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ICHTHYOFAUNA ASSOCIATED TO AQUATIC MACROPHYTES IN THE UPPER PARANA RIVER FLOODPLAIN

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ABSTRACT. The ichthyofauna of the macrophyte banks in different environments of the upper Paraná River floodplain (Rivers Ivinheima, Paraná and Baía, Cortado Channel, Patos and Guaraná Lakes) is analysed with regard to its specific composition and abundance. Sample collecting undertaken from March 1992 to February 1993 with a rectangular sieve measuring 1.0m x 1.5m and a 500 µm mesh resulted in the capture of 3,485 specimens pertaining to 30 species and 14 families of teleosts. In these biotopes the dominant species were *Cheirodon notomelas*, *Cheirodon* sp, *Moenkhausia intermedia* and *Aphyocharax nasutus*, representing 86% of total catches. The last two mentioned species were constant in lentic and lotic environments whilst the former were constant in environments with lentic characteristics. Higher diversity values were recorded in lotic environments. Grouping analysis with regard to ichthyofaunic composition revealed groups of environments with similarity in water velocity, concentration of oxygen and pH values but with little likeness with regard to the specific composition of the macrophyte bank, bottom type and conductivity. Half of the species was recorded only in their juvenile forms although young specimens of big-sized species have low occurrence. Thus, the importance of the banks of macrophytes for the development of young specimens of migratory big-sized species in the high Paraná River basin still lacks comprobatory evidence.

Key words: ichthyofauna, aquatic macrophytes, diversity, Characiformes, Siluriformes.

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ICTIOFAUNA ASSOCIADA ÀS MACRÓFITAS AQUÁTICAS NA PLANÍCIE DE INUNDAÇÃO DO ALTO RIO PARANÁ

RESUMO. Neste estudo, a ictiofauna dos bancos de macrófitas, em distintos ambientes da planície de inundação do alto Paraná (rios Paraná, Ivinheima, Baía, canal Cortado e lagoas dos Patos e Guaraná), é analisada quanto à sua composição e abundância específica. Amostragens realizadas durante o período de março de 1992 a fevereiro de 1993, com o uso de um peneirão retangular com dimensão de 1,0 X 1,5 m e malhagem de 500 μm resultaram na captura de 3.485 exemplares, pertencentes a 30 espécies e 14 famílias de teleósteos. As espécies dominantes nestes biótopos foram Cheirodon notomelas, *Cheirodon* sp, *Moenkhausia intermedia* e *Aphyocharax nasutus* que representaram 86% das capturas totais, sendo as duas últimas constantes em ambientes lênticos e lóticos e as primeiras naqueles com características lênticas. Valores mais altos de diversidade foram registrados nos ambientes lóticos. A análise de agrupamento conforme a composição ictiofaunística revelou grupos de ambientes com similaridade na velocidade da água, concentração de oxigênio e valores do pH, sendo pouco semelhantes quanto à composição específica dos bancos de macrófitas, tipo de fundo e condutividade. Metade das espécies foram registradas apenas em suas formas juvenis, e jovens de espécies de grande porte tiveram baixa ocorrência. Assim, a importância destes bancos de macrófitas para o desenvolvimento de juvenis das espécies migradoras de grande porte na bacia do alto rio Paraná ainda carece de comprovação.

Palavras-chave: ictiofauna, macrófitas aquáticas, diversidade, Characiformes, Siluriformes.

INTRODUCTION

The remaining parts of the "varzeas" of the high Paraná River have been considered fundamental for the development of the juvenile forms of fish, which are the object of fisheries in the river channel and in the Itaipu reservoir (Agostinho *et al.*, 1993b; Agostinho *et al.*, 1994).The heterogeneity of the habitat provided by these ecotones, together with the dynamics of the flood regimen permits the fauna diversity still found in the basin. The fact that these areas are being submitted to a continuous process of degradation and destruction by the improper use of water, principally through agropastoral projects and the construction of hydroelectric plants, urgently requires the development of research in the area (Agostinho & Zalewski, forthcoming).

Aquatic macrophytes, an important component of the complex formed by these environments, and whose importance for the ecological system's metabolism was described by Esteves (1988), have been considered as a shelter against excessive preying and as feeding substratum of juvenile forms of big fish or of small foragers (Lowe-McConnell, 1987; Welcomme, 1979; Agostinho, 1993). However, studies on the composition of ichthyofauna associated to this vegetation are rare, and published data refer to particular species of macrophyte (Cordiviola de Yuan et al, (1984), Junk (1973). This paper deals with the composition of the assemblages of fish linked to this type of vegetation and its spatial-temporal variations.

MATERIAL AND METHODS

Monthly samplings were undertaken between March 1992 and February 1993 in six stations distributed in the floodplain of the Paraná River in the vicinity of the municipalities of Porto Rico - PR, (Figure 1). Stations consisted of two lakes (Patos and Guaraná), two channels (Baía and Cortado) and two rivers (Paraná and Ivinheima).

