Fish assemblage attributes in a small oxbow lake (Upper Paraná River Basin, São Paulo State, Brazil): species composition, diversity and ontogenetic stage.

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ABSTRACT: Fish assemblage attributes in a small oxbow lake (Upper Paraná River Basin, São Paulo State, Brazil): species composition, diversity and ontogenetic stage. The composition and diversity of fish species in a seasonally isolated small oxbow lake (area = 8,592 m^2), located in the transition zone between the Paranapanema River and the Jurumirim Reservoir (São Paulo State, Brazil), was studied from July/ 1998 to June/1999. Fish samples were taken monthly using three gear types: a 0.5mm-mesh sieve of 0.89m^2 in area; a seining net (width = 1.40m, length =10.0m, mesh size = 5mm); and gill-nets (1.5 – 3.5 cm between adjacent knots). Species composition and some ecological attributes (diversity, evenness, species richness) were determined for the study period (rainy and dry seasons), using the three gears. Fish caught in all gears were separated according to life stage (larvae, juvenile and adult). Some abiotic and environmental variables were determined in order to verify their correlation with the seasonal distribution of life stages in the study site. Species composition in this lake comprised four orders (Characiformes, Siluriformes, Gymnoformes and Perciformes), 11 families, 21 genera and 24 species. A total of 5,481 individuals were collected with a total weight of 27.53 kg. Characiformes dominated the samples. The Characidae species Serrapinus notomelas and Cheirodon stenodon, prevailed in number whereas the species Cyphocharax modestus, Hoplosternum littorale, Pimelodus maculatus, Prochilodus lineatus and Hoplias malabaricus predominated in weight. There were statistical differences between the dry and rainy seasons only for samples captured with seining net and gill-nets, with the latter presenting greatest diversity, evenness and species richness. A significant relationship among some abiotic variables (dissolved oxygen, suspended solids and conductivity) and biotic variables (life stages) were indicated by the first canonical function. In conclusion, the lentic zones formed by lakes and floodplains, which are found near big rivers, may seasonally offer ideal conditions, such as food and shelter, to most river fish species and thus, play an important role in sustaining the trophic network and increasing fish yield in the different ecosystems of riverine systems.

Key words: fish fauna, diversity, ontogenetic stage, oxbow lake, reservoir, transition zone.

RESUMO: Atributos da assembléia de peixes de uma pequena lagoa marginal (Bacia do Alto Paraná, Estado de São Paulo, Brasil): composição, diversidade e estádio ontogenético das espécies. No período de julho/1998 a junho/1999, estudou-se a composição e alguns atributos ecológicos (diversidade, equitabilidade e riqueza de espécies) das espécies de peixes de uma pequena lagoa marginal isolada (área = 8.592 m^2), na região de transição entre o Rio Paranapanema e a Represa Jurumirim (São Paulo, Brasil). Os peixes foram coletados mensalmente utilizando-se três tipos de aparatos: peneirão com área de 0,89m^2 (malhagem de 0,5mm); rede de arrasto (com comprimento de 10,0 m; altura de 1,40 m e malhagem de 5 mm); e uma bateria de redes de espera (com malhagens variando entre 1,5 a 3,5 cm entre nós adjacentes, tendo cada rede 20 metros de comprimento). Os dados desta assembléia de peixes foram analisados em cada estação (seca e chuvosa) do período de estudo. Também, os peixes amostrados foram separados de acordo com o estádio ontogenético (larvas, jovens e adultos). A abundância numérica destes indivíduos foi

