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Diet and niche breadth and overlap in fish communities within the area affected by an Amazonian reservoir (Amapá, Brazil)

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ABSTRACT

We investigated the niche breadth and overlap of the fish species occurring in four environments affected by the Coaracy Nunes reservoir, in the Amapá Brazilian State. Seasonal samples of fishes were taken using a standard configuration of gillnets, as well as dragnets, lines, and cast-nets. Five hundred and forty stomach contents, representing 47 fish species were analyzed and quantified. Niche breadth and overlap were estimated using indexes of Levins and Pianka, respectively, while interspecific competition was evaluated using a null model (RA3). ANOVA and the Kruskal-Wallis test were used, respectively, to evaluate differences in niche breadth and overlap between areas. The data indicate that the majority of the fish species belong to the piscivore, omnivore, and detritivore guilds. These species have likely colonized the environments due to the availability of suitable feeding resources, and the favorable physical conditions created by the river damming. Overall, few species have ample niches, but most of them are highly specialized. Resources seasonal variation had little effect on the feeding behavior of most species in the study areas. The null models indicated that competition was not a factor determining on community structure.

Key words: competition, neotropical reservoir, diet, species coexistence.

INTRODUCTION

Understanding the ecological mechanisms that support the coexistence of species in a given community and their partitioning of resources is one of the fundamental objectives of the ecological investigation of Neotropical fish assemblages (Cassemiro et al. 2008). Trophic resources partitioning is one of the principal factors that influence the structure of fish communities (Silva et al. 2008) and it may vary according to local characteristics, physical-chemical variables, the integrity of the environment, the composition of the fish fauna, and seasonality, as well as latitudinal gradients and other factors that may affect the dietary patterns and the feeding behavior of the fishes (Pianka 1969, Goulding 1980, Prejs and Prejs 1987, Hahn et al. 2004, Mérona and Mérona 2004, Lappalainen and Soininen 2006, Novakowski et al. 2008).

Niche breadth is an important parameter for the evaluation of the level of dietary specialization

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in a given group of species (Segurado et al. 2011). Species with niches of reduced breadth are relatively specialized, whereas more ample niches are typical of generalist species. The analysis of niche overlap also provides an important approach for the evaluation of the structuring of communities in terms of the feeding niches of the different species that compose them (Corrêa et al. 2011). The degree of specialization for the exploitation of specific types of resources could be used to classify groups of species in feeding guilds (Winemiller and Pianka 1990).

Damming river causes changes to feeding behavior of species: herbivores can change their diets to invertivorous (Casatti et al. 2003), carnivores reduce predation on crustaceans and insects, making it essentially piscivorous (Santos 1995) and changing biotic interactions (competition and predation). Consequently, opportunistic strategy (feeding plasticity) is essential for species adaptation in the new environment (Araújo-Lima et al. 1995, Agostinho et al. 1999). In reservoir environments, the identification of the dietary resources that sustain populations and the understanding of feeding patterns are essential for the evaluation of the factors that are dominant on occurrence of the species in these environments and their distinctive regions (Esteves and Galetti 1994, Abelha et al. 2006). The Coaracy Nunes Dam was the first hydro-electric power station built in the Brazilian Amazon basin, with construction being started in 1967, and the reservoir being established in 1970 (ELETRONORTE 1997). The dam is located in the Ferreira Gomes municipality, in the state of Amapá. Despite its relatively long history, no research into the fish fauna of the area had been conducted prior to the present study.

This study compares the diets of the fish species in four regions influenced by Coaracy Nunes reservoir and it estimates niche breadth and overlap between the species taking into account the dry and wet seasons, in order to comprehend species resources partition.

MATERIALS AND METHODS

The Araguari is the main river of the Brazilian State of Amapá, with a total length of 498 km and a drainage basin of 38,000 km^2. This river arises in the Tumucumaque range and discharges into the Atlantic Ocean, although it is strongly influenced by the Amazon River. The Coaracy Nunes reservoir is located approximately 200 km from the Atlantic Ocean, in the middle of Araguari River basin. The reservoir drains a total area of 23.5 km^2, and has a mean discharge of 976 m^3.s^{-1}, mean depth of 15 m, and a total volume of 138 Hm^3. The local climate is typical of the Amazon basin, with a rainy season between January and June, and a dry season from July to December (Bezerra et al. 1990, IBGE 2010, ANA 2011).

The region's vegetation is characterized by elements of the typical lowland Amazon rainforest, savanna, and floodplain forest (várzea). For the present study, four areas influenced by the Coaracy Nunes reservoir (Fig. 1) were discriminated: 1 - Downriver Area (DWN): located downstream from the dam, this area presents lotic characteristics with the flow of water being influenced by the control of the dam's flood gates and the discharge of the turbines in the hydro-electric power station, which it could create areas with reduced flow; 2 - Reservoir (RES): main body of the reservoir, with semi-lotic characteristics intermediate between those of a river and a lake; 3 - Lacustrine (LAK): an area adjacent to the reservoir, with extremely lentic characteristics; 4 - Upriver Area (UPR): area upstream from the reservoir with lotic conditions. The effects of deforestation and permanent flooding from várzea are apparent throughout this area. A number of deforested areas and scattered settlements can be observed in the middle and upper reaches of the reservoir. The margins of the lower reservoir, lacustrine, and downriver areas are characterized by relatively well-preserved riparian vegetation.

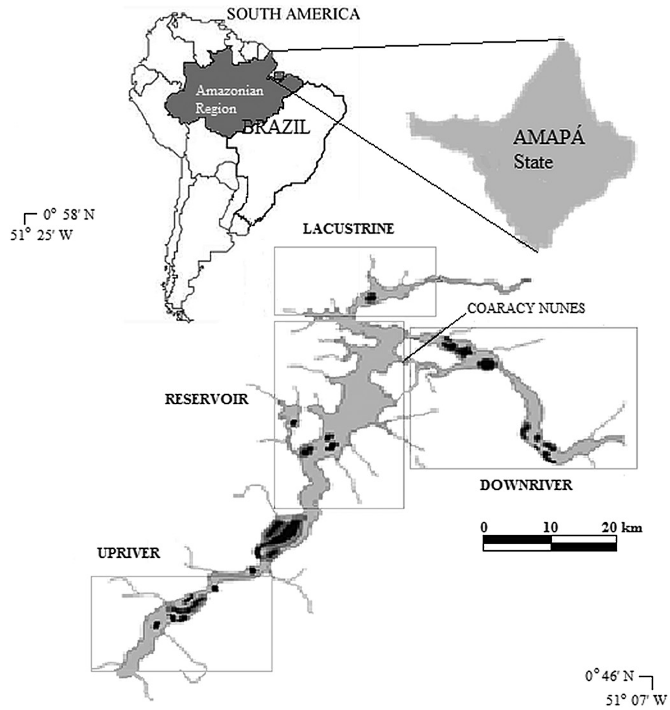

Figure 1 - Study region localization of Coaracy Nunes Reservoir. Samplings were made in distinct areas: Downriver, Reservoir, Lacustrine and Upriver (State of Amapá - Brazil).

Specimen collection was divided into eight bimonthly sampling campaigns between May 2009, and July 2010, with four samplings in flood season and four in dry season. Sampling sites were selected randomly within each area. The collection of specimens for the analysis of the composition of the community and the diet of the different species was conducted using a number of different fishing techniques, including cast nets, trawls, dragnets, harpoons, spears, hand-nets, hand-lines, and standardized samples with eight gillnets (mesh size of 10 -100 mm).

All captured specimens were identified to the lowest possible taxonomic level, measured (total length in mm), weighed (g), and photographed. Species identification was based on the available literature (Planquette et al. 1996, Santos et al. 2004, Buckup et al. 2007, PIATAM 2008) and was confirmed by specialists. Diet composition was based on analysis of 5 up to 10 stomach contents of the 47 most abundant species because the other species presented no content. Diet items were standardized in ten categories (Hahn and Delariva 2003, Mérona et al. 2005, Novakowki et al. 2007): 1 – plant material (unidentified remains of leaves, flowers and algae); 2 – insect; 3 – larva (terrestrial or aquatic); 4 – zooplankton; 5 – phytoplankton; 6 – crustacean (crab or shrimp); 7 – fish (whole animals or remains, including scales and fins); 8 – arthropod (other representatives of the phylum Arthropoda); 9 – detritus (organic detritus at different stages of decomposition); 10 – animal fraction (unidentified fraction of non-fish vertebrates).

Diet composition was measured by data volume, which was obtained either by compressing the material (food items) under a glass slide on a plate with a one-millimeter grid, to a known height (1 mm), and converting to milliliters based on the area covered; or by placing the items in a graduated cylinder and calculating the displacement of water.

The volume of each item was converted to a percentage. We assumed that the results obtained using these two methods were similar.

Diet composition was analyzed by volume ($VO_{\%}$) and the frequency of occurrence ($F_{O\%}$) using an optical microscope and a stereomicroscope (Hynes 1950, Hyslop 1980). These two parameters were combined to calculate the feeding index. IAi was calculated to characterize fish species diets (Kawakami and Vazzoler 1980), which combines total volume (%) and frequency of occurrence (%) of each item (lowest taxonomic level):

$$IA_i = \left\lfloor \frac{(FO_i * VO_i)}{\sum (FO_i * VO_i)} \right\rfloor * 100$$

where IAi = alimentary index; FOi = occurrence frequency percentage and VOi = volumetric frequency percentage; i = 1, 2,.., n food item;

Based on this analysis, the diet preferences and feeding specialization of the different species were evaluated on the basis of a FI ≥ 0.5 criterion for a given category or type of item. In some specific cases, where a number of different items were consumed in relatively reduced proportions, a criterion of FI ≥ 0.4 was adopted (Gaspar da Luz et al. 2001). Species that presented a co-dominance of plant and animal items, or a relatively balanced consumption (difference < 20%) of the two types of item, were considered to be omnivorous.