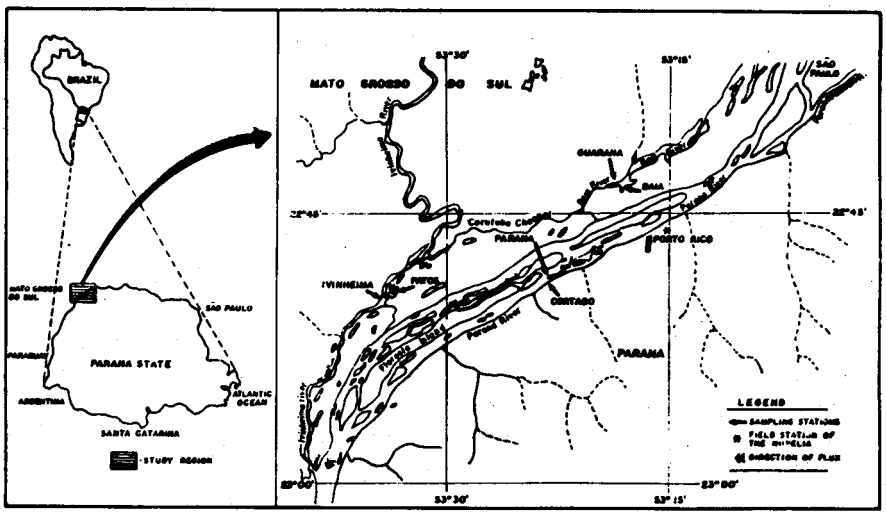

Figure 1: Localization of sampling stations

Ichthyofauna associated to aquatic macrophyte banks in each site was sampled by a rectangular 1.5m x 1.0m sieve with 500 μm mesh between 16:00 and 18:00 hours. Samples were fixed in 4% formaldehyde, conditioned in labeled polyethylene flasks and sent to the laboratory for identification and counting.

Abundance of aquatic macrophytes was visually evaluated through the covered area base and specific identification was made from species collected and examined in the laboratory.

Regarding the physical and chemical characteristics of sampling stations, values of water temperature, pH, dissolved oxygen, electrical conductivity and bottom type were determined on each occasion. Temperature was taken instantly by a mercury column thermometer. Samplings for other determinations were obtained by a Van Dorn (water) bottle and Van Veen bottom recipient. Concentrations of dissolved oxygen were determined by Winkler's method, modified by Golterman *et al.*, (1978), while pH values and conductivity (μS/cm) were obtained with a portable pHmeter and digital conductivity-meter respectively. Samplings of sediment were submitted to analysis methods of sieving and pipetting described by Suguio (1973).

Specimens were identified by taxonomic keys proposed by Ringuelet *et al.*, (1967), Britski (1972), Gery (1977) and Itaipu Binacional (1981).

Differences between proportions in the number of species represented by the main taxonomic groups of Osteichthyes captured inside and outside the aquatic macrophyte banks were tested by χ^2.

Diversity in each site was analysed by the Shannon-H' (Pielou, 1975) diversity index, expressed by the equation:

$$H' = \Sigma (n_i / N) . \log (n_i / N)$$

where:

n i = the number of individuals of species i;

N= total number of specimens.

Equitability, one of the components of Shannon's index, was determined by the formula E = H'/ log S, where S is the number of species.

Spatial and temporal variations in the specific composition in each sampling site were analysed on the basis of the relative frequency of species in captures. Composition was related to the environmental conditions effected by graphic outlines. With regard to the ichthyofauna composition, similarity between sampling sites was evaluated by the calculation of the Euclidian Distance applied to the data of species frequency in each site.

Each species was classified as constant, accessory or accidental (Bodenheimer, 1955 and Balogh, 1958 apud Dajoz, 1983), according to their constancy in the sampling community.

RESULTS

Survey of associated ichthyofauna

Sampling resulted in the capture of 3,485 specimens pertaining to 14 families and 30 species (appendix I) according to the classification of Britski (1972) and Nelson (1984).

The proportion of the number of species between the orders of Osteichthyes registered in the region shows that ichthyofauna associated to the banks of aquatic macrophytes differs significantly ($\chi^2 = 19.8$; GL = 4; $p > 0.05$) from that recorded by captures in nets in open areas (Table 1)

Table 1: Number of species of different orders of Osteichthyes captured within or outside the aquatic macrophytes in the floodplain of the Paraná River.

Order	Macrophyte Banks		Other Areas *	
	n. of species	%	n. of species	%
Characiformes	21	70.0	38	50.0
Siluriformes	6	20.0	28	36.8
Perciformes	3	10.0	7	9.2
Rajiformes	0	0	2	2.6
Pleuronectiformes	0	0	1	1.3

* Report of FUEM/CIAMB-PADCT (1993).