correlacionada com variáveis abióticas no intuito de se verificar a possível relação entre a distribuição sazonal das larvas, jovens e adultos e tais variáveis. A composição das espécies desta lagoa compreende quatro ordens (Characiformes, Siluriformes, Gymnoformes e Perciformes), 11 famílias, 21 gêneros e 24 espécies, representada por um total de 5.481 indivíduos (com biomassa total de 27,53 kg). Constatou-se que os Characiformes foram numericamente mais abundantes. A família Characidae, representada por Serrapinus notomelas e Cheirodon stenodon dominou em número, enquanto que as espécies Cyphocharax modestus, Hoplosternum littorale, Pimelodus maculatus, Prochilodus lineatus e Hoplias malabaricus foram as mais representativas em peso. Para as amostras dos peixes capturados com rede de arrasto e de espera observaram-se diferenças estatisticamente significativas entre as estações seca e chuvosa, sendo que as amostras obtidas com redes de espera apresentaram maiores médias de diversidade, eqüitabilidade e riqueza de espécies. De acordo com a primeira função canônica, a distribuição sazonal das larvas e dos adultos está fortemente correlacionada com oxigênio dissolvido, materiais em suspensão e condutividade elétrica da lagoa. Pode-se concluir que as áreas lênticas constituídas por lagoas e planícies de inundação, encontradas próximas aos grandes rios, podem prover sazonalmente condições ideais como alimentação e refúgio, para a maioria das espécies de peixes fluviais, respondendo assim pela base de sustentação da rede trófica e pelo aumento da produtividade pesqueira nestes diferentes ecossistemas.
Palavras-chaves: fauna de peixes, diversidade, ciclo ontogenético, lagoas marginais, represa, zona de transição.

Introduction

Fish fauna and its lato sensu biodiversity are negatively affected by several factors such as reduction of riparian vegetation and forests, silting of water courses, draining of floodplains, introduction of exotic fish species (Orsi & Agostinho, 1999; Castro et al., 2003), and river damming for the construction of power plants (Tundisi & Barbosa, 1995; Carvalho & Silva, 1999).

Negative impacts of damming on fish communities are alterations in composition and structure (Fernando & Holcik, 1991; Carvalho & Silva, 1999), and inundation of oxbow lakes, which are nurseries for neotropical fish (Agostinho & Zalewski, 1995; Meschiatti et al., 2000).

Oxbow lakes favor aquatic organisms, specially fish, during all the life cycle or ontogenetic stage. Littoral zones of these lakes, with mosaics of aquatic macrophytes, are ideal for sheltering and development of several species (Vazzoler, 1996; Meschiatti et al., 2000). In addition, in the littoral zone, a great variety of food sources, such as periphyton and macroinvertebrates can be found in roots and leaves of macrophytes (Araújo-Lima et al., 1986; Junk et al., 1997).

According to Henry (1993; 2003), Carvalho et al. (1998; 2003) and Nogueira et al. (1999), the site located at the mouth zone of the Paranapanema River, into the Jurumirim reservoir, features a longitudinal transition zone where the oxbow-type marginal lakes, are permanently connected with the river. Therefore, lakes are crucial for the maintenance of the ecological equilibrium of the aquatic ecosystem and fishing activities of the area because they are nurseries and thus contribute to the replacement and conservation of the river/reservoir fish fauna (Meschiatti et al, 2000).

The aim of the study was to evaluate, in dry and rainy seasons, fish assemblage ecological attributes (species richness, Shannon diversity index, evenness and composition) and temporal distribution of life stages (larvae, juvenile and adult) from a small oxbow lake located in the mouth zone of the Paranapanema River into Jurumirim Reservoir (Upper Paraná River Basin, São Paulo, Brazil).

Study Site

The study site is one of the oxbow-type marginal lakes (Pompêo et al., 1997) located in the Paranapanema River upstream the Jurumirim Reservoir (23° 30'10" S and 48°42'35" W and 567.0 m altitude) near Bairro da Ponte, between the municipal districts of Paranapanema and Angatuba, State of São Paulo, Brazil (Fig. 1).