Species were classified in five trophic guilds: 1 - herbivore (predominance of leaves, fruits, flowers, seeds and algae); 2 - piscivore (predominance of fish); 3 - carnivore (arthropods and other animals besides fish); 4 - omnivore (balance of plant and animal material); 5 - detritivore (predominantly on detritus or sediment).

The niche breadth of each species was based on Levin's standardized index:

$$B_i = \frac{1}{(n-1)} \left(\frac{1}{(\sum_j p_{ij}^2)} - 1 \right)$$

where *Bi* = standardized index of niche breadth, *pij* = proportion of diet of predator i on prey j, and *n* = total number of item (resources). Bi values vary from 0 (species consume a single item) to 1 (species exploits available items in equal proportion). Values of *Bi* are considered high when higher than 0.6, moderate, when between 0.4 and 0.6 and low when below 0.4 (Novakowski et al. 2008).

Analysis of niche overlap between the most common species was based on classical Pianka's index (Pianka 1973), which is derived from the composition of the diet (percentages) of the different species:

$$O_{jk} = \frac{\sum_i^n p_{ij} p_{ik}}{\sqrt{\sum_i^n p_{ij}^2 \sum_i^n p_{ik}^2}}$$

where O_{jk} = Pianka's index of niche overlap between species *j* and *k*, *pij* = the proportion of the *i*th resource in the diet of species *j*, p_{ik} = the proportion of the *i* the resource in the diet of species *k*, and n = the total number of items. Pianka index values were classified according to the scheme of Grossman (1986) and Novakowski et al. (2008) which follow the same boundaries as those of Levins index (see above). A basic assumption adopted here was that the different dietary resources were equally accessible to all species, given that no data was collected on the availability of resources within the study area (Abelha et al. 2006).

The data were initially analyzed for normality using the Kolmogorov-Smirnov test and Levene's test for homogeneity of variance (Conover 1990, Sokal and Rohlf 1995). Seasonal differences in the mean indices of niche breadth and overlap were evaluated using an Analysis of Variance (ANOVA) and the Kruskal-Wallis test respectively. A $\alpha < 0.05$ significance level was considered for all tests.

In order to evaluate whether the pattern of niche overlap diverged significantly from a random distribution (absence of overlap), data on the abundance of diet resources by each species were randomized using null models based on 5000 iterations using the RA3 algorithm (randomization algorithm) of the EcoSim program (Gotelli and Entsminger 2006), which runs a Monte Carlo resampling in order to create "pseudo-communities" (Joern and Lawlor 1980, Winemiller and Pianka 1990), and then compares the random communities statistically with the observed data set. The statistical significance of observed overlap with that indicated by the null model was evaluated considering $\alpha < 0.05$. In this analysis, interspecific competition was suspected when the observed mean overlap was significantly lower than that expected by chance. When observed overlap is greater than that expected by chance, abiotic limitations could be provoking the homogenization of foraging patterns among species (Albrecht and Gotelli 2001).

RESULTS

A total of 108 species (Table A9-Appendix) and 1977 fish specimens were captured during the present study, of which 540 had stomach contents belonging to 47 species, which were included in the analysis of diet (Tables I and II). Half of the fish species (51%) consumed more than one item in all areas and seasons, except in the reservoir during the dry season, when 55% of the species consumed a single resource, reflecting a higher specialization. Fish was the item most consumed in all areas, followed by detritus and plant material (Tables I and II, Fig. 2).

In the downriver area, fish was the main item (23%) during the flood season, while detritus was the most consumed (18%) in the dry season. In the reservoir, fish was the main item (19%) during the dry season, whereas fish (21%), detritus (21%) and plant (21%) were the main items during the flood season. Two items – fish and insects – were the most consumed (25%) in the lacustrine area during the dry season, while insects and detritus were the main items (21%) during the flood season. In the upriver area, detritus was the most consumed item in both the dry (25%) and the flood (20%) seasons (Fig.2).

The predominant species are the piscivorous, *Ageneiosus ucayalensis, Boulengerella cuvieri, Serrasalmus gibbus, Charax gibbosus*, and *Pimelodus ornatus*, which were found in all four studies areas (Tables I and II). Plant material was ingested by herbivorous species, such as *Metynnis lippincottianus* and *Tometes trilobatus*, as well as by omnivores like *Geophagus proximus, Hemiodus unimaculatus, Leporinus* aff. *parae, Leporinus affinis, Leptodoras* sp., and *Triportheus auritus*. Similarly, detritus was consumed by specialists, such as *Harttia duriventris*, *Hypostomus plecostomus*, *Pseudocanthicus spinosus*, *Gyptoperichthys joselimaianus*, and *Hypostomus emarginatus*, which fed exclusively on this material, but also consumed by omnivores.

In the downriver area, some species with a diverse diet presented a co-dominance of dietary items. These species included *H. unimaculatus* who consumed plant material and detritus in equal proportions. A similar pattern was observed in the reservoir and lake environments, in species such as *G. proximus, H. unimaculatus, L.* aff. *parae, L. affinis, Leptodoras* sp., and *T. auritus* who also presented relatively diversified diets, with a predominance of plant material. *Triportheus angulatus* consumed insects, arthropods, and plant material in roughly equal proportions, while the diet of *L. affinis* was based on three main items – fish, insects, and plant material. In both the lake and upriver areas, equal proportions of detritus and plant material dominated the diet of *H. unimaculatus*.

Slight seasonal variation was observed in the diet of the majority of species (Tables I and II). Accordingly, *Plagioscion squamosissimus,* in the downriver area, changed its diet during dry season, feeding mostly on invertebrates (crustaceans, insects and arthropods). At reservoir area, *A. ucayalensis* and *H. unimaculatus* ingested a more ample diversity of items during the flood period while *L. affinis* consumed more items during the dry season, as opposed to what occurred in the

TABLE I
Alimentary index (AI) values and trophic classification of species analyzed in the areas under influence of Coaracy Nunes Dam (Amapá State, Brazil; n: number of stomachs analyzed).

Species/Area	n	Fish		Crustacean		Insect		Larva		Animal parts		Arthropod		Plant material		Zooplankton		Phytoplankton		Detritus		Guild
Downriver		Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	
Astyanax bimaculatus	12			0.05		0.3								0.6		0.025		0.025				Herbivorous
Acestrorhynchus falcatus	8	0.7	0.8	0.3	0.2																	Piscivorous
Ageneiosus ucayalensis	12	1.00	0.95																		0.05	Piscivorous
Boulengerella cuvieri	10	1.00	1.00																			Piscivorous
Bivibranchia notata	8																			1.00		Detritivorous
Chaetobranchus flavescens	6					0.2						0.4		0.3		0.1						Omnivorous
Charax gibbosus	12	0.7	0.66	0.2	0.2	0.1	0.14															Piscivorous
Glyptoperichthys joselimaianus	6																			1.00		Detritivorous
Geophagus proximus	12				0.4	0.6								0.4	0.6							Omnivorous
Hoplias aimara	5		1.00																			Piscivorous
Harttia duriventris	12																			1.00	1.00	Detritivorous
Hemiodus microlepis	6													0.7		0.05		0.05		0.2		Herbivorous
Hypostomus plecostomus	12																			1.00	1.00	Detritivorous
Hemiodus. unimaculatus	12					0.15	0.1							0.4				0.05		0.4		Omnivorous
Hoplerythrinus unitaeniatus	8		0.8		0.2																	Piscivorous
Hypostomus emarginatus	6																			1.00		Detritivorous
Leporinus aff parae	12	0.5	0.6											0.3	0.3					0.2	0.1	Omnivorous
Leporinus affinis	8		0.3												0.4						0.3	Omnivorous
Laemolyta petiti	8			0.05		0.2								0.5						0.25		Omnivorous
Moenkhausia chrysargyrea	5				0.8								0.2									Carnivorous
Metynnis lippincottianus	8														1.00							Herbivorous
Pimelodina flavipinnis	6	0.6		0.2		0.1						0.1										Piscivorous
Pachypops fourcroi	5		0.7					0.2								0.1						Piscivorous
Peckoltia oligospila	6																				1.00	Detritivorous
Psectrogaster aff *falcata*	12																				1.00	Detritivorous
Pimelodus ornatus	8	0.83		0.17																		Piscivorous
Pseudocanthicus spinosus	6																			1.00	1.00	Detritivorous
Plagioscion squamosissimus	8	0.45	0.6	0.27	0.05	0.13	0.3					0.15	0.05									Carnivorous
Roeboides affinis	5		0.6		0.3		0.1															Piscivorous
Retroculus lapidifer	6					0.3								0.2		0.3		0.1		0.1		Omnivorous
Retroculus septentrionalis	6					0.2								0.3		0.3		0.2				Omnivorous
Satanoperca acuticeps	8					0.2						0.2		0.2		0.1		0.1		0.2		Omnivorous
Serrasalmus gibbus	12	1.00	1.00																			Piscivorous
Triportheus albus	6						0.5						0.25		0.25							Omnivorous
Triportheus auritus	6						0.2								0.8							Omnivorous

TABLE I (continuation)