$\chi^2_{calc} = 19.8$

$\chi^2_{0,05,\ 4} = 9.49$

The great variety of the species of the Characiformes order in relation to that of the Siluriformes order was the determining factor of this difference. Predominance of Characiformes was even more salient in the number of captured specimens since this group contributed 98.9% of the captured specimens (Siluriformes: 0.9%; Perciformes: 0.2%).

Abundance and constancy of the species

Frequency of capture of species for each sampling site is shown in Figure 2. The species with higher contribution in the catches were: *Cheirodon notomelas* (31.5%), *Cheirodon* sp (27.4%) and *Moenkhausia intermedia* (19.3%) which approximately totalled 3/4 of total captures. Besides *Aphyocharax nasutus* and *Hemigrammus marginatus*, these species were the only ones (among the 30 recorded species) occurring in all stations.

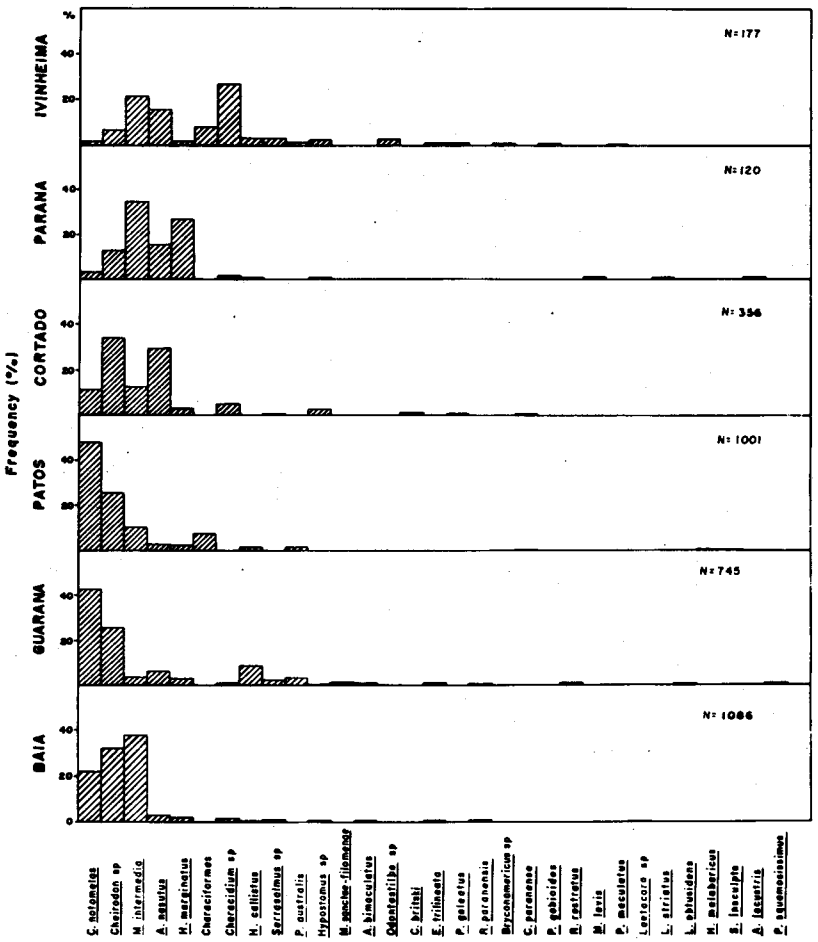

Figure 2: Frequency of species abundance recorded in the aquatic macrophyte banks sampling stations.

Table 2 shows the constancy of species in the different sampling stations and in all stations considered together. Only three species out of 30 were constant in the 72 samples taken (as registered in at least half of them). *Cheirodon notomelas* and *Characidium* sp were considered accessory as is shown by the fact that they occur in 25% to 50% of samples. The other species, including all the juvenile forms of medium and large size species, were considered accidental (as registered in less than 18 samples).

Analysis of specific constancy in each sampling station shows that *M. intermedia* and *A. nasutus*, respectively the third and fourth most abundant species, were constant in most sampling stations. However, the two species that were dominant in captures, *C. notomelas* and *Cheirodon* sp, were more characteristic of macrophyte banks of the environment with lower water renovation (lentic), such as Guaraná, Patos and Baía. *Hypostomus* sp and *Characidium* sp were constant only in the Cortado station, whilst *H. callistus* was constant in the Guaraná station. The macrophyte banks of the Paraná River had only *M. intermedia* as constant.

Table 2: Constancy of species in samples taken in aquatic macrophyte banks in different sampling stations of the Paraná River floodplain.