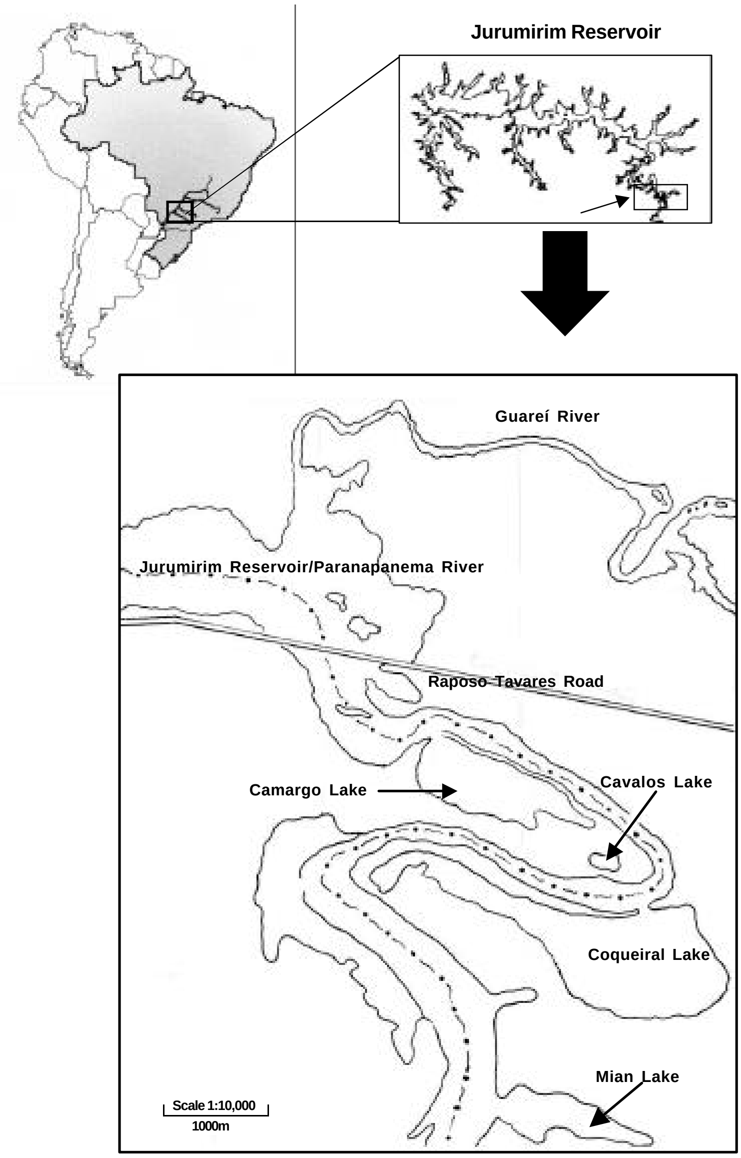

Figure 1: The Cavalos Lake in the Paranapanema River/Jurumirim Reservoir transition zone (Upper Paraná River Basin, São Paulo State, Brazil).

The small lake, named Cavalos Lake, lies isolated 60m from the Paranapanema River channel on its left bank. During flood peaks the lake may connect with the contiguous Camargo Lake. Afonso (2002) determined the morphometric and limnological characteristics of the lake and reported that during an atypically dry period, November 1999, it was slightly oval shaped, with an area of 3,361m^2 that could reach 8,592 m^2 if aquatic and terrestrial macrophytes (such as Brachiaria sp. and Eichhornia azurea among others) were computed. Maximum depth was approximately 2.4 meters during the rainy season (Afonso, 2002). In addition, zooplankton (Copepoda and Cladocera) as well as other invertebrates such as Gastropoda, Oligochaeta, Ephemeroptera and Chironimadae were observed in the lake (Henry, 2003). Moreover, this region is characterized by two distinct climatic seasons (dry and rainy). Rainfall data collected by the meteorological station located at hydroelectrical power plant “Engenheiro Armando Avellanal Laydner” (Piraju, SP), were used to confirm the duration of rainy (from September/1998 to February/1999) and dry (from July to August/1998 and, from March to June/1999) seasons. Further details on the limnological characteristics of the study site and its fish fauna can be found in Nogueira et al. (1999), Marcus (2000), Carvalho et al. (1998); Carvalho et al. (2003), Afonso (2002).