Species/Area	n	Fish		Crustacean		Insect		Larva		Animal parts		Arthropod		Plant material		Zooplankton		Phytoplankton		Detritus		Guild
Downriver		Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	
Triportheus trifurcatus	6				0.05		0.4						0.05		0.5							Omnivorous
Tometes trilobatus	12													1.00								Herbivorous
Reservoir																						
Acestrorhynchus falcirostris	8	1.00	1.00																			Piscivorous
Ageneiosus ucayalensis	10	1.00	0.8										0.05								0.15	Piscivorous
Boulengerella cuvieri	8	1.00																				Piscivorous
Curimata inornata	10																			1.00	1.00	Detritivorous
Charax gibbosus	10	0.8		0.2																		Piscivorous
Electrophorus electricus	5	1.00																				Piscivorous
Geophagus proximus	10			0.1		0.05	0.4					0.05	0.2	0.5	0.3		0.05			0.3	0.05	Omnivorous
Hoplias aimara	8		1.00																			Piscivorous
Hypostomus plecostomus	6																			1.00		Detritivorous
Hemiodus unimaculatus	10					0.1	0.05							0.6	0.4		0.1	0.1	0.05	0.2	0.4	Herbivorous
Leporinus aff *parae*	8	0.2	0.05											0.6	0.75					0.2	0.2	Omnivorous
Leporinus affinis	8			0.05		0.1								0.85								Omnivorous
Leptodoras sp.	8					0.05								0.75						0.2		Herbivorous
Metynnis lippincottianus	6													1.00								Herbivorous
Parauchenipterus galeatus	6		0.2										0.2		0.4						0.2	Omnivorous
Psectrogaster aff *falcata*	8																			1.00	1.00	Detritivorous
Pimelodus ornatus	10	0.8	0.6		0.2	0.2	0.2															Piscivorous
Pseudacanthicus spinosus	6																			1.00		Detritivorous
Roeboides affinis	6		0.3		0.2		0.2														0.3	Carnivorous
Serrasalmus gibbus	10	1.00	1.00																			Piscivorous
Triportheus angulatus	6					0.3	0.4					0.3	0.1	0.4	0.5							Omnivorous
Triportheus auritus	6					0.2	0.3							0.8	0.7							Omnivorous
Triportheus trilobatus	6													1.00								Herbivorous
Lacustrine																						
Acestrorhynchus falcirostris	6	0.6	0.7	0.2	0.3	0.2																Piscivorous
Ageneiosus ucayalensis	10	1.00	0.7								0.1		0.1								0.1	Piscivorous
Boulengerella cuvieri	6	1.00																				Piscivorous
Charax gibbosus	10	0.82	0.7	0.1	0.1	0.08	0.1						0.05								0.05	Piscivorous
Curimata inornata	10																			1.00	1.00	Detritivorous
Geophagus proximus	10		0.3				0.1						0.2		0.3						0.1	Omnivorous

TABLE I (continuation)

Species/Area	n	Fish		Crustacean		Insect		Larva		Animal parts		Arthropod		Plant material		Zooplankton		Phytoplankton		Detritus		Guild
Downriver		Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	Dry	Flood	
Hypostomus plecostomus	5																			1.00		Detritivorous
Hemiodus unimaculatus	10					0.2	0.4							0.4	0.2			0.1	0.1	0.3	0.3	Omnivorous
Leporinus affinis	8	0.3	0.2		0.1	0.2	0.2							0.5	0.4						0.1	Omnivorous
Pseudacanthicus spinosus	6																			1.00		Detritivorous
Psectrogaster aff *falcata*	6																			1.00	1.00	Detritivorous
Pimelodus blochii	8	0.6												0.4								Piscivorous
Pachypops fourcroi	6		0.6				0.2										0.1				0.1	Piscivorous
Pimelodus ornatus	6	0.6	0.6			0.4	0.1						0.4				0.2					Piscivorous
Roeboides affinis	5				0.2		0.2						0.4		0.2							Omnivorous
Serrasalmus gibbus	10	0.9	1.00			0.1																Piscivorous
Triportheus angulatus	8					0.3						0.4		0.3								Omnivorous
Triportheus auritus	8					0.05	0.1							0.95	0.9							Herbivorous
Upriver																						
Acestrorhynchus falcirostris	6	1.00	1.00																			Piscivorous
Ageneiosus ucayalensis	10	0.8	0.8	0.1	0.1	0.05		0.05													0.1	Piscivorous
Boulengerella cuvieri	6	1.00																				Piscivorous
Charax gibbosus	10	0.8		0.2																		Piscivorous
Curimata inornata	8																			1.00		Detritivorous
Electrophorus electricus	5	0.7	0.5								0.5	0.3										Piscivorous
Geophagus proximus	10					0.2				0.3				0.5								Omnivorous
Hypostomus plecostomus	5																			1.00	1.00	Detritivorous
Hemiodus unimaculatus	10					0.1								0.4						0.5		Omnivorous
Leptodoras sp.	6													0.6	0.7	0.1	0.1			0.3	0.2	Herbivorous
Psectrogaster aff *falcata*	5																			1.00		Detritivorous
Pseudacanthicus spinosus	5																			1.00		Detritivorous
Serrasalmus gibbus	10	1.00	0.8								0.2											Piscivorous
Serrasalmus rhombeus	6	0.7										0.3										Piscivorous
Triportheus angulatus	6					0.22	0.35	0.33						0.45	0.65							Omnivorous
Triportheus auritus	5					0.34	0.2							0.66	0.8							Omnivorous

TABLE II
Niche breadth (Bi) values of species analyzed in the areas under influence of Coaracy Nunes Dam (Amapá State, Brazil)

Species	Dowriver		Reservoir		Lacustrine		Upriver	
	flood	dry	flood	dry	flood	dry	flood	dry
A. bimaculatus		0.10						
A. falcirostris			0.00	0.00	0.10	0.18	0.00	0.00
A. falcatus	0.07	0.00						
A. ucayalensis	0.01	0.00	0.07	0.00	0.13	0.00	0.09	0.07
B. cuvieri	0.00	0.00		0.00		0.00		0.00
B. notata		0.00						
C. flavescens		0.33						
C. gibbosus	0.15	0.12		0.07	0.07	0.13		0.06
C. inornata			0.00	0.00	0.00	0.00		0.00
E. electricus				0.00			0.15	0.12
G. joselimaianus		0.00						
G. proximus	0.13	0.13	0.17	0.26	0.29			0.20
H. aimara	0.00		0.00					
H. duriventris	0.00	0.00						
H. microlepis		0.12						
H. plecostomus	0.00	0.00		0.00		0.00	0.00	0.00
H. unimaculatus	0.20	0.27	0.28	0.20	0.33	0.20		0.17
H. unitaeniatus	0.07							
H.emarginatus		0.00						
L. aff *parae*	0.17	0.23	0.18	0.18				
L. affinis	0.28			0.05	0.41	0.12		
L. petiti		0.26						
Leptodoras sp.				0.09			0.2	0.15
M. chrysargyrea	0.07							
M. lippincottianus	0.00	0.17				0.00		
P. aff *falcata*	0.00		0.00	0.00	0.00	0.00		0.00
P. blochii						0.13		
P. flavipinnis		0.20						
P. fourcroi	0.12							
P. galeatus	0.37	0.00						
P. oligospila	0.00							
P. fourcroi					0.20			
P. ornatus		0.07	0.18	0.07	0.20	0.13		
P. spinosus	0.00	0.00		0.00				0.00
P. squamosissimus	0.17	0.35						
R. affinis	0.17		0.41		0.37			
R. lapidifer		0.45						
R. septentrionalis		0.41						
S. acuticeps		0.65						
S. gibbus	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.00
S. rhombeus		0.09						
T. albus	0.24		0.28	0.28		0.28	0.14	0.22
T. auritus	0.07		0.07	0.07	0.59	0.03	0.08	0.10
T. trifurcatus	0.20							
T. trilobatus		0.00		0.00				

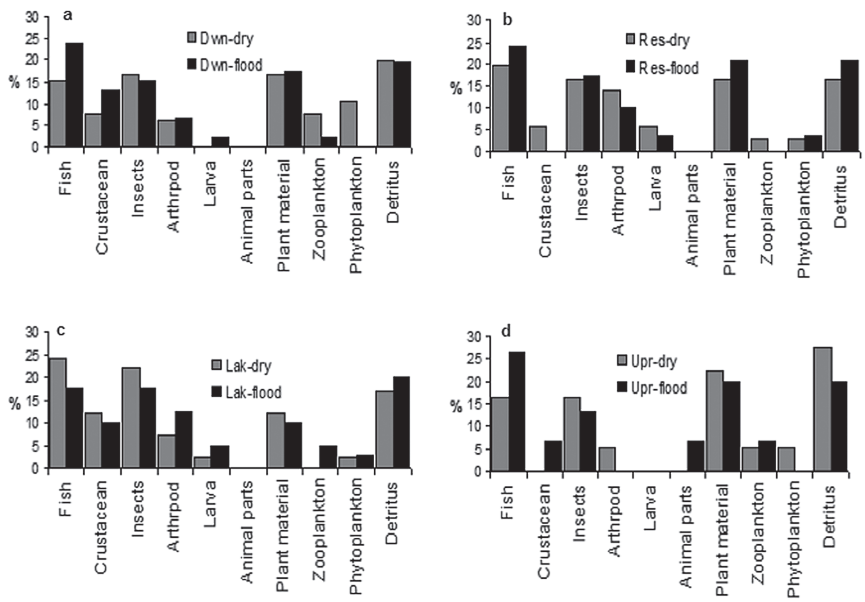

Figure 2 - Fish Fauna diet at areas influenced by Coaracy Nunes Dam (Amapá State, Brazil) in dry and flood seasons: a) Dwn: Downriver area; b) Res: Reservoir area; c) Lak = Lacustrine area and d) Upr: Upriver area.

lacustrine area, where *L. affinis* (and *Pimelodus ornatus*) fed on a greater diversity of items during the flood period, while *C. gibbosus* consumed more in the dry season. In the upriver area, *A. ucayalensis* and *T. angulatus* consumed more items in the dry season, while *S. gibbus* ingested more during the flood season (Tables I and II).