SPECIES	N	TOTAL	BAIA	GUARANÁ	PATOS	CORTADO	PARANÁ	IVINHEIMA
C.notomelas	1097							
Cheirodon sp	956							
M.intermedia	671							
A.nasutus	257							
H.marginatus	115							
Characiformes*	88							
H.callistus	86							
Characidium sp	85							
P.australis	36							
Serrasalmus sp	26							
Hypostomus sp	24							
M.sanctae-filomenae	8							
A.bimaculatus	5							
Odontostilbe sp	5							
C.britski	3							
E.trilineata	3							
P. galeatus	3							
R.paranensis	2							
Byconamericus sp	2							
C.paranaense	2							
P.gobioides	1							
R.rostratus	1							
M.levis	1							
Laetacara sp	1							
L.striatus	1							
L.obtusidens	1							
H.malabaricus	1							
S.insculpta	1							
A.lacustris	1							
P.maculatus	1							
P.squamosissimus	1							

=constant = accessory = accidental = absent

* = not identified

With regard to the six stations analysed, the greatest abundance in fish was registered in the Baía (31.2%), Patos (28.7%) and Guaraná (21.4%) stations, the first one being a semilentic environment and the others lentic environments. In the Baía and Paraná stations the most frequent species was *M. intermedia. C. notomelas* was predominant in the Guaraná and Patos stations, *Characidium* sp, a species predominant in the Ivinheima station, had small participation in the samplings of the other stations. In the Cortado station *Cheirodon* sp, a species with high participation in all the sampling sites, was predominant.

Table 3 shows the capture per unit/effort (CPUE = the number of individuals captured in a square meter of sieve, per hurl) in different phases of the hydrological cycle. The largest captures were recorded during the dry and decreasing water level periods. However, the number of species was greater in the dry and high water periods (December and February).

Table 3: CPUE (number of specimens/m²) according to the hydrological cycle phases.

Hydrological cycle phases	CPUE
Flood (March-April-May)	157
Low water (June)	328
Dry period (July-August-September)	359
Flooding (October-November)	61
Flood (December-January-February)	109

Frequency of captures of species in each phase of the hydrological cycle (Figure 3) reveals that the capture of *C. notomelas* occurred predominantly during the three months of the dry period (78.8% of annual captures), being the principal species in this and the following periods, although it has been the most frequent species during the year under study. On the other hand, *M. intermedia* was captured chiefly in the four months at the end of the flood and decreasing water level periods (79.6%), when it became the dominant species in captures. *Cheirodon* sp presented a relative frequency approximately constant during the phases of the hydrological cycle, being predominant in captures from December(1992) to February (1993) (Flood period) with 40% of specimens being captured during the dry months.

In the increasing water level period, the uniformity in species abundance was greater. This was different from the other periods when there were few abundant species and many of them were poorly represented. Data also suggested differences in specific abundance between the flood periods of the following years, particularly with regard to the abundance of *M. intermedia*. In this case, it is important to note that these differences may be related to the fact that the Flood period of 1992 comprised only its final phase whilst in 1993 it included its initial one.