Material and methods

Fishes were monthly collected during two consecutive days, between July 1998 and June 1999, at Cavalos Lake. Three different fishing gears were used: 1) a 0.5 mm-mesh sieve with an area of 0.89m² was thrown in the aquatic macrophytes of the littoral zone, in the morning. The distance between the sample sites was approximately fifteen meters. The throw was made by a person that held the sieve horizontally and pushed for about 2 meters under the aquatic vegetation. Each one of these samples was obtained by throwing the sieve three times; 2) a “picaré”- type seining net (height = 1.40m, length = 10.0m and mesh size = 5mm) was used twice a day in the littoral zone of the lake; and 3) five 20m gill-nets with an area of 154.2 m² (1.5 to 3.5 cm between adjacent knots and 1.44 to 1.75 m heights) were set in the lake for an average of 18 hours (between 2 and 3 p.m. until 8 and 9 am).

Individuals caught by sieve and seining nets were kept in labeled plastic bags, and fixed in 40% formalin whereas those captured by gill-nets were kept in dry ice (carbon dioxide). In the laboratory, samples were sorted and kept in 4% formalin ($CaCO_3$ neutralized). Fish samples were deposited in the collection of the Department of Morphology, Botucatu, Institute of Biological Sciences- UNESP.

All fish species collected were identified according to Reis et al. (2003), scored, measured (standard lengths; cm) and weighed (body weight; g). The ecological attributes (Shannon-Weaver diversity, Pielou evenness and Simpson species richness indexes - Krebs, 1989) were used to compare seasonal variations between the fish assemblages. Student’s t-test (Magurran 1988) was used to statistically compare the Shannon- Wiener diversity indexes found in the rainy season with those observed in the dry season ($p > 0.05$).

Fish caught by all gears were separated in larvae, juvenile and adult individuals according to the proposed classification by Nikolski (1963, in Marcus, 2000). For some individuals, data on fish maturation reported for the Upper Paraná fish fauna basin by Vazzoller (1996) were used to separate juvenile from adult individuals. Eight abiotic variables (water temperature, dissolved oxygen, pH, electrical conductivity, suspended solids, Secchi disk, precipitation and relative water level) were determined monthly, according to Nogueira et al. (1999).

Canonical Correlation Analysis (Gittins, 1985) was applied in order to determine relationships between the abundance of fish according to life stages (larvae, juvenile and adult) and abiotic variables. The performed analysis was based on: 1) a numerical abundance data matrix, which included the larvae, juvenile and adult densities during one year per sampling site and; 2) the eight abiotic variables variables for the studied period. Data matrices (abiotic and biotic variables) were processed separately in order to compute the correlations between all variables.

Results

The species composition observed in the study lake comprised four fish orders (Characiformes, Siluriformes, Gymnoformes and Perciformes), 11 families, 21 genera and 21 native species (Tab.I). Characiformes (with 19 species and one unidentified individual, sub-family Tetragonopterinae) were notably the most dominant in number and biomass, followed by Siluriformes (02), Perciformes (01) and Gymnotiformes (01).

A total of 5,481 individuals which weighed 27.535 kg were caught. Characidae was the greatest in number and biomass. Among the captured species, S. notomelas and C. stenodon (subfamily Cheirodontinae) were the most numerous whereas C. modestus, H. littorale, P. maculatus, P. lineatus and H. malabaricus showed the highest biomass (Tab.I).

Table I: Species name, order, family/subfamily, species rank *, number (n) and biomass (Kg) of the fish collected in the year of study, at Cavalos Lake.

