DIET AND FEEDING OF FISH FROM GRANDE RIVER, LOCATED BELOW THE VOLTA GRANDE RESERVOIR, MG-SP

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(With 1 figure)

ABSTRACT

We compare the classic model of feeding of tropical fish by means of six bimonthly samplings using gillnets of varying mesh sizes that were inspected every twelve hours throughout a forty-eight hour period. The stomachs of the fish caught were classified in three categories according to quantity of food found. The amount of fat in the visceral cavity with respect to the energetic reserve deposition was also studied. The relative frequencies of the different categories of stomach repletion and fat deposition were examined for patterns of feeding seasonality. The stomachs considered full were examined to record diet composition. To assess the relative importance of the different food resources, we applied Feeding Importance Degree (FID), which is a useful index when difficulties exist in determining a common basis for volume, number, or weight of a given food item in different species, a common problem when dealing with fish species having different feeding habits. The fish species whose stomach contents were analyzed using the FID index were *Serrasalmus spilopleura* (Characidae), *L. prolixa* (Loricaridae), *Schizodon nasutus* (Anostomidae), and *Pimelodus maculatus* (Pimelodidae). Our findings indicate some contrasting elements , in dietary composition in relation to the classic model for tropical rivers. These factors include the importance of aquatic macrophytes, the lack of piscivorous species, and a lesser presence of allochthonous vegetation in the diet of the species studied.

Key words: fish, feeding, reservoirs, Feeding Importance Degree.

RESUMO

Dieta e alimentação de peixes no rio Grande, a jusante da barragem de Volta Grande, MG/SP

Comparamos um modelo clássico de alimentação de peixes tropicais com os resultados de amostragens bimestrais com redes de espera de diversas malhas, vistoriadas a cada doze horas durante quarenta e oito horas. Os estômagos dos peixes coletados foram classificados em três categorias, de acordo com a quantidade de alimento. A quantidade de gordura depositada na cavidade abdominal, relacionada ao acúmulo de reservas energéticas, também foi estudada. Foram determinadas as freqüências relativas bimestrais dos diferentes graus de repleção estomacal e de gordura visceral acumulada para avaliar a dinâmica da atividade alimentar das espécies. Os estômagos considerados repletos foram examinados para registrar a composição da dieta. Para determinar a importância relativa dos diferentes itens alimentares foi empregado o índice Grau de Preferência Alimentar, um método útil em casos em que existam dificuldades de determinar para várias espécies, numa base comum, o número, peso ou volume dos itens alimentares, situação comum quando se trata de comparar a dieta de espécies com hábitos alimentares distintos. As espécies de peixes das quais foi amostrada a maioria dos estômagos foram *Serrasalmus spilopleura* (Characidae), *Loricaria prolixa* (Loricaridae), *Schizodon nasutus* (Anostomidae) e *Pimelodus maculatus* (Pimelodidae). Nosso estudo mostrou algumas diferenças quanto à composição da dieta em relação a um modelo clássico para ambientes tropicais, como a importância de macrófitas aquáticas, a escassez de espécies piscívoras e a pequena participação de vegetação alóctone na dieta das espécies estudadas.

Palavras-chave: peixe, alimentação, reservatórios, Grau de Preferência Alimentar.

INTRODUCTION

The Lowe-McConnel description of the characteristics of tropical water trophic chains (Lowe-McConnel, 1975) has become a basic model for this type of ecosystems. The author delineates the variation of trophic groups along the longitudinal dimension of a river as well as the most common feeding resources in tropical waters. However, these generalizations were proposed for systems that have, if not all, at least some of their basic characteristics undisturbed. In Brazil, some authors have compared their own findings with this model (Braga, 1990; Andrian & Barbieri, 1996).

Several river systems in Brazil have had their dynamics altered due to intense human occupation and, thus, the characteristics of their biological communities may be distinct from those less impacted. The damming of rivers, mainly for the purpose of generating electric energy, is one of the foremost anthropic alterations of Brazilian river basins. This practice produces alterations in several characteristics, which in turn have hydrological, atmospheric, biological, and social side effects (Tundisi, 1986).

With the alteration and reduction of water flow, the main channel connections with the adjacent flooding plains are hindered or even completely disrupted (Allan, 1995), thus increasing the probability of reductions in the production of a given system. In a river with a series of dams, like the Grande River on the border between São Paulo and Minas Gerais states, one would expect many seasonal dynamic features to have been modified in relation to nondammed rivers. Furthermore, one would expect that the feeding resources available to the ichthyofauna are different from those found at nondammed rivers as well as those classically described for tropical fish food chains. With these expectations in mind, this paper aims to describe the diet and the feeding dynamics of fish species captured below the Volta Grande Dam in the Grande River, which is severely dammed and presents grave environmental modifications.

MATERIALS AND METHODS

The sampling site is in the middle course of the Grande River below the Volta Grande Dam, between latitudes 19°57'52" and 20°10'00"S and longitudes 48°25'47"W and 47°35'00". The Grande River runs approximately 1300 kilometers from its headwaters near the city of Bocâina de Minas, MG, until its confluence with the Paranaíba River where the Paraná River begins. It should be borne in mind that the Grande River is one of the most intensely dammed rivers in the country, making it an important site for studying basic biological aspects of tropical riverine ichthyofauna under such conditions.

According to the Koeppen classification, the climate at the study site is Aw, characterized by a dry season in the winter, from June to early September. In summer, the amount of rain reaches its highest levels from December to early March. In order to represent the dry season, we sampled the site in April, June, and August whereas the rainy season was represented by samples in October, December, and February. Samples were collected from April 1998 to February 1999.