Niche breadth (Bi) values varied from 0.00 to 0.65. Most species presented relatively low values (Bi < 0.4) in all four areas (Tables I and II). In all areas and seasons, more than half the species returned Bi values of zero, although some species presented much higher values, such as *Satanoperca acuticeps* in the downriver area during the flood period (Bi = 0.65). The high frequency of Bi values lower than 0.4 in all the areas indicate that most species have relatively limited niches. However, increased variation (Bi > 0.4) was found in the lake and reservoir during the flood period, and in the downriver area during the dry season, indicating the presence of broader niches within these areas in comparison with the upriver area, where narrower niches were more typical (Fig. 3, Tables I and II). Nevertheless, no statistical difference was found in niche breadth (Fig. 3) among areas (ANOVA: $F_{(3, 72)} = 2.5301$; p = 0.0639), seasons ($F_{(1, 127)} = 2.8002$; p = 0.09671) or the season-area interface ($F_{(3, 127)} = 4.1386$; p = 0.0776).

The analyses of dietary overlap based on Pianka's index (Oi) found relatively high values (> 50%) for most pairs of species in all areas. The mean (± standard deviation) seasonal values were relatively similar in all four areas – downriver area (flood = 0.33±0.16, dry = 0.31±0.12), reservoir (flood = 0.40±0.16, dry = 0.39±0.26), lake (flood = 0.32±0.13, dry = 0.42±0.34), and upriver area (flood = 0.26±0.19, dry = 0.38±0.35). The mean niche overlap between pairs of species (Fig. 3) did not vary significantly among areas (Kruskal-Wallis K = 0.92; p = 0.818) nor seasons (K = 0. 82; p = 0.734). Tables A1-A8 in the Appendix show all Pianka's index values.

In general, niche overlap was greater in pairs of more specialized species, such as the piscivores:

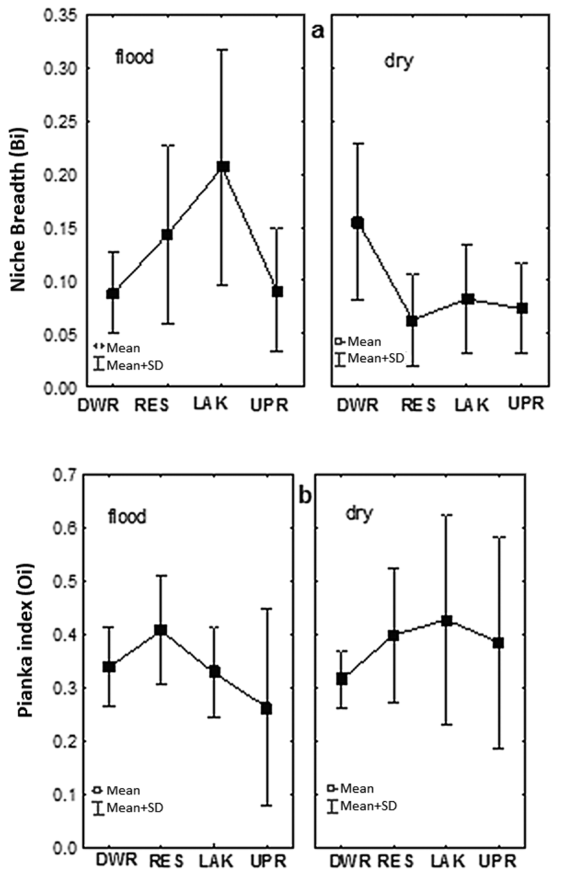

Figure 3 - Fish communities from areas under influence of Coaracy Nunes Dam: a) Niche breadth; b) Pianka's Index (overlap niche). DWR: Downriver area; RES: Reservoir; LAK = Lacustrine area and UPR: Upriver area.

A. ucayalensis, Acestrorhynchus falcirostris, P. ornatus, B. cuvieri, S. gibbus, Serrasalmus rhombeus, Electrophorus electricus, and *Hoplias aimara*; detritivores: *Curimata inornata, P.* aff. *falcata, Hypostomus plecostomus*, *Pimelodus spinosus, Bivibranchia notata, H. duriventris*, and *Peckoltia oligospila* and some omnivores, e.g., *T. auritus, T. angulatus, L. affinis, G. proximus*, and *H. unimaculatus*, who fed preferentially on plant material, insects, and detritus. Herbivorous species, such as *T. trilobatus* and *Metynnis lippincottianus*, also presented relatively high levels of overlap, as did omnivores like *L. affinis* and *L.* aff. *parae*, who consumed large amounts of plant material, insects, and detritus. *Pachypops folcroi* had a relatively diverse diet, feeding preferentially on fish, but also insects, zooplankton, and detritus, which reinforced the overlap of the feeding niche of this species with piscivores and omnivores.

The highest proportions of high overlap values (Oi > 0.6) were recorded in the upriver area during the flood period (37.5%), in the reservoir during both seasons (35.5%), and in downriver area, also during both seasons (31.5%). In the lacustrine area (dry = 28.57%; flood = 26.39%), high overlap values were less frequent, since they were in the upriver area during the dry season (26.5%).

These high values of Oi (> 0.6) could be indicative of the influence of interspecific competition between the pairs of species. However, observed overlap was significantly higher ($p < 0.05$) than expected according to the null (RA3) models (Table III), exposing that interspecific competition may not have constituted a major pressure in any of the seasons in any of the study areas.

TABLE III
Probability test of null models (RA3) between the mean observed and expected trophic niche overlap for fish assemblages in the areas of influence of Coaracy Nunes Dam (State of Amapá, Brazil). (p-value = pobs averages observed; pesq = p-value of expected average).

Area - Season	Mean observed	Mean estimate	pobs > pesp
Downriver- dry	0.33	0.24	0.001
Downriver- flood	0.34	0.17	0.000
Reservoir- dry	0.34	0.17	0.000
Reservoir- flood	0.38	0.24	0.001
Lacustrine- dry	0.34	0.19	0.001
Lacustrine- flood	0.35	0.25	0.005
Upriver- dry	0.28	0.16	0.001
Upriver- flood	0.31	0.15	0.010

During the present study, large quantities of *Macrobrachium* shrimp were captured as bycatch during trawls, especially in the impounded areas, which indicates the availability of this resource as a local complementary item used by many species and as the main item for *M. chrysargyrea* and *G. proximus*.

DISCUSSION

Small seasonal variation between consumed items in the different areas caused insignificant change on the breadth values of the seasons and areas. The smallest seasonal variation in diets of piscivores, herbivores and detritivores may reflect the abundances of the resources exploited by these guilds throughout the study period. While discreet, the variation observed in the diets of the species of the remaining guilds was probably related to seasonal fluctuations in the availability of preferred items. Niche overlap did not change either, and despite high values concerning some guilds, especially detritivores and piscivores, the interspecific competition does not control the community development. Despite the high diversity of fish species in the reservoir (108), 47 of them remain in the same guilds regardless of season or region. Following 40 years of damming, fish species in Coaracy Nunes reservoir apparently reached trophic homogeneity.

Even though in some environments the temporal dynamics influence the carbon source and consequently the diet composition of many fish species (Zeug and Winemiller 2008) in different habitats in Pantanal, a Brazilian floodplain, there is no pattern on the use of seasonal food resources (Novakowski et al. 2008, Angelini et al. 2013). In our study, few generalist species such as *L. affinis* and *C. gibbosus* and the piscivore-omnivores *A. falcirostris* and *P. ornatus* showed opportunistic feeding behavior, which was probably related to the seasonal resource abundance (Araújo-Lima et al. 1995). Otherwise the highly specialized feeding behavior of some species, such as the piscivores *H. aimara, B. cuvieri*, and *S. gibbus*, can be accounted for by the relative abundance of prey species (e.g., *H. unimaculatus*) within all the areas studied.

The relatively high frequencies of fish, crustaceans, insects, plant material, and detritus in the diets of the species analyzed in the present study are similar to the pattern recorded in other reservoirs in Brazil (Ferreira 1984, Hahn et al. 1998) reflecting the typical pattern expected for a fish community in South America, in particular in artificial reservoirs (Mérona et al. 2001, Loureiro 2000, Angelini et al. 2006) where the opportunistic behavior does not mean that the species are able to use the full diversity of available feeding resources, but that they may shift from one resource to another, according to their needs (Gerking 1994).

In the same way, low levels of consumption of plankton in the study areas, as well as the absence of fish species specialized for the exploitation of this resource were consistent with the reduced abundance of planktivores in reservoirs, as recorded at a number of locations (e.g., Agostinho et al. 1994, Hahn et al. 1998, Delariva 2002). Species in downriver area, consumed more plankton than in other areas, but even so, in small amounts. This area is mainly characterized by a more heterogeneous environment, with marginal lakes rich in nutrients that may support the production of phytoplankton, which are transferred to the river during the ebb period, but other resources seem more abundant since they were more prevalent in stomachs contents.

The presence of plant material in the diets of a number of species in all four study areas could be related to the availability of this resource, derived from the riparian vegetation, which occurs throughout the study area, and contributes with fruits, seeds, flowers, and filamentous algae to the resource base. This indicates that the colonization of environments such as reservoirs by herbivorous species is related to both the composition of the original fish fauna of the river prior to impoundment (Agostinho et al. 1999, Silva et al. 2008) and the availability of this resource, derived primarily from the riparian vegetation (Barthem and Goulding 1997). In the present study, despite the small number of herbivorous species recorded overall, plant material was an important complement of the diets of many species, in particular, omnivores.

The coexistence of species with the same feeding habits depends on the breadth and overlap of their niches (Pielou 1972, Evans 1983). While we did not detect any seasonal variation in niche breadth in any of the study areas, the broader niches recorded in the reservoir and lake during the flood period could indicate that a more ample resource base, in terms of both diversity and abundance, was available during this period. Mérona et al. (2003) concluded that the reduced niche breadth generally found in reservoir fishes – as observed in the present study – indicates that the populations of generalist species could become reduced in size or even extinct as the environment becomes increasingly stable.