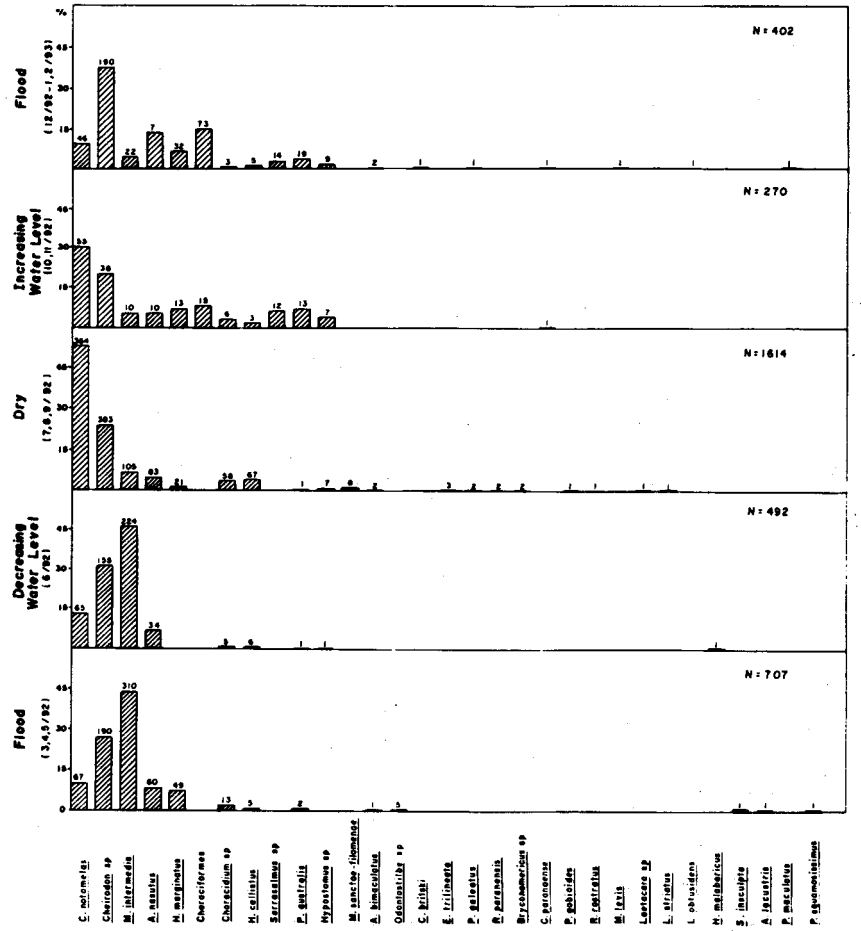

Figure 3: Frequency of species recorded at the aquatic macrophyte banks in the different phases of the hydrological cycle.

Length structure of the principal species

The sampled community is chiefly composed of small-sized specimens (maximum length 94 mm, except one species of 230 mm) (table IV). Of the 30 captured species, at least 27 (90.0%) were recorded in their immature forms. Exceptions are *Odontostilbe* sp and *Bryconamericus* sp (without data as regard to first maturation) and *Laetacara* sp. However, it has been found that the abundance of juvenile forms of large size species was low (Figure 3).

Table 4: Standard length range and development stage species captured at the macrophyte banks of the Paraná River floodplain.

Species	Standard length range (mm)	Phase of development	
		Immature	Adult
C.notomelas	10 - 30	x	x
Cheirodon sp	04 - 28	x	x
M.intermedia	10 - 55	x	x
A.nasutus	11 - 38	x	x
H.marginatus	13 - 32	x	x
Characidium sp	13 - 35	x	x
H.callistus	12 - 25	x	x
Serrasalmus sp	10 - 30	x	
P.australis	05 - 30	x	
Hypostomus sp*	12 - 50	x	
M.sanctae-filomenae	10 - 45	x	x
A.bimaculatus	30 - 42	x	x
Odontostilbe sp	13 - 17	?	x
C.britski	35 - 56	x	x
E. trilineata	74 - 94	x	x
P. galeatus	21 - 54	x	
R.paranensis	32 - 34	x	x
Bryconamericus sp	21 - 27	?	x
P.gobioides	22	x	
*R.rostratus**	230	x	
*M.levis**	32	x	
Laetacara sp	31		x
L.striatus	26	x	
*L.obtusidens**	30	x	
*H.malabaricus**	42	x	
S.insculpta	27	x	
A.lacustris	80	x	
*P.maculatus**	21	x	
C.paranaense	16 - 17	x	
*P.squamosissimus**	27	x	

* species reaching more than 250 µm (s l.).
? without any information with regard to size at first maturation.
Source: Data on first maturation based on unpublished information by Edson K.Okada, Harumi I. Suzuki, Angelo A. Agostinho e Anna E.A.de Moraes Vazzoler.

Ichthyofaunic similarity between sampling stations

Grouping of sampling stations based on similarity among sampling stations with regard to the occurrence and abundance of species is shown in the dendrogram of Figure 4. The first group of stations with greater similarity is formed by the Paraná, Ivinheima and Cortado stations. The first two are the most similar. The second group is formed by the Guaraná and Patos stations. The Baía station forms an isolated environment, distinct from the rest.

It has been verified that the first group of stations (Paraná, Ivinheima and Cortado) whose waters are more lotic than the rest, presents higher values of dissolved oxygen, pH and electric conductivity. On the other hand, in the second group there are the stations with lentic characteristics (Patos and Guaraná) where the lowest values are registered with regard to the parameters mentioned above. The third group represented by the semilotic environment (Baía) presented intermediary values with regard to the rest, with the exception of values obtained from dissolved oxygen which were similar to those registered in the first group. With respect to aquatic macrophytes a marked predominance of *Eichhornia azurea* has been established in all stations, with the exception of the sampled area of the Paraná River where this species has not been recorded. Gramineae has been registered only in the Ivinheima and Paraná stations which are characteristically lotic.

Few differences have been found with regard to temperature in different environments. However, greater amplitude of variation in the Patos station stands out.

The bottom type of Baía, Patos and Guaraná stations are essentially of clay. In the Cortado station there are argillaceous silt and medium-sized sand. Fine sand is found in the Ivinheima and Paraná stations.

Ichthyofaunic diversity

The highest diversity values were registered at the Ivinheima station where captures represented only 5% of total (Figure 4). On the other hand, Baía and Patos with a greater contribution in the number of captured specimens (31% and 29% respectively) presented the lowest diversity values.