Species	Order	Family/subfamily	Rank*	n	Kg
Serrapinus notomelas	CH	Cheirodontinae**	sp1	2,808	1.207
Cheirodon stenodon	CH	Cheirodontinae **	sp2	1,008	0.422
Cyphocharax modestus	CH	Curimatidae	sp3	396	6.941
Hyphessobrycon anisitsi	CH	Tetragonopterinae**	sp4	369	0.169
Astyanax altiparanae	CH	Tetragonopterinae**	sp5	193	0.344
Hyphessobrycon sp	CH	Tetragonopterinae**	sp6	137	0.035
Serrasalmus spilopleura	CH	Characidae	sp7	107	0.931
Steindachnerina insculpta	CH	Curimatidae	sp8	99	1,318
Hoplosternum littorale	SI	Callichthyidae	sp9	78	5.416
Pimelodus maculatus	SI	Pimelodidae	sp10	49	3.888
Oligosarcus paranensis	CH	Characidae	sp11	49	0.162
Hoplias malabaricus	CH	Erythrinidae	sp12	38	2.024
Prochilodus lineatus	CH	Prochilodontidae	sp13	33	2.891
Astyanax fasciatus	CH	Tetragonopterinae**	sp14	27	0.078
Leporinus obtusidens	CH	Anostomidae	sp15	24	0.402
Characidium fasciatum	CH	Characidae	sp16	20	0.022
Geophagus brasiliensis	PE	Cichlidae	sp17	14	0.370
Galeocharax knerii	CH	Characidae	sp18	9	0.245
Odontostilbe microcephala	CH	Tetragonopterinae**	sp19	7	0.006
Schizodon nasutus	CH	Anostomidae	sp20	6	0.471
Gymnotus cf sylvius	GY	Gymnotidae	sp21	5	0.134
Salminus hilarii	CH	Characidae	sp22	2	0.047
Apareiodon affinis	CH	Parodontidae	sp23	1	0.009
Leporinus striatus	CH	Anostomidae	sp24	1	0.001
Tetragonopterinae**	CH	Characidae	sp25	1	›0.001
Total				5,481	27. 535

CH = Characiformes. SI = Siluriformes. PE = Perciformes. GY = Gymnotiformes

*Based on total number by specimens; ** Subfamily of Characidae.

Considering the number of fish caught, seining net was the most efficient gear in both seasons, with 73 % of the individuals (= 4,043 specimens of small size with relative weight of 1% = 2.84 kg) whereas gill-net was the most efficient in relative weight (89% of relative weight = 24.35 kg of medium and large-sized species but not in number - 12% of relative number = 641 individuals). However, for sieve fishing, relative frequency in number and weight were, respectively, 15% (= 797 individuals) and 10% (= 0.39 kg).

Specimens of 19 species were captured with the seining net. S. notomelas – sp1 (56.44% and 37.61% in number and weight, respectively) and C. stenodon – sp2 (20.68% and 13.13% in number and weight, respectively) were the most abundant species both in number and weight (Fig. 2A).

Sixteen species were caught by gill-nets. C. modestus – sp3 (44.15%) and H. littorale – sp9 (12.01%) prevailed in relation to the others and presented the highest biomass (27.19% and 22.24%, respectively) (Fig. 2B).

Among the fish collected with sieve, 11 species were identified. The most numerous species were S. notomelas – sp1 (66.04%) and C. stenodon– sp2 (21.55%). S. notomelas also showed the highest weight values (40.79%) followed by H. malabaricus – sp12 (31.39%) (Fig. 2C).