It seems reasonable to conclude that the adoption of a more specialized feeding strategy may be advantageous in older reservoirs (Silva et al. 2008), and that this tendency may at least partly account for the predominance of the narrow niches recorded in the present study, given that Coaracy Nunes reservoir is now more than 40 years old. These results also suggest that niche breadth is not an important factor regulating the diversity of species in the reservoir or lake area, and that this conclusion also applies to other reservoirs (Agostinho et al. 2005), given that, theoretically, a reduction in niche breadth would be expected with an increase in the number of species in the community (Schoener 1974).

In the downriver area, the broader niches recorded during the dry season could have been related to the increase in environmental heterogeneity and the abundance of resources caused by decrease of level of water which lead to the creation of many habitats and increased the density of fish fauna. These factors tend to reinforce competition, which would force the less competitive and/or more specialized species to modify their diets or include additional items in order to coexist (Pielou 1972).

The high degree of niche overlap recorded in the present study for piscivores and detritivores may reflect the relatively ample categories adopted for the classification of the resources exploited by these guilds. This could have resulted in an overestimate of overlap (Uieda 1983, Sabino and Castro 1990), given that the specific details that differentiate the diets could have been overlooked.

Overlap in the detritivores was related primarily to the marked abundance of this resource throughout the study area, without necessarily being reflected in competitive processes given that, in addition to the relative abundance of resources, the species tended to segregate over time and space during foraging, especially in complex habitats (Matthews 1998, Schoener 1974, Colwell and Futuyma 1971).

The null model analysis indicated that mean niche overlap was significantly higher than that expected, which suggested that interspecific competition was not a significant mechanism of niche partitioning in any of the fish communities within the study area, and that the species tended to share the most abundant resources. Under these conditions, the absence of competition would be expected (Pianka 2000), and variation in population parameters would be determined by fluctuations in abiotic factors, such as the unpredictable daily variation in the level of the reservoir, which creates a permanent state of instability on the study area. This affects, not only the feeding behavior, but also the reproductive patterns and the predator defense of the different species (Agostinho et al. 1999, Oliveira et al. 2005).

CONCLUSION

The results of the present study indicated that the species that composed the fish communities of the area influenced by the Coaracy Nunes reservoir were able to share preferred resources with small variations among seasons and areas, reflecting feeding resources abundance. Niche overlap did not change either, and despite high values concerning some guilds, especially detritivores and piscivores, whose resources were abundant, and interspecific competition does not control the community development.

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RESUMO

Nós investigamos a amplitude e a sobreposição de nicho de espécies de peixes que ocorrem em quatro ambientes afetados pelo reservatório Coaracy Nunes, no Estado brasileiro do Amapá. Amostras sazonais de peixes foram coletadas usando uma configuração padrão com malhadeiras, tarrafas, linhas e armadilhas. Quinhentos e quarenta conteúdos estomacais, representando 47 espécies de peixes, foram analisados e quantificados. Amplitude e sobreposição de nichos foram estimadas usando os índices de Levin e Pianka, respectivamente, enquanto a competição interespecífica foi avaliada usando (RA3) modelo nulo. ANOVA e o teste de Kruskal-Wallis foram usados para avaliar, respectivamente, as diferenças de amplitude e sobreposição de nichos entre áreas. Os dados indicaram que a maioria das espécies de peixes pertence às guildas de psicívoros, onívoros e detritívoros. Estas espécies provavelmente colonizaram os ambientes devido à disponibilidade de adequados recursos alimentares e às favoráveis condições físicas criadas pelo represamento do rio. De maneira geral, poucas espécies têm nichos amplos, mas muitas delas são altamente especializadas. Variação sazonal de recursos tem pouco efeito no comportamento alimentar da maioria das espécies nas áreas de estudo. Os modelos nulos indicaram que competição não foi um fator determinante na estrutura da comunidade.

Palavras-chave: competição, reservatório neotropical, dieta, coexistência de espécies.

REFERENCES

Abelha MCF, Goulart E, Kashiwaqui EAL and Silva MR. 2006. *Astyanax paranae* Eigenmann, 1914 (Characiformes: Characidae) in the Alagados Reservoir, Paraná, Brazil: diet composition and variation. Neo Icht 4: 349-356.

Agostinho AA, Júlio HF Jr and Petrere M Jr. 1994. Itaipu reservoir (Brazil): impacts of the impoundment on the fish fauna and fisheries. In: Cowx IG (Org), Rehabilitation of freshwater fisheries. Oxford, UK: Fishing News Books/ Blackwell Scientific Publication, p. 171-184.

Agostinho AA, Miranda LE, Bini LM, Gomes LC, Thomaz SM and Suzuki HI. 1999. Patterns of Colonization in Neotropical Reservoirs, and Prognoses on Aging. In: TUNDISI JG AND STRAŠKRABA M (Eds), Theoretical Reservoir Ecology and its Applications. International Institute of Ecology, p. 227-265.

Agostinho AA, Thomaz SM and Gomes LC. 2005. Conservação da biodiversidade em águas continentais do Brasil. Megadiv 1: 70-78.

Albrecht M and Gotelli NK. 2001. Spatial and temporal niche partitioning in grassland ants. Oec 26: 134-141.

ANA - Agência Nacional de Águas. 2011. www.ana.gov.br. Acesso em 20/08/2012

Angelini R, Agostinho AA and Gomes LC. 2006. Modeling energy flow in a large Neotropical reservoir: a tool do evaluate fishing and stability. Neo Icht 4: 253-260.

Angelini R, Morais RJ, Catella AC, Resende EK and Libralato S. 2013. Aquatic food webs of the oxbow lakes in the Pantanal: a new site for fisheries guaranteed by alternated control? Ecol Model 253: 82-96.

Araújo-Lima CARM, Agostinho AA and Fabré NN. 1995. Trophic aspects of fish communities in Brazilian rivers and reservoirs. In: TUNDISI JG, BICUDO CEM AND MATSUMURA-TUNDISI T (Eds), Limnology in Brazil**.** Brazilian Academy of Science/Brazilian Limnological Society, São Paulo, p. 105-136.

Barthem R and Goulding M. 1997. The catfish connection: ecology, migration and conservation of Amazonian predators.New York, Columbia University Press, 144 p.

Bezerra PE et al. 1990. Projeto de zoneamento de recursos naturais da Amazônia Legal. IBGE/Departamento de Recursos Naturais e Estudos Ambientais, RJ, 212 p.

Buckup PA, Menezes NA and Ghazzi MS. 2007. Catálogo das espécies de peixes de água doce do Brasil. Rio Janeiro, Museu Nacional, 195 p.

Casatti L, Mendes HF and Ferreira KM. 2003. Aquatic macrophytes as feeding site for small fishes in the Rosana Reservoir, Paranapanema River, Southeastern Brazil. Braz J of Biol 63(2): 213-222.

Cassemiro FAZ, Rangel TFLVB, Pelicice FM and Hahn NS. 2008. Allometric and ontogenetic patterns related to feeding of a neotropical fish, Satanoperca pappaterra (Perciformes, Cichlidae). Ecol Fresh Fish 17: 155-164. doi: 10.1111/j.1600-0633.2007.00270.x

Colwell RK and Futuyma DJ. 1971. On the measurement of niche breath and overlap. Ecol 52: 567-576.

Conover WJ. 1990. Practical nonparametric statistics. New Jersey, J Willey & Sons, 584 p.

Corrêa CE, Albrecht MP and Hahn NS. 2011. Patterns of niche breadth and feeding overlap of the fish fauna in the seasonal Brazilian Pantanal, Cuiabá River basin. Neo Icht 9(3): 637-646.

Delariva RL. 2002. Ecologia trófica da ictiofauna do Rio Iguaçu, PR, e efeitos 'decorrentes do represamento de Salto Caxias. Tese de Doutorado. Curso de Pós-Graduação em Ecologia de Ambientes Aquáticos Continentais. Universidade Estadual de Maringá, 65 p.

Esteves KE and Galetti PM. 1994. Feeding ecology of *Moenkhausia intermedia* (Pisces, Characidae) in a small oxbow lake of Mogi-Guaçu River, São Paulo, Brazil. Int Vere fuer Theo und Ange Lim Verh 25: 2198-2204.

Evans S. 1983. Production, Predation and Food Niche Segregation in a Marine Shallow Soft - Bottom Community. Mar Ecol 10: 147-157.

ELETRONORTE. 1997. www.eln.gov.br. Acessed in 20/04/2012

Ferreira EJG. 1984. A ictiofauna da represa hidrelétrica de Curuá-Una, Santarém, Pará. Amaz 3: 351-363.

Gaspar da Luz KD, Abujanra F, Agostinho AA and Gomes LC. 2001. Caracterização trófica de três lagoas na planície aluvial do alto rio Paraná, Brasil. Acta Sci 23: 401-407.

Gerking SD. 1994. Feeding ecology of fish. San Diego, Academic, 416 p.

Gotelli NJ and Entsminger GL. 2006. EcoSim: nullmodels software for ecology. Version 7. Acquired Intelligence Inc. and Kesey-Bear. Jericho, VT05465. http://garyentsminger.com/ecosim.htm.

Goulding M. 1980. The fishes and the forest: explorations in amazon natural history. Berkeley: University of California Press, 280 p.

Grossman GD. 1986. Food resources partitioning in a rocky intertidal fish assemblage. J Zool 1: 317-355.

Hahn NS, Agostinho AA, Gomes LC and Bini LM. 1998. Estrutura trófica da ictiofauna do reservatório de Itaipu (Paraná – Brasil) nos primeiros anos de sua formação. Interc 23: 229-235.

Hahn NS and Delariva L. 2003. Métodos para avaliação da alimentação natural de peixes: o que estamos usando? Interciencia 28: 100-104.