Equitability in sampling distribution among species was greater in the Ivinheima, Cortado and Paraná stations which are more lotic environments. Low values in equitability were registered in Baía, Patos and Guaraná stations since there was a high dominance of *Moenkhausia intermedia* and *Cheirodon* sp in the first station and of *Cheirodon notomelas* and *Cheirodon* sp in the last two.

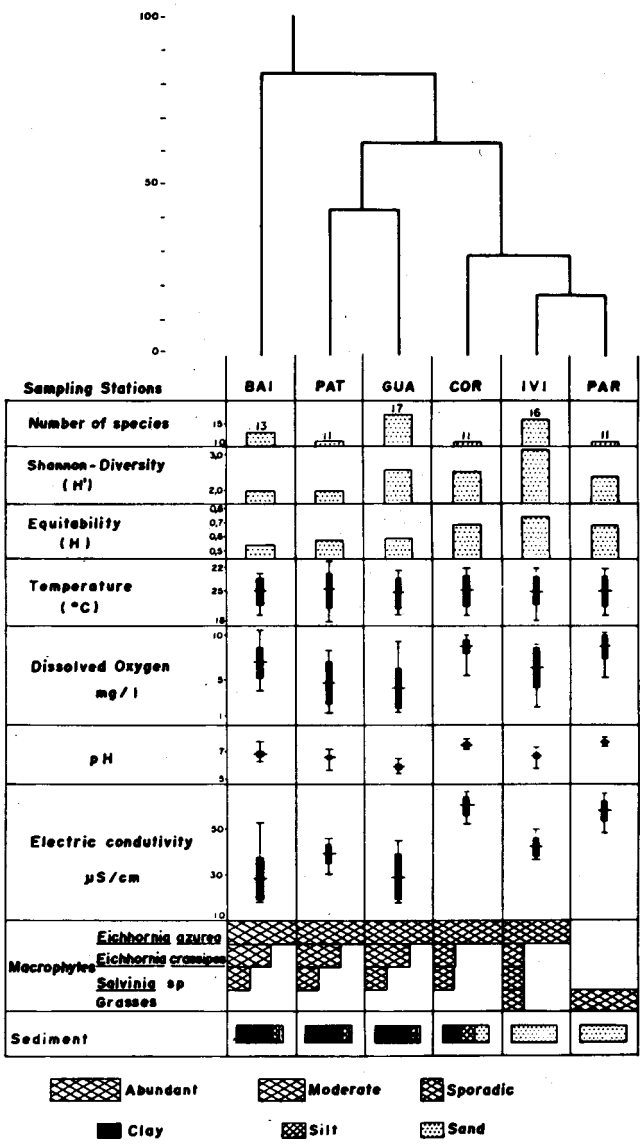

Figure 4: Dendrogram of ichthyofaunic similarity between sampling stations (Euclidian distances); diversity and physical, chemical and biological characteristics of the different sampling stations during the period.(Vertical bar - Standard deviation Vertical line - range)

DISCUSSION

The neotropical ichthyofauna is characterized by a great variety of characiforms and siluriforms which together constitute more than 85% of all species of fish (Lowe-McConnell, 1987). The two groups have been considered as similarly diverse in the high Paraná River basin with a slight predominance of the former (Agostinho, 1993a). However, in the present study it was found that characiforms presented a greater variety of species (3.5 times) than that of the siluriforms, differing inclusively from the composition reported for samples obtained in experimental fishing outside the macrophyte banks in the same region and period (FUEM/CIAMB-PADCT, 1993). Even though the reasons for this fact are not totally clear, they may be associated to (a) the specificity represented by the biotope found in macrophyte banks which present favourable conditions of shelter (characiforms are structurally less protected from predators), dissolved oxygen (characiforms are generally more particular with regard to contents of this element) and food; (b) the fact that captures were undertaken only at one particular timetable (hour) during the day since siluriforms generally have high nocturnal activity (Lowe-McConnell, 1987); (c) the superior layer of the water column explored in samplings, since siluriforms are generally animals of the bottom. Escape response, which could be relevant with this sampling method, does not seem to be related to this fact since, in general, siluriforms present less favourable morphology to abrupt movements. Bonetto *et al.*, (1969, 1970) and Verissimo (1994) studied many temporary lakes in the middle and high Paraná River, respectively, and also verified a marked predominance of characiforms in comparison to other orders.

The composition of ichthyofauna associated to macrophytes has revealed the presence of species characteristic of this biotope. Junk (1973) presents a list of species found in such environments in the Amazon, in particular the species of the genera *Hyphessobrycon*, *Hemigrammus*, *Serrasalmus*, *Mylossoma*, *Pyrrhulina*, *Hoplias* and *Leporinus*. The same genera were found in lakes occupied by *Eichhornia crassipes*, *Pistia* sp and *Paspalum repens* in the middle Paraná River by Bonetto *et al.*, (1969) and Cordiviola de Yuan *et al.*, (1984) who emphasized the predominance of Tetragonopterinae and Cheirodontinae. Ringuelet (1975) mentions that in still and plant-populated waters more than one ecological complex of fish is found, among which small fish are in a distinguished position. Tetragonopterinae are the most characteristic,

followed by *Characidium* sp, *Pyrrhulina* sp and some cichlids. The same author distinguishes these biotopes from those of the main channel of the great rivers where there is predominance of predator species of Siluriforms and Characiforms.