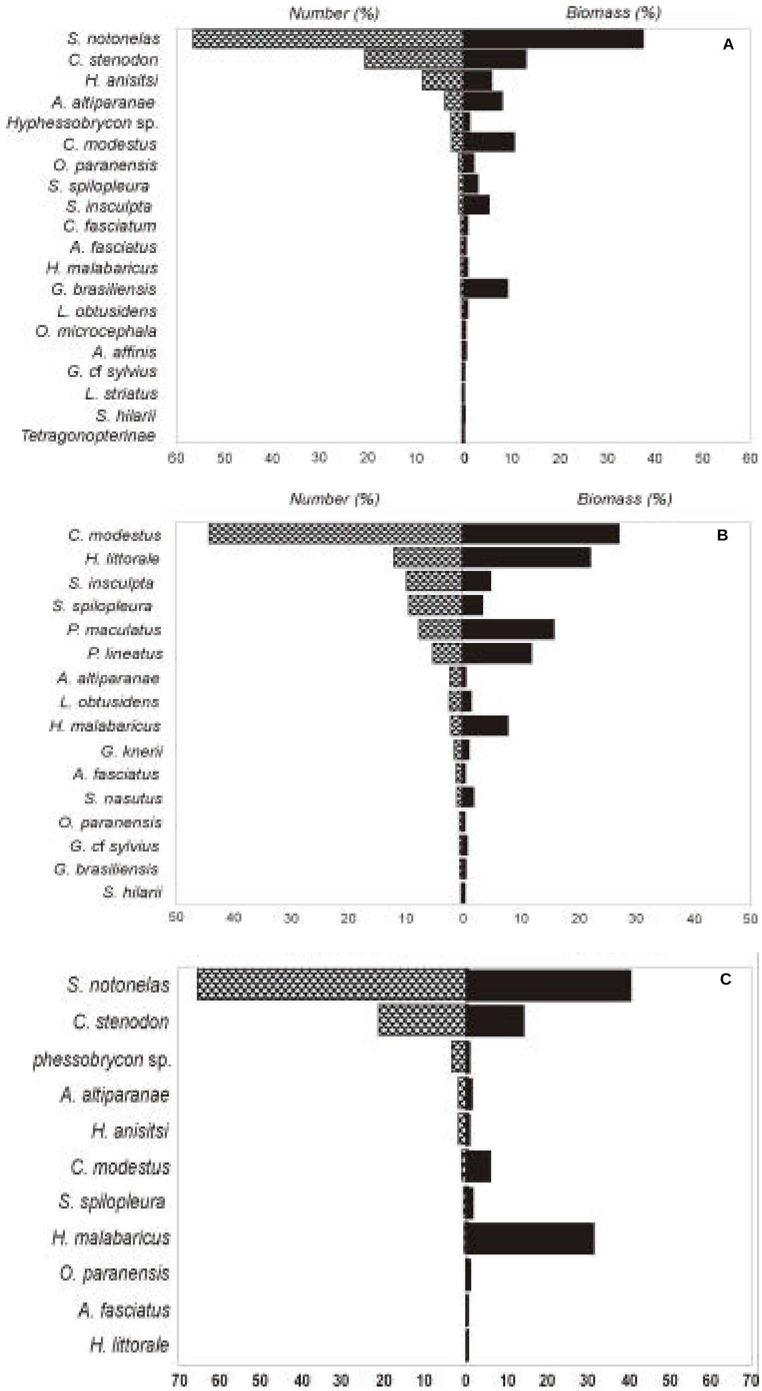

Figure 2: Relative frequency in number and biomass of the fish species collected in the sampled period, at Cavalos Lake. A : Seining-net; B: Gill-net; C: Sieve.

Throughout the sampling period, five species were caught exclusively with seining-net (C. fasciatum – sp16, Odontostilbe microcephala – sp19, A. affinis – sp23, L. striatus – sp24, and an individual of the Tetragonopterinae subfamily – sp25) and four were captured only with gill-nets (P. maculatus – sp10, P. lineatus – sp13, G. knerii – sp18, and S. nasutus – sp20). No species was caught exclusively by sieve (Fig. 2).

The t-test revealed statistical differences (P› 0.05) in the Shannon-Wiener diversity index between seasons (rainy and dry) for seining-net and gill-nets, with higher values during the rainy season for both gears (Tab.II).

Table II: Evenness (E'), Simpson species richness (r), total number of species (n) and total number of individuals (N) for the samples collected according to gears, in the dry and rainy seasons.

Fishing gear	**H'**		**t**	**D.F.**	**P**
	dry	**rainy**			
Seining-net	1.86*	2.09*	4.117	3.931	‹ 0.001
Gill-net	2.38*	3.09*	5.501	472	‹ 0.001
Sieve	1.54	1.46	0.704	756	0.481

t (t estimated); D.F. (degrees of freedom); * (P ‹ 0.05).

Evenness was high in gill-net catches in the rainy season (0.79) and lower in the dry season (0.60). For the other gears, means were lower in both seasons (Tab.III). The highest Simpson species richness values (r) were observed during the rainy season in all gears when compared with the dry season (Tab. III). In relation to the number of species collected, seining-net yielded a higher value during both periods (Tab.III).

Table III: Evenness (E'), Simpson species richness (r), total number of species (n) and total number of individuals (N) for the samples collected according to gears, in the dry and rainy seasons.

Fishing gear	**Season**	**Icthyofaunistic attributes**			
		E'	**r**	**n**	**N**
Seining-net	Dry	0.46	1.48	17	1782
	Rainy	0.49	1.61	19	2261
Gill-net	Dry	0.60	1.68	16	470
	Rainy	0.79	1.88	15	171
Sieve	Dry	0.51	0.81	8	397
	Rainy	0.44	1.04	10	400

The first component of the canonical correlation was 0.998 and was highly significant (p=0.000288). This means that 91% of the variability of the canonical abundance variable (linear combination of the abundances) is explained by the canonical variable of the abiotics factors.

