), in the city of Sorocaba, São Paulo State, Brazil. Samples were collected during 1993, using a set of waiting nets with different mesh sizes (3, 4, 5, 7, 8, 10, and 12 cm).

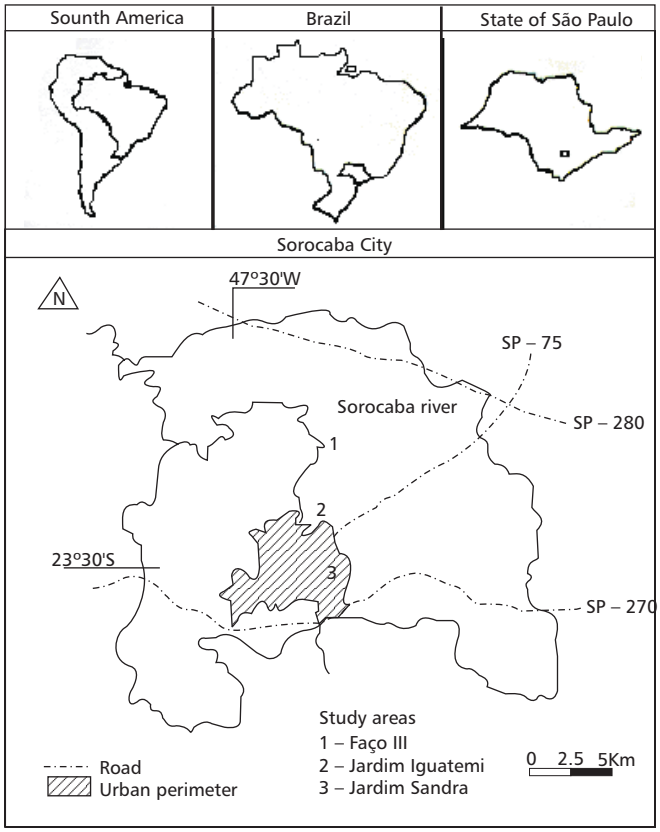

Fig. 1 — Location of the collecting stations along the Sorocaba River, SP, Brazil.

A casting net and a sieve were also used. The fishes were kept in formaldehyde and classified by identification keys (Britski, 1972; Britski *et al.*, 1984).

The quantity and biomass of collected species were determined in each collecting season. Dissolved oxygen, pH and temperature of the water were measured in three repetitions. The number of species was used as an indicator of richness in each lagoon. The diversity was calculated using the Shannon-Weaver (H') index for fish abundance and mass. Pearson's correlation was employed to determine the correlation between diversity and dissolved oxygen.

RESULTS AND DISCUSSION

Throughout this study, the dissolved oxygen levels were always higher in the water of the lagoon than in the Sorocaba River. In the lagoons, the figures oscillated between 5.8 and 8.1 mg/L of dissolved oxygen while the river dissolved oxygen levels oscillated between 1.3 and 5.6 mg/L. When the river water enters the city of Sorocaba (Jardim Sandra station – JS) it has 2.9 mg/L of dissolved oxygen. Due to the large quantities of domestic and industrial discharges the water becomes less oxygenated, thus dissolved oxygen level drops to 1.5 mg/L at Jardim Iguatemi station (JI). Further downstream (Faço III station – FC) most of the organic matter is cleared and the dissolved oxygen level rises to 5.6 mg/L. Lateral variation shows that the water of the lagoons remained well oxygenated along the study area when compared to the Sorocaba River water.

This fact contributes to the role of marginal lagoons as a refuge to the fish communities when there are hazard situations such as low dissolved oxygen levels in the river water due to domestic and industrial effluent discharges. But these refuges are not completely protected against impacts such as deforesting and river dumping which are the main modifying agents of these marginal lagoons. The shallow lagoons and the presence of large quantities of sediment in their bottom may be explained by the fact that the three study areas are deforested and clear of trees (Table 1).

The Table 1 shows a comparison of the Sorocaba River and the marginal lagoons in relation to environmental factors. The river is deeper than the lagoons, indicating that the lagoons were dumped due to poor vegetation protection along their margins. Macrophytes were present in larger amounts in the marginal lagoons than in the Sorocaba River, since better conditions were provided by it's lentic characteristics and nutrient retention. Temperature and pH were similar in both habitats while dissolved oxygen levels were higher in the lagoons, as it was presented above.

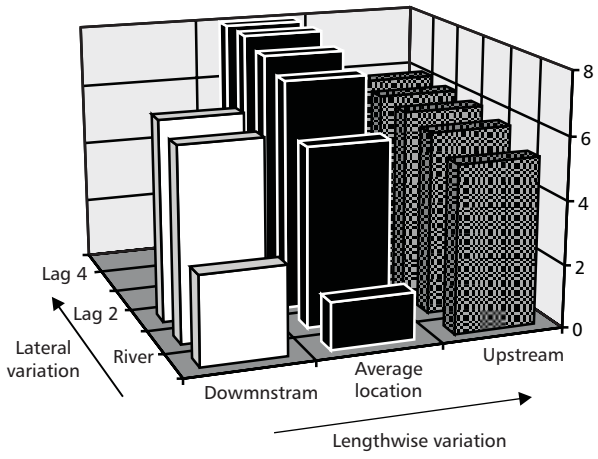

Fig. 2 — Amount of oxygen diluted (mg/L) on Sorocaba River and marginal lagoons, located on different areas.

TABLE 1
Comparison of environmental factors of the Sorocaba River and marginal lagoons.