Hahn NS, Fugi R, Lourero-Crippa VE, Peretti D and Russo MR. 2004. Trophic structure of the fish fauna. In: Agostinho AA, Rodrigues L, Gomes LC, Thomaz SM and Miranda LE (Eds), Structure and functioning of the Paraná River and its floodplain. Maringá, EDUEM, p. 139-143.

Hynes HBN. 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. J An Ecol 19: 36-57.

Hyslop EJ. 1980. Stomach contents analysis - a review of methods and their application. J Fish Biol 17: 411-429.

IBGE - Instituto Brasileiro de Geografia e Estatística. 2010. www.ibge.gov.br. Acesso: 25/07/2012

Kawakami E and Vazzoler G. 1980. Método gráfico e estimativa de índice alimentar aplicado no estudo de alimentação de peixes. Bol Inst Oceanogr 29: 205-207.

Joern A and Lawlor LR. 1981. Guild structure in grasshopper assemblages based on food and micrihabitat resources. Oik 37: 93-104.

Lappalainen J and Soininen J. 2006. Latitudinal gradients in niche breadth and position-regional patterns in freshwater fish. Natur 93: 246-250. DOI 10.1007/s00114-006-0093-2.

Loureiro VE. 2000. Dieta da ictiofauna nos períodos de pré e pós-barramento do rio Jordão-PR-Brasil. Dissertação de Mestrado. Universidade Estadual de Maringá, Maringá. (Unpublished).

Matthews WJ. 1998. Patterns in freshwater fish ecology. New York: Chapman and Hall.

Mérona B and Mérona JR. 2004. Food resource partitioning in a fish community of central Amazon floodplain. Neo Icht 2: 75-84.

Mérona B, Vigouroux R and Horeau V. 2003. Changes in food resources and their utilization by fish assemblages in a large tropical reservoir in South America (Petit-Saut Dam, French Guiana). Acta Oecol 24: 147-456.

Mérona B, Vigouroux R and Tejerina-Garro FL. 2005. Alteration of fish diversity downstream from Petit-Saut Dam in French Guiana. Implication of ecological strategies of fish species. Hydr 551: 33-47.

Mérona D, Santos GM and Almeida RG. 2001. Short term effects of Tucuruí Dam (Amazônia, Brazil) on the trophic organization of fish communities. Environ Biol Fish 60: 375-392.

Novakowski GC, Hahn NS and Fugi R. 2007. Feeding of piscivorous fish before and after the filling of the Salto Caxias Reservoir, Parana State, Brazil. Bio Neotrop 7(2): 149-157.

Novakowski GC, Hahn NS and Fugi R. 2008. Diet seasonality and food overlap of the fish assemblage in a pantanal pond. Neo Icht 6: 567-576.

Oliveira EF, Minte-Vera CV and Goulart E. 2005. Structure of fish assemblages along spatial gradients in a deep subtropical reservoir (Itaipu Reservoir, Brazil-Paraguay border). Environ Biol Fish 72: 283-304.

Pianka ER. 1969. Notes on the biology of *Varanus caudolineatus* and *Varanus gilleni*. West Aust Nat 11: 76-82.

Pianka ER. 1973. The structure of lizard communities. Ann Rev Ecol Syst 4: 53-74.

Pianka ER. 2000. Evolutionary ecology. 6th ed., San Francisco: Addison Wesley Longman.

PIATAM I. 2008. Peixes de lagos do Médio Rio Solimões. In: Soares MGM - 2^{a} ed., Manaus (AM).

Pielou EC. 1972. Niche width and niche overlap: A method for measuring them. JSTOR: Ecol 53: 687-692.

Planquette P, Keith P and Le Bail PY. 1996. Atlas des Poissons D'eau Douce de Guyane (tome I). Paris, Service du Patrimoine Naturel, Instutut d'Ecologie et de Gestion de laBiodiversite, 430 p.

PREJS A AND PREJS K. 1987. Feeding of tropical freshwater fishes: seasonality in resource availability and resource use. Oecol 71: 397-404.

SABINO J AND CASTRO RMC. 1990. Alimentação, período de atividade e distribuição espacial dos peixes de um riacho da floresta Atlântica (Sudeste do Brasil). Rev Brasil Biol 50: 23-36.

SANTOS GM. 1995. Impactos da hidrelétrica Samuel sobre as comunidades de peixes do rio Jamari (Rondônia, Brasil). Acta Am 25(3-4): 247-280.

SANTOS GM, MERONA B, JURAS AA AND JEGU M. 2004. Peixes do Baixo Tocantins: 20 anos depois da Usina Hidrelétrica de Tucuruí. Brasília, Eletronorte, 216 p.

SCHOENER TW. 1974. Resource partitioning in ecological communities. Sci 185: 27-39.

SEGURADO P, SANTOS JM, PONT D, MELCHER AH, JALON DG, HUGHES RM AND FERREIRA MT. 2011. Estimating species tolerance to human perturbation: Expert judgment versus empirical approaches. Ecol Ind 11: 1623-1635.

SILVA CCS, FERREIRA EFG AND DEUS CP. 2008. Dieta de cinco espécies de Hemiodontidae (Teleostei, Characiformes) na área de influência do reservatório de Balbina, rio Uatumã, Amazonas, Brasil. Iher Sér Zool 98(4): 464-468.

SOKAL R AND ROHLF FJ. 1995. Biometry. New York, W. H. Freeman, 859 p.

UIEDA VS. 1983. Regime alimentar, distribuição espacial e temporal de peixes (Teleostei) em um riacho na região de Limeira, São Paulo. Dissertação de Mestrado. Universidade Estadual de Campinas, 151 p. (Unpublished).

WINEMILLER KO AND PIANKA ER. 1990. Organization in natural assemblages of desert lizards and tropical fishes. Ecol Mono 60: 27-55.

ZEUG SC AND WINEMILLER KO. 2008. Evidence supporting the importance of terrestial carbon in a large-river food web. Ecol 89(6): 1733-1743.

APPENDICES (TABLES A1 - A9)

Observation: Abbreviations corresponding to first letter of Genus and species, respectively, for instance: *Hemiodus unimaculatus*: Hu; *Ageneiosus ucayalensis*: Au; and so on.

TABLE A1
Niche overlap between pairs of species analyzed from Downriver area of Coaracy Nunes Dam, Ferreira Gomes - Amapá (AM-Brazil).

Down River - flood	*Hu*	*Au*	*Hdu*	*Lap*	*Pol*	*Bc*	*Psp*	*Cg*	*Hyp*	*Paf*	*Af*	*Gp*	*Laf*	*Mlip*	*Sg*	*Hou*	*Psqua*	*Ttri*	*Hai*	*Mcry*	*Pfoi*	*Raff*	*Talb*	*Tau*
Hemiodus unimaculatus		0.04	0.77	0.38	0.77	0.00	0.77	0.03	0.77	0.77	0.00	0.51	0.82	0.61	0.00	0.00	0.06	0.54	0.00	0.00	0.00	0.02	0.37	0.63
Ageneiosus ucayalensis			0.05	0.89	0.05	0.99	0.05	0.93	0.05	0.05	0.96	0.00	0.54	0.00	1	0.96	0.88	0.00	0.99	0.00	0.95	0.88	0.00	0.00
Harttia duriventris				0.14	1.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leporinus af. parae					0.14	0.88	0.14	0.82	0.14	0.14	0.85	0.36	0.83	0.44	0.9	0.85	0.78	0.34	0.88	0.00	0.84	0.78	0.18	0.42
Peckoltia oligospila						0.00	1.00	0.00	1.00	1.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boulengerella cuvieri							0.00	0.93	0.00	0.00	0.97	0.00	0.51	0.00	1.00	0.97	0.88	0.00	1.00	0.00	0.95	0.88	0.00	0.00
Pseudacanthicus spinosus								0.00	1.00	1.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Charax gibbosus									0.00	0.00	0.97	0.15	0.48	0.00	0.9	0.97	0.94	0.15	0.93	0.00	0.88	0.98	0.17	0.05
Hypostomus plecostomus										1.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Psectrogaster af. falcata											0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acestrorhynchus falcatus												0.13	0.49	0.00	1	1.00	0.88	0.01	0.97	0.23	0.92	0.96	0.00	0.00
Geophagus proximus													0.57	0.83	0.00	0.13	0.04	0.68	0.00	0.53	0.00	0.24	0.33	0.80
Leporinus affinis														0.65	0.5	0.49	0.45	0.53	0.51	0.00	0.49	0.45	0.28	0.66
Metynnis lippincottianus															0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.40	0.97
Serrasalmus gibbus																0.97	0.88	0.00	1.00	0.00	0.95	0.88	0.00	0.00
Hoplerythrinus unitaeniatus																	0.88	0.01	0.97	0.23	0.92	0.96	0.00	0.00
Plagioscion squamosissimus																		0.28	0.88	0.08	0.84	0.88	0.39	0.10
Triportheus trifurcatus																				0.09	0.00	0.12	0.85	0.90
Hoplias aimara																				0.00	0.95	0.88	0.00	0.00
Moenkhausia chysargyrea																					0.00	0.42	0.09	0.00
Pachypops fourcroi																						0.84	0.00	0.00
Roeboides affinis																							0.12	0.03
Triportheus albus																								0.60
Triportheus auritus																								