The correlation of the abiotic factors canonical variables with abundance are presented at the top of Tab.IV, and the correlation of the abiotic canonical variables with themselves are shown at the bottom of the same table. The canonical variable (Bio1) is positively correlated with dissolved oxygen (0.723), and negatively correlated with suspended solids (-0.689) and conductivity (-0.551).

Therefore, these variables influenced the abundance distribution, specially for larvae (r=-0.513) and adult (r=0.869) (Tab.IV). Then, adults were more abundant when dissolved oxygen was high and less abundant when suspended solids and conductivity were high. High larvae abundance was correlated with suspended solids and conductivity. Juvenile fish abundance does not seem to correlate with the abiotic factors.

Table IV: Respective correlations of biotic (ontogenetic stage evaluated by seining-net and sieve numerical abundance) and environmental variables on the first canonical variable.

Variables	**Linear Combination**
Abundance	**Bio1**
Larvae	-0.513
Juvenile	-0.018
Adult	0.869
Abiotic factors	**Abio1**
Water temperature	-0.156
Dissolved oxygen	0.723
pH	-0.195
Electrical conductivity	-0.551
Suspended solids	-0.689
Secchi depth	0.356
Precipitation	-0.407
Relative water level	-0.089

Discussion

The ichthyofauna of South American rivers and non-estuarine small streams is mainly composed by Siluriformes and Characiformes, being the latter slightly more numerous (Lowe-McConnel, 1999; Castro et al., 2003). However, synchronism between these orders may be less pronounced in lentic environments where Characiformes are likely to be more abundant (Marcus, 2000).

Carvalho et al. (1998), studying three lakes connected to the Paranapanema River, collected 32 native species belonging to 25 genera, 11 families and 11 orders, with gill-nets and sieve. However, in this single small lake (Cavalos Lake), we collected 24 (21 genera, 11 families and 04 fish orders) of the 32 native species mentioned above with a seining net besides gill–nets and sieve.

Castro et al. (2003) sampled tributaries on both sides of the Paranapanema River Basin and caught 52 species, 37 genera, 16 families and 06 orders of fish. They captured 10 of 11 eleven families collected in the study lake, except Prochilodontidae (Prochilodus lineatus, which is large-sized and migrates long distances). Furthermore, in our study, the presence of exotic/introduced species Oreochromis niloticus, Tilapia rendalli and Poecilia reticulata captured by Castro et al. (2003) was not observed.

In Jurumirim Reservoir, 49 species belonging to 17 families of 06 orders (Characiformes, Siluriformes, Gymnotiformes, Synbranchiformes, Perciformes and Cypriniformes) were registered. Forty-six of these species are native (two were reintroduced: Piaractus mesopotamicus and Leporinus obtusidens; one was transferred: Hoplias cf. lacerdae; and two were exotics species: Oreochromis niloticus and Cyprinus carpio) (Carvalho et. al., in press).

In a small lake, such as Cavalos Lake, which is seasonally isolated from the river, the smaller number of species observed than that reported by Carvalho et al. (1998) may be explained by the absence of a continuous river/lake connectivity that favors ichthyofauna. Therefore, Cavalos Lake may be considered an important biotope for fish, in the site where the Paranapanema river flows into the Jurumirim Reservoir.

Gill-nets are known to be selective in terms of fish size and consequently species (Carvalho et al., 1998; Carvalho & Silva, 1999; Mellado et al., 2002). In order to minimize this selective effect, we opted to use other gears such as sieve and seining-net. However, in lentic environments, gill-net has proved to be efficient in catching mid to big-sized individuals of significant importance (Silvano & Begossi, 2001).

Sieves are used mainly to catch small-sized organisms (egg, larvae and juvenile) which very often inhabit aquatic macrophytes in shallow areas (Pavanelli & Caramaschi, 1997; Nakatani et al., 2001). Yet, the largest number from small to mid- sized individuals was caught with a seining-net, specially in aquatic macrophytes located at both, the surface and midwater.