Environmental factors	Sorocaba River	Marginal lagoons
Average depth	Four meters (dumped)	One meter (dumped)
Kind of layer	Rocky/muddy	Muddy
Macrophytes	Not abundant	Abundant, mostly *Salvinia* sp., *Elodea* sp. and water lilies
Ciliary woods	Reduced by deforestation	Reduced by deforestation
Dissolved oxygen	Low, subjected to varation	High, oscillating during the day
pH	6.7 to 7.5	6.5 to 7.8
Temperature	17.2 to 19.2°C	16.6 to 20°C

A total of 449 individuals were collected, summing 17 species. The most abundant species collected were*: Phaloceros caudimaculatus* and *Geophagus brasiliensis*. The most representative species in relation to biomass were *Prochilodus lineatus* and *Hoplias malabaricus* (Table 2).

The fish population of the lagoons composed of small sized species, such as guaru (*Phaloceros caudimaculatus*), pequira (*Cheirodon notomelas*), canivete (*Characidium fasciatum*), cará (*Geophagus brasiliensis*), tilápia (*Tilapia rendali*) and the lambaris (*Astyanax bimaculatus*) usually inhabits the lagoons margins and uses macrophytes such as *Salvínia* sp., *Elodea* sp. and water lilies for feeding, shelter and egg laying. It was observed a predominance of Characiformes in relation to the number of species, and a balance in the number of individuals among the orders Characiformes, Cyprinodontiformes and Perciformes.

The dominance of Characiformes species, mainly of small sized individuals is due to the fact that these species use more frequently the shelter supplied by macrophytes (Welcomme, 1979, 1985) and the dissolved oxygen present in the surface of the water column (Veríssimo, 1994).

The lagoons presented differences in species composition and its abundance. The Jardim Iguatemi station presented higher number of individuals followed by Jardim Sandra station.

This pattern was also observed for the large variety of collected species. Among the collected species only *Prochilodus lineatus* (curimbatá) and *Pimelodella* sp. (mandi) do not reproduce in lentic environments, being restricted to the Faço III and Jardim Sandra stations, that are connected to the Sorocaba River.

Reophylic species were not observed at the Jardim Iguatemi station due to their isolation. The differences observed in the lagoon ichthyofauna are due to their natural characteristics such as their size, habitat diversity and the influence of water-land ecotone. Besides that, anthropogenic actions such as the deforesting and earthworks may increase the differences between the lagoons. These impacts reduce the supply of branches and leaves, decreasing the availability of shelters and places for egg laying, as well as an increase in the lagoons dumping.

Abundance and biomass diversity in different lagoons are shown in Fig. 3. The diversity was higher in the Jardim Iguatemi lagoons. Comparing abundance and biomass diversity and dissolved oxygen levels it may be observed that there is a positive correlation between higher values of dissolved oxygen and high abundance and biomass (for abundance $r = 0.998$, and biomass $r = 0.915$ with $0.05 < p < 0.01$; $n = 3$).

The reverse is also true, reduced oxygen due to pollution or evaporation is a limiting factor for the survival of fishes in the marginal lagoons (Esteves, 1988; Veríssimo, 1994).

The reduction on environmental heterogeneity was more evident in the Jardim Sandra and Faço III lagoons than in the Jardim Iguatemi station. Since the river lowlands have a large diversity of habitats and niches of different fish species, it results on clear structural differences in the fish communities that live in the different habitats of an hydrographic basin (Barrella & Petrere Jr., 1994). This can explain why marginal lagoons of a given river might present differences in it's fish communities (Bonetto, 1985).

TABLE 2

Abundance (N), biomass in grams (P) and harvesting location of the collected species.

Species	JS (N)	JS (P)	JI (N)	JI (P)	FC (N)	FC (P)
Astyanax bimaculatus	8	100	13	35	4	30
Astyanax fasciatus	6	35	4	25	0	0
Astyanax scabripinnis	0	0	3	43	0	0
Acestrorhynchus lacustris	0	0	3	35	0	0
Cheirodon notomelas	0	0	47	50	0	0
Characidium fasciatum	0	0	45	16	0	0
Cyphocharax modestus	3	50	4	80	5	105
Prochilodus lineatus	0	0	0	0	8	2,970
Hoplias malabaricus	5	1,380	9	330	0	0
Pimelodella sp.	1	5	0	0	0	0
Hoplosternum litoralle	4	150	0	0	6	365
Gymnotus carapo	0	0	2	5	0	0
Hypostomus ancistroides	0	0	0	0	0	0
Phaloceros caudimaculatus	30	10	42	10	15	15
Poecilia vivipara	52	54	0	0	0	0
Geophagus brasiliensis	14	555	40	140	11	30
Tilapia rendalli	17	102	20	100	22	22
Hemigramus marginatus	0	0	35	13	0	0
TOTAL	140	2,441	238	911	71	3537

* JS – Jardim Sandra station; FC – Faço III station; JI – Jardim Iguatemi.

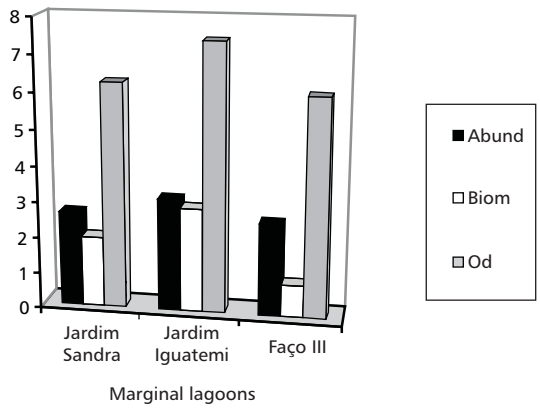

Fig. 3 — Comparison between variations in diversity for the abundance (abund), biomass (biom) and dissolved oxygen (od) in marginal lagoons.

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