Specific diversity is one of the more relevant communities attributes related to their organization and stability (Krebs, 1986). Comparing diversity values found in the analysed environments, it has been established that lotic environments presented a greater equitability. In ecological terms, this fact reflects the stability of the environment which favours a higher level of organization. Lowe-McConnell (1987) comments that in the main channel of big rivers, biotopes are more numerous and diversified than in streams and varzeas and that the association of fish are less well defined.

Although a great number of species in lentic environments has been recorded, the diversity of the later was lower because of the high dominance of some species. This fact may be related to stressing conditions to which the assemblages are subjected. It has been established that in these environments, pH and dissolved oxygen values were less than in lotic environments. These conditions may be restricting the presence of some species which are ecologically more particular. On the other hand, some species which tolerate these conditions may occupy empty niches and become numerous. Cordiviola de Yuan *et al.*, (1984), analysing populations of fish linked to vegetation in the middle Paraná River, found lower values of diversity in the months in which there was a marked dominance of *H. pequira*. Eadie *et al.*, (1986) verified a lower number of species in lakes acidified by anthropic action than in other lakes of the same area. It should be emphasized, however, that a relative small number of abundant species and many rare species have a normal occurrence in natural communities (Margalef, 1983) and that environmental stress conditions may turn this fact more pronounced.

A higher degree of similarity was registered among the lotic environments (Paraná and Ivinheima), followed by the semilotic (Cortado). Lentic environments (Guaraná and Patos), although with less similarity between them, presented a fauna distinct from the rest. The station Baía showed a particular ichthyofauna. The distinction between these environments should be related to the physical and chemical characteristics of water and sediment type determined to a large extent by the water velocity.

The Paraná, Ivinheima and Cortado stations presented similar characteristics with regard to chemical parameters analysed and to the sediment. However, when the specific composition of the macrophytes was analysed, it revealed differences among the sites. Baía station, whose composition and abundance of macrophytes were similar to those found in lakes, showed itself distinct from these with regard to ichthyofauna. The great dominance of *M. intermedia* in Baía was the main difference. The possibility that this species restricts the occurrence of others because of its large size, abundance or activity should not be eliminated.Differences in the composition of the ichthyofauna may not be related exclusively to the specific composition of the macrophytes, but also to an interaction of biotic, hydrological (velocity of water) and chemical (oxygen, conductivity, pH) factors.

Constancy measurement of a given species in a given environment produces valuable indications for the establishment of the temporality of utilization that the species makes of its biotope. Taking into account total samplings undertaken in macrophyte banks, it was found that only three species were resident (*Cheirodon* sp, *M. intermedia* and *A. nasutus*). These species were recorded in their adult and in immature forms. However, they have been captured also in hauling at the marginal areas lacking macrophytes (personal observation). This suggests they may be widely distributed and abundant in the region, particularly in the littoral areas.

The low constancy found revealed that the majority of species recorded in this type of biotope is temporary. This is a remarkable fact in the Paraná River where, excepting *M. intermedia* with wide spatial occurrence, no other species may be considered constant or resident in its macrophyte banks. With regard to this species, it should be emphasized that its occurrence near the macrophyte banks is restricted to lengths inferior than 5.5 cm. Lowe-McConnell (1975) argued that the species composition of ichthyofauna in neotropical rivers is always changing because of the time and water level.

Analysing the community during one year, it has been found that the greatest density of fish was found in the dry and decreasing water level periods. Similar results were obtained by Cordiviola de Yuan (1984) who found an inverse relation between the density of fish and fluviometric levels when he analysed a community of fish in one of the lakes of the middle River Paraná.

As a first approach, the inverse relation between the fluviometric level and capture may be related to a greater relative density resulting from the water reduction in the dry period and to a greater absolute density resulting from recent reproduction during the decreasing water level period. Further, it may be related to the effect that the reduction in vital space has on predation, increasing it and inducing the foraging or small-sized species to take refuge in the macrophytes. This fact and the search for food in the macrophytes seem to explain the great abundance of *C. notomelas* and *Cheirodon* sp in the dry period. Oliveros (1980) emphasizes that littoral communities which developed in the midst of macrophytes were the great source of food for the majority of fish found in the lentic environments of the middle Paraná River.

The large number of species found in the dry and in the beginning of the high water periods is accountable for the presence of juveniles of big-sized species not observed in earlier periods. The concentration of these forms during the dry period and the reproduction at the beginning of the flood period may explain this occurrence.