TABLE A2
Niche overlap between pairs of species analyzed from Downriver area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Down River - dry	*Hu*	*Au*	*Bc*	*Sg*	*Hdur*	*Lap*	*Ttri*	*Cg*	*Hyp*	*Psqua*	*Psp*	*Afa*	*Ab*	*Gprox*	*Gjos*	*Lpet*	*Po*	*Rlapd*	*Sacu*	*Bntt*	*Cflav*	*Hmicr*	*Hyets*	*Pflav*	*Rsept*
Hemiodus unimaculatus		0.00	0.00	0.00	0.68	0.55	0.68	0.03	0.68	0.06	0.68	0.00	0.72	0.60	0.7	0.94	0.00	0.60	0.78	0.68	0.46	0.84	0.68	0.03	0.53
Ageneiosus ucayalensis			1.00	1.00	0.00	0.81	0.00	0.95	0.00	0.80	0.00	0.91	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00
Boulengerella cuvieri				1.00	0.00	0.81	0.00	0.95	0.00	0.80	0.00	0.91	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00
Serrasalmus gibbus					0.00	0.81	0.00	0.95	0.00	0.80	0.00	0.91	0.00	0.00	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.92	0.00
Harttia duriventris						0.32	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.41	0.00	0.20	0.47	1.00	0.00	0.27	1.00	0.00	0.00
Leporinus af. parae							0.48	0.77	0.32	0.65	0.32	0.74	0.43	0.26	0.3	0.54	0.78	0.26	0.38	0.32	0.26	0.55	0.32	0.75	0.28
Tometes trilobatus								0.00	0.00	0.00	0.00	0.00	0.89	0.55	0.00	0.83	0.00	0.40	0.47	0.00	0.54	0.95	0.00	0.00	0.60
Charax gibbosus									0.00	0.92	0.00	0.98	0.08	0.11	0.00	0.06	0.99	0.08	0.06	0.00	0.04	0.00	0.00	0.98	0.05
Hypostomus plecostomus										0.00	1.00	0.00	0.00	0.00	1.00	0.41	0.00	0.20	0.47	1.00	0.00	0.27	1.00	0.00	0.00
Plagioscion squamosissimus											0.00	0.91	0.15	0.22	0.00	0.12	0.89	0.16	0.25	0.00	0.29	0.00	0.00	0.96	0.10
Pseudacanthicus spinosus												0.00	0.00	0.00	1.00	0.41	0.00	0.20	0.47	1.00	0.00	0.27	1.00	0.00	0.00
Acestrorhynchus falcatus													0.02	0.00	0.00	0.03	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00
Astyanax bimaculatus														0.86	0.00	0.90	0.01	0.66	0.64	0.00	0.65	0.85	0.00	0.09	0.73
Geophagus proximus															0.00	0.74	0.00	0.73	0.65	0.00	0.60	0.53	0.00	0.12	0.65
Glyptoperichthys joselimaianus																0.41	0.00	0.20	0.47	1.00	0.00	0.27	1.00	0.00	0.00
Laemolyta petiti																	0.02	0.63	0.75	0.41	0.60	0.91	0.41	0.07	0.62
Pimelodus ornatus																		0.00	0.00	0.00	0.00	0.00	1.00	0.97	0.00
Retroculus lapidifer																			0.76	0.20	0.55	0.50	0.20	0.09	0.92
Satanoperca acuticeps																				0.47	0.81	0.61	0.47	0.14	0.69
Bivibranchia notata																					0.00	0.27	1.00	0.00	0.00
Chaetobranchus flavescens																						0.53	0.00	0.16	0.60
Hemiodus microlepis																							0.27	0.00	0.63
Hypostomus emarginatus																								0.00	0.00
Pellona flavippinis																									0.06
Retroculus septentrionalis																									

TABLE A3
Niche overlap between pairs of species analyzed from Reservoir area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Reservoir - dry	*Af*	*Au*	*Bc*	*Sg*	*Ee*	*Cg*	*Po*	*Gp*	*Hu*	*Lap*	*Laf*	*Lsp*	*Tan*	*Tau*	*Paf*	*Psp*	*Cin*	*Hyp*	*Mly*	*Ttri*
Acestrorhynchus falcirostris		1.00	1.00	1.00	1.00	0.97	0.97	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ageneiosus ucayalensis			1.00	1.00	1.00	0.97	0.97	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boulengerella cuvieri				1.00	1.00	0.97	0.97	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serrasalmus gibbus					1.00	0.97	0.97	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electrophorus electricus						0.97	0.97	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Charax gibbosus							0.94	0.04	0.00	0.29	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pimelodus ornatus								0.02	0.03	0.29	0.02	0.01	0.12	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Geophagus proximus									0.94	0.91	0.85	0.94	0.66	0.83	0.50	0.50	0.50	0.50	0.83	0.83
Hemiodus unimaculatus										0.93	0.93	0.98	0.71	0.93	0.30	0.30	0.30	0.30	0.92	0.92
Leporinus af. parae											0.89	0.94	0.62	0.87	0.30	0.30	0.30	0.30	0.90	0.90
Leporinus affinis												0.96	0.74	0.99	0.00	0.00	0.00	0.00	0.99	0.99
Leptodoras sp.													0.69	0.95	0.3	0.25	0.25	0.25	0.96	0.96
Triportheus angulatus														0.79	0.00	0.00	0.00	0.00	0.68	0.68
Triportheus auritus															0.00	0.00	0.00	0.00	0.97	0.97
Psectrogaster af. falcata																1.00	1.00	1.00	0.00	0.00
Pseudacanthicus spinosus																	1.00	1.00	0.00	0.00
Curimata inornata																		1.00	0.00	0.00
Hypostomus plecostomus																			0.00	0.00
Metynnis lippincottianus																				1.00
Tometes trilobatus																				

TABLE A4
Niche overlap between pairs of species analyzed from Reservoir area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Reservoir - flood	*Au*	*Hu*	*Sg*	*Gp*	*Af*	*Po*	*Tau*	*Raf*	*Cin*	*Hai*	*Paf*	*Lap*	*Pga*	*Tan*
Ageneiosus ucayalensis		0.12	0.98	0.03	0.98	0.88	0.00	0.68	0.18	0.98	0.18	0.35	0.46	0.03
Hemiodus unimaculatus			0.00	0.52	0.00	0.02	0.69	0.44	0.69	0.00	0.69	0.83	0.78	0.51
Serrasalmus gibbus				0.00	1.00	0.90	0.00	0.58	0.00	1.00	0.00	0.30	0.37	0.00
Geophagus proximus					0.00	0.22	0.71	0.34	0.09	0.00	0.09	0.52	0.60	0.94
Acestrorhynchus falcirostris						0.90	0.00	0.60	0.00	1.00	0.00	0.30	0.37	0.00
Pimelodus ornatus							0.07	0.76	0.00	0.90	0.00	0.27	0.34	0.15
Triportheus auritus								0.10	0.00	0.00	0.00	0.87	0.73	0.79
Roeboides affinis									0.60	0.60	0.60	0.35	0.44	0.20
Curimata inornata										0.00	1.00	0.30	0.37	0.00
Hoplias aimara											0.00	0.30	0.37	0.00
Psectrogaster af. falcata												0.30	0.37	0.00
Leporinus af. parae													0.91	0.62
Parauchenipterus galeatus														0.71
Triportheus angulatus														

TABLE A5
Niche overlap between pairs of species analyzed from Lacustrine area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Lacustrine - dry	*Af*	*Ag*	*Bc*	*Po*	*Cg*	*Sg*	*Hu*	*Laf*	*Pb*	*Tan*	*Tau*	*Cin*	*Paf*	*Psp*	*Hyp*
Acestrorhynchus falcirostris		0.90	0.90	0.75	0.96	0.93	0.11	0.53	0.75	0.15	0.02	0.00	0.00	0.00	0.00
Ageneiosus ucayalensis			1.00	0.55	0.97	0.99	0.00	0.48	0.83	0.00	0.00	0.00	0.00	0.00	0.00
Boulengerella cuvieri				0.55	0.97	0.99	0.00	0.48	0.83	0.00	0.00	0.00	0.00	0.00	0.00
Pimelodus ornatus					0.65	0.64	0.30	0.53	0.46	0.42	0.07	0.00	0.00	0.00	0.00
Charax gibbosus						0.98	0.08	0.51	0.81	0.11	0.01	0.06	0.06	0.06	0.06
Serrasalmus gibbus							0.40	0.51	0.82	0.05	0.01	0.00	0.00	0.00	0.00
Hemiodus unimaculatus								0.71	0.40	0.56	0.75	0.54	0.54	0.54	0.54
Leporinus affinis									0.85	0.58	0.83	0.00	0.00	0.00	0.00
Pimelodus blochii										0.28	0.55	0.00	0.00	0.00	0.00
Triportheus angulatus											0.55	0.00	0.00	0.00	0.00
Triportheus auritus												0.00	0.00	0.00	0.00
Curimata inornata													1.00	1.00	1.00
Psectrogaster af. falcata														1.00	1.00
Pseudacanthicus spinosus															1.00
Hypostomus plecostomus															

TABLE A6
Niche overlap between pairs of species analyzed from Lacustrine area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Lacustrine - flood	*Cin*	*Gp*	*Af*	*Au*	*Cg*	*Sg*	*Hu*	*Po*	*Ra*	*Tau*	*Laf*	*Paf*	*Pfo*
Curimata inornata		0.20	0.00	0.13	0.00	0.00	0.54	0.15	0.00	0.00	0.19	1.00	0.15
Geophagus proximus			0.24	0.11	0.08	0.00	0.48	0.18	0.61	0.62	0.72	0.20	0.09
Acestrorhynchus falcirostris				0.89	0.94	0.91	0.00	0.85	0.14	0.00	0.43	0.00	0.85
Ageneiosus ucayalensis					0.97	0.97	0.17	0.98	0.15	0.01	0.46	0.13	0.96
Charax gibbosus						0.99	0.17	0.93	0.09	0.01	0.44	0.00	0.94
Serrasalmus gibbus							0.00	0.92	0.00	0.00	0.39	0.00	0.92
Hemiodus unimaculatus								0.19	0.27	0.42	0.68	0.54	0.30
Pimelodus ornatus									0.29	0.01	0.45	0.15	0.92
Roeboides affinis										0.03	0.22	0.00	0.17
Triportheus auritus											0.81	0.00	0.02
Leporinus affinis												0.19	0.51
Psectrogaster af. falcata													0.15
Pachypops fourcroi													