Shallow littoral areas located near margins at the water/land interface zone very often present a strip of aquatic plants that enhance environmental complexity (Ward et al., 1999) and therefore provide habitats for feeding, sheltering and reproduction for several fish species, different from that of open waters (Pompêo et al., 1997; Nogueira et al., 1999). Fish species prefer habitats that favor feeding and reproduction and offer sheltering in adverse conditions (Lowe- McConnell, 1999). In lentic waters such as river backwaters, lakes and floodplains with aquatic macrophytes, a great diversity of fish species (of small size) can be found, mainly Tetragonopterinae and Cheirodontinae - (Delariva et al., 1994; Carvalho et al., 1998; Carvalho et al., 2003).

In seining-net catches, the species H. anisitsi and A. altiparanae were numerous. This high frequency may be related to the great mobility of these species, specially while feeding (Agostinho et al., 1997) or even to the fact that they are found on the surface and/or midwater, around the marginal aquatic vegetation (Marcus, 2000).

In relation to calculated assemblage attributes, Carvalho et al. (1998) found in others lakes and in the river of this same transition zone, higher values of Shannon diversity index and evenness in gill- net catches than in sieve catches. For Pavanelli & Caramaschi (1997), these higher values are due to the homogeneity of the fauna caught with gill-nets.

In gill-net catches, Shannon diversity index was greater in the rainy season. However, in comparison with the dry season, the number of specimens captured was smaller. This may be due to species distribution which is more homogeneous (greater evenness) during the rainy season.

Some authors reported that lower diversity is associated with low evenness and species richness, reflecting an ecosystem dominated by a small number of species (Barretto & Uieda, 1998). Delariva et al. (1994) suggest that low diversity values are consequent of the high dominance by small fishes, as Cheirodon stenodon and Serrapinus notomelas, in the aquatic macrophytes of the Upper Paraná River floodplain. For these authors, the conditions found in lentic environments may restrict the presence of non adjusted species while others become abundant.

Thus, the lower diversity values found in both sieve and seining-net catches may be related to the remarkable presence (=dominance) of S. notomelas (= Cheirodon notomelas) and C. stenodon in this lake.

Barreto & Uieda (1998) showed the strong correlation between fish fauna composition and abiotic variables in a tributary from Tiête River. Carvalho et al. (1998) using canonical correlation analysis showed that some abiotic factors (conductivity and temperature) were correlated with larvae and adults numerical abundance in lakes nearby the Paranapanema River/Jurumirim Reservoir transition zone. In this work, the canonical correlation analysis between fish fauna abundance and abiotic variables showed that dissolved oxygen, suspended solids and conductivity are the most correlated factors with larvae and adult abundance in Cavalos Lake.

Pianka (1994) argues that numerical abundance and species richness are not the only way of estimating the importance of species within a community. Others methods can be employed, for example, the species importance curves (Carvalho & Silva, 1999). Thus, space sharing and food resources by fish assemblage dwelling in the Cavalos lake, should be studied further as a different condition in the dominance of trophic guilds (number and biomass) was clearly observed (Tab.I and Fig. 2). For instance, the species S. notomelas, classified as algivorous, prefers filamentous and periphitic algae (Silva, 2002) whereas Cyphocharax modestus, as a detritivorous species (Carvalho & Silva, 1999), catches most of its food from aquatic macrophytes detritus in this lake (Afonso, 2002).

In conclusion, the lentic zones formed by lakes and floodplains, which are found near big rivers, may seasonally offer ideal conditions, such as food and shelter, to most river fish species and thus, play an important role in sustaining the trophic network and increasing fish yield in the different ecosystems of riverine systems. According to the present study associated with others (Carvalho et al., 1998; Carvalho et al., 2003) fish diversity found in the oxbow lakes from the Paranapanema River/Jurumirim Reservoir complex have a high ecological relevance and may sustain fishing activities in this hydrographic basin. Furthermore, the loss or severe impacts on these ecosystems may also affect the equilibrium and integrity of the fish fauna found.

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