The species caught at the macrophyte banks essentially consist of (a) juveniles and adults of small-sized species and (b) immature forms of large-sized species, including migratory species. The former, numerically predominant and highly constant during the year, has a salient role as foragers (Almeida, 1994). The latter species, constituting, at least, half of the recorded species, were captured only in an immature form. These species seem to use the macrophyte banks for initial food-taking and shelter from predators. They are typically temporary and are generally classified as accidental or accessory.

In this study the low catch of initial forms of development of big migratory fish was an unexpected fact due to the incidence of juveniles of these species in adjacent environments, especially in the floodplain (FUEM-CIAM/PADCT, 1994). Although the plain areas in which these forms concentrate have not been yet defined, it is possible that this happens at more interior points of the macrophyte banks which were not sampled in this study.

CONCLUSION

The ichthyofauna associated to macrophyte banks is composed of small-sized species, predominantly by Tetragonopterinae and Cheirodontinae, differing significantly from that found in the open areas of the same environment. With the exception of the few species constant in the captures (residents), the composition of the ichthyofauna suffered marked changes related to the withdrawal of water (intensification of

predation and search for shelter) and to the birth of new individuals. Although there is a high incidence of juvenile forms (50% of the species only recorded as immature), the frequency of very young large-sized migratory species was very low. This suggests that the importance of these environments as a "nursery" of these species seems to lack proof, at least in the area under examination. Groups established according to the ichthyofaunic similarity are more related to water dynamics and its physical and chemical characteristics than with regard to the specific composition of the macrophyte banks or bottom type.

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Appendix I: List of the species found in the macrophyte banks of upper Parana floodplain.

CLASS OF OSTEICHTHYES

Sub-class ACTINOPTERYGII
Order CHARACIFORMES
Suborder CHARACOIDEI
Family CHARACIDAE
Subfamily TETRAGONOPTERINAE
Astyanax bimaculatus (LINNAEUS, 1758) - tambiú, lambarí
Bryconamericus sp - pequira
Hemigrammus marginatus (ELLIS, 1911) - lambarí
Hyphessobrycon callistus (BOULENGER, 1900) - mato grosso
Moenkhausia intermedia (EIGENMANN, 1908) - viuvinha
Moenkhausia sanctae-filomenae (STEINDACHNER, 1907) - viuvinha
Subfamily CHEIRODONTINAE
Aphyocharax nasutus (AHL, 1936) - piqui
Cheirodon notomelas (EIGENMANN, 1915) - pequira
Cheirodon sp - pequira
Odontostilbe sp - pequira
Sub-family ACESTRORHYNCHINAE
Acestrorhynchus lacustris (REINNHARDT, 1874) - peixe cachorro
Sub-family CHARACINAE
Roeboides paranensis (PIGNALBERI, 1975) - dentudo
Sub-family CHARACIDIINAE
Characidium sp - canivete
Sub-family MYLEINAE

Myloplus levis (EIGENMANN & McATEE, 1907) - pacu-prata
Family SERRASALMIDAE
Sub-family SERRASALMINAE
Serrasalmus sp - piranha
Family ANOSTOMIDAE
Leporinus obtusidens (VALENCIENNES, 1847) - piapara
Leporinus striatus (KNER, 1859) - canivete
Family CURIMATIDAE
Steindachnerina insculpta (FERNANDES-YÉPEZ, 1948) - saguiru
Family ERYTHRINIDAE
Hoplias aff. *malabaricus* (BLOCH, 1794) - traíra
Family LEBIASINIDAE
Pyrrhulina australis (EIGENMANN KENNEDY, 1903) - charutinho
Order SILURIFORMES
Sub-order GYMNOTOIDEI
Family STERNOPYGIDAE
Eigenmannia trilineata (LOPEZ & CASTELLO, 1966) - espadinha
Family RHAMPHYCHTYIDAE
Ramphychtys rostratus (LINNAEUS, 1766) - peixe espada
Sub-order SILUROIDEI
Family AUCHENIPTERIDAE
Parauchenipterus galeatus (LINNAEUS, 1766) - cangati
Family PIMELODIDAE
Sub-family PIMELODINAE
Pimelodus maculatus (LACÉPÈDE, 1803) - mandi
Family LORICARIIDAE
Sub-family HYPOSTOMINAE
Hypostomus sp - cascudo
Family CETOPSIDAE
Pseudocetopsis gobioides (KNER,1857) - candiru
Superorder ACANTHOPTERYGII
Order PERCIFORMES
Family SCIAENIDAE
Plagioscion squamosissimus (HECKEL, 1840) - curvina
Family CICHLIDAE
Cichlasoma paranaense (KULLANDER, 1982) - acará
Crenicichla britski (KULLANDER, 1982) - joaninha
Laetacara sp - acará