TABLE A7
Niche overlap between pairs of species analyzed from Upriver area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Up River - dry	*Af*	*Au*	*Bc*	*Cg*	*Ee*	*Sg*	*Srh*	*Gp*	*Hu*	*Lsp*	*Tan*	*Tau*	*Paf*	*Psp*	*Hyp*	*Cin*
Acestrorhynchus falcirostris		0.98	1.00	0.97	0.83	1.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ageneiosus ucayalensis			0.98	0.98	0.82	0.98	0.90	0.02	0.01	0.00	0.05	0.02	0.00	0.00	0.00	0.00
Boulengerella cuvieri				0.97	0.83	1.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Charax gibbosus					0.80	0.97	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electrophorus electricus						0.83	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serrasalmus gibbus							0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Serrasalmus rhombeus								0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Geophagus proximus									0.43	0.00	0.72	0.86	0.00	0.00	0.00	0.00
Hemiodus unimaculatus										0.27	0.41	0.49	0.86	0.86	0.9	0.86
Leptodoras sp.											0.00	0.00	0.31	0.31	0.3	0.31
Triportheus angulatus												0.83	0.00	0.00	0.00	0.00
Triportheus auritus													0.00	0.00	0.00	0.00
Psectrogaster af. falcata														1.00	1.00	1.00
Pseudacanthicus spinosus															1.00	1.00
Hypostomus plecostomus																1.00
Curimata inornata																

TABLE A8
Niche overlap between pairs of species analyzed from Upriver area of Coaracy Nunes Dam, Ferreira Gomes – Amapá (AM-Brazil).

Up River - flood	*Au*	*Sg*	*Lsp*	*Af*	*Ee*	*Tan*	*Hyp*	*Tau*
Ageneiosus ucayalensis		0.95	0.05	0.98	0.81	0.00	0.12	0.00
Serrasalmus gibbus			0.00	0.97	0.94	0.00	0.00	0.00
Leptodoras sp.				0.00	0.00	0.78	0.44	0.85
Acestrorhynchus falcirostris					0.83	0.00	0.00	0.00
Electrophorus electricus						0.00	0.00	0.00
Triportheus angulatus							0.00	0.97
Hypostomus plecostomus								0.00
Triportheus auritus								

TABLE A9
Species sampled in all areas of Coaracy Nunes Dam (Brazil)

Taxa
CLASSE OSTEICHTHYES
ORDEM CHARACIFORMES
Família Acestrorhynchidae
Acestrorhynchus falcatus (Bloch, 1794)
Acestrorhynchus falcirostris (Cuvier, 1819)
Família Anostomidae
Laemolyta petiti (Géry, 1964)
Leporinus af. parae (Eigenmann, 1908)
Leporinus affinis (Günther, 1864)
Leporinus friderici (Bloch, 1794)
Leporinus maculatus (Müller & Troschel, 1844)
Leporinus taeniatus (Lütken, 1875)
Schizodon fasciatus (Spix & Agassiz, 1829)
Schizodon vittatus (Valenciennes, 1850)
Família Characidae
Agoniates halecinus (Müller & Troschel, 1845)
Astyanax bimaculatus (Linnaeus, 1758)
Bryconops caudomaculatus (Günther, 1864)
Charax gibbosus (Linnaeus, 1758)
Colossoma macropomum (Cuvier, 1818) *
Metynnis lippincottianus (Cope, 1870)
Moenkhausia chrysargyrea (Günther, 1864)
Moenkhausia collettii (Steindachner, 1882)
Moenkhausia oligolepis (Günther, 1864)
Mylesinus paraschomburgkii (Jégu, Santos & Ferreira, 1989)
Mylesinus paucisquamatus (Jégu & Santos, 1988)
Myleus rhomboidalis (Cuvier, 1818)
Myleus rubripinnis (Müller & Troschel, 1844)
Mylossoma duriventre (Cuvier, 1818)
Piaractus brachypomus (Cuvier, 1818)
Pristobrycon striolatus (Steindachner, 1908)
Pygopristis denticulata (Cuvier, 1819)
Roeboides affinis (Günther, 1868)
Serrasalmus elongatus (Kner, 1858)
Serrasalmus gibbus (Castelnau, 1855)
Serrasalmus rhombeus (Linnaeus, 1766)
Serrasalmus sp. (Cuvier, 1819)
Tetragonopterus chalceus (Spix & Agassiz, 1829)
Tometes trilobatus (Valenciennes, 1850)
Triportheus albus (Cope, 1872)
Triportheus angulatus (Spix & Agassiz, 1829)
Triportheus auritus (Valenciennes, 1850)
Triportheus trifurcatus (Castelnau, 1855)
Família Ctenoluciidae
Boulengerella cuvieri (Agassiz, 1829)
Família Curimatidae
Curimata inornata (Vari, 1989)
Curimata sp. (Linnaeus, 1766)
Curimatella dorsalis (Eigenmann & Eigenmann, 1889)
Cyphocharax gouldingi (Vari, 1992)
Cyphocharax notatus (Steindachner, 1908)
Psectrogaster af. *falcata* (Eigenmann & Eigenmann, 1889)
Família Erythrinidae
Hoplerythrinus unitaeniatus (Agassiz, 1829)
Hoplias aimara (Valenciennes, 1847)
Hoplias macrophthalmus (Pellegrin, 1907)
Hoplias malabaricus (Bloch, 1794)
Família Hemiodontidae
Bivibranchia notata (Vari & Goulding, 1985)
Hemiodus microlepis (Kner, 1858)
Hemiodus quadrimaculatus (Pellegrin, 1908)
Hemiodus unimaculatus (Bloch, 1794)
ORDEM PERCIFORMES
Família Cichlidae
Astronotus ocellatus (Agassiz, 1831)
Caquetaia spectabilis (Steindachner, 1875)
Chaetobranchus flavescens (Heckel, 1840)
Cichla monoculus (Spix & Agassiz, 1831)
Cichla ocellaris (Bloch & Schneider, 1801)
Crenicichla labrina (Spix & Agassiz, 1831)
Crenicichla strigata (Günther, 1862)
Geophagus proximus (Castelnau, 1855)
Geophagus surinamensis (Bloch, 1791)
Retroculus lapidifer (Castelnau, 1855)
Retroculus septentrionalis (Gosse, 1971)
Satanoperca acuticeps (Heckel, 1840)
Satanoperca jurupari (Heckel, 1840)
Família Sciaenidae
Pachypops fourcroi (La Cepède, 1802)
Plagioscion auratus (Castelnau, 1855)
Plagioscion squamosissimus (Heckel, 1840)
ORDEM SILURIFORMES
Família Auchenipteridae
Ageneiosus inermis (Linnaeus, 1766)
Ageneiosus ucayalensis (Castelnau, 1855)
Auchenipterus nuchalis (Spix & Agassiz, 1829)
Auchenipterus osteomystax (Miranda Ribeiro, 1918)
Parauchenipterus galeatus (Linnaeus, 1766)
Parauchenipterus sp. (Kner, 1858)
Família Callichthyidae
Hoplosternum littorale (Hancock, 1828)
Família Doradidae
Leptodoras sp. (Günther, 1868)
Megalodoras uranoscopus (Eigenmann & Eigenmann, 1888)
Família Heptapteridae
Pimelodella cristata (Müller & Troschel, 1848)

TABLE A9 (continuation)

Taxa	
Família Loricariidae	*Gymnotus* sp. (Linnaeus, 1758)
Dekeyseria amazonica (Rapp Py-Daniel, 1985)	**Família Sternopygidae**
Glyptoperichthys joselimaianus (Weber, 1991)	*Archolaemus blax* (Korringa, 1970)
Harttia duriventris (Rapp Py-Daniel & Oliveira, 2001)	*Sternopygus macrurus* (Bloch & Schneider, 1801)
Hemiancistrus sp. (Kner, 1854)	**ORDEM CLUPEIFORMES**
Hypostomus emarginatus (Valenciennes, 1840)	**Família Pristigasteridae**
Hypostomus plecostomus (Linnaeus, 1758)	*Pellona castelnaeana* (Valenciennes, 1847)
Peckoltia oligospila (Günther, 1864)	*Pellona flavipinnis* (Valenciennes,1836)
Pseudacanthicus spinosus (Castelnau, 1855)	**ORDEM BELONIFORMES**
Família Pimelodidae	**Família Belonidae**
Brachyplatystoma filamentosum (Lichtenstein, 1819)	*Potamorrhaphis guianensis* (Jardine, 1843)
Brachyplatystoma rousseauxii (Castelnau, 1855)	**ORDEM OSTEOGLOSSIFORMES**
Hypophthalmus marginatus (Valenciennes, 1840)	**Família Osteoglossidae**
Megalonema platycephalum (Eigenmann, 1912)	*Osteoglossum bicirrhosum* (Cuvier, 1829)
Pimelodina flavipinnis (Steindachner, 1877)	**ORDEM SYMBRANCHIFORMES**
Pimelodus blochii (Valenciennes, 1840)	**Família Simbrachidae**
Pimelodus ornatus (Kner, 1858)	*Simbranchus marmoratus*
Platynematichthys notatus (Jardine, 1841)	**CLASSE CHONDRICHTHYES**
Família Pseudopimelodidae	**ORDEM RAGIFORMES**
Pseudopimelodus bufonius (Valenciennes, 1840)	**Família Potamotrygonidae**
ORDEM GYMNOTIFORMES	*Potamotrygon constellata* (Vaillant, 1880)
Família Gymnotidae	*Potamotrygon humerosa* (Müller & Henle, 1841)
Electrophorus electricus (Linnaeus, 1766)	*Potamotrygon motoro* (Muller & Henle, 1841)