To capture the fish, 1.5 meter in leight gillnets were used with 2, 3, 4, 5, and 6 cm between-knot mesh sizes. Among them, the gillnets totaled 750 meters, with 5 sets of 150 meters for each gillnet mesh size. Another set of approximately 800 meters long by 2.5 meters in height with 8 cm between-knot mesh size was used to capture larger fish. On each field trip, gillnets were extended during 48 hours and surveyed every 12 hours.

Upon dissection of the fish, we registered the degree of stomach repletion (repletion degree RD = 1 for empty stomachs, RD = 3 for full stomachs, and RD = 2 for intermediate cases) and fat deposition degree in the visceral cavity (fat degree FD = 1 for little or no fat, FD = 3 for a great amount of fat, and FD = 2 for intermediate cases). The relative frequencies of the repletion and fat degrees were recorded to examine patterns of feeding activities and fat deposition dynamics. In order to look for patterns of feeding activity, the counts of the different repletion and fat deposition degrees were tested using contingency tables and chi–square tests against the month of sampling.

The stomachs considered RD = 3 were dissected and their contents placed in Petri dishes under a stereomicroscope in order to identify the diet items. To evaluate the importance of the different items in the diet, we used the feeding importance degree index (FID) (Braga, 1999). This consists of a series of scores of 4 values (4, 3, 2, and 1) that are given to each item present in the stomach of an individual fish and considering only fish with full stomachs. Those presenting only one item received score 4; for stomachs with more than 1 item, we attributed scores 3, 2, or 1, depending on the relative proportion of these items in the stomach content. The FID was calculated averaging the sum of scores for each item in all the stomachs divided by the number of stomachs analyzed. Then, according to the FID value, the food items were classified as: absolute preference (FID = 4), high degree of preference ($3 \leq FID < 4$), preferential ($2 \leq FID < 3$), secondary ($1 \leq FID < 2$), or occasional ($0 \leq FID < 1$).

Lastly, information about water-level variation at the sampling site was obtained from the technical staff of the hydroelectric plant.

RESULTS

The sampling resulted in the capture of 1202 fishes comprising 29 different species, 11 families, and three orders. The most abundant species were the characiforms *Serrasalmus spilopleura, Prochilodus lineatus,* and *Schizodon nasutus*; in addition, the study found the siluriforms *Pimelodus maculatus, Loricaria prolixa*, and the scienid *Plagioscion squamosissimus*, which appeared on all sampling dates. Other species, such as *Cichla ocellaris, C. monoculus, Cichlasoma fascetum, Leporinus friderici, L. octofasciatus*, and *Megalancistrus paranus* were captured in all but one or two samples. The remaining species appeared only sporadically (Table 1).

We examined 149 stomachs from 15 fish species, only four of which had their diet assessed by the FID due to the number of full stomachs obtained. These species were *S. spilopleura, S. nasutus, L. prolixa*, and *P. maculatus*. The main food types classified as preferential by FID index were aquatic macrophytes, mainly *Egeria* sp. (Hydrochariceae), and insect larvae and nymphs (orders Coleoptera, Odonata, Chironomidae, and Trichoptera). Among the preferential items we also found periphyton, fish fragments, and alochthonous insects (Coleoptera).

Among the most abundant fish species, *L. prolixa* and *S. nasutus* were specialized herbivores, each of them exploiting different resources. The former species fed on periphyton growing on the rocky bottom of the river, while the latter fed on aquatic macrophytes such as *Egeria* sp. Piscivores were scarce, with *P. squamosissimus* being the most abundant in this category. The only detritivore species was *P. lineatus*, which was mainly captured in August. Some species such as *P. maculatus* and *S. spilopleura*, which showed the most diverse diet among the species studied, were classified as generalist carnivores.

We analyzed 21 stomach contents of *L. prolixa*, whose diet items consisted mainly of periphyton and small snails, varied very little throughout the sampling period. During both seasons, autumn-winter and spring-summer, periphyton was classified by the FID index as a highly preferred item, although snails appeared more frequently during spring-summer. Feeding activity was more intense during June, August, and October ($\sum\chi^2 = 32{,}92$; $\chi^2_{0,05,\,10} = 18{,}307$), and the amount of visceral fat did not show significant variation throughout the sampling period ($\sum\chi^2 = 14{,}1$; $\chi^2_{0,05,\,10} = 18{,}307$).

The preferential food resource of the piranha *S. spilopleura*, whose stomach content comprised pieces of muscle, scales, and fin rays, was fish fragments of several species. Fragments of allochthonous insects were also found; in addition, all the stomachs inspected in October were full of adult Coleoptera. The remaining food items were classified as occasional by the FID index. Fish with full stomachs predominated during the sampling periods ($\sum\chi^2 = 12{,}57$; $\chi^2_{0,05,\,10} = 18{,}307$), but this result may be biased since the piranhas captured may have bitten fish already caught in the gillnets. Notwithstanding, Bistoni & Haro (1995) suggested that the scarcity of empty stomachs might be due to this species' aggressive behavior. The deposition of visceral fat increased from Octo ber to February ($\sum\chi^2 = 41{,}03$; $\chi^2_{0,05,\,10} = 18{,}307$).

The aquatic macrophyte *Egeria* sp. was the preferential item in the diet of *S. nasutus*, with the remaining items classified as occasional. During the autumn-winter season, the number of food items was higher and the number of stomachs containing larvae and nymphs of non–aquatic insects was higher as well. Nevertheless, macrophytes were the main resource exploited by *S. nasutus*. The amount of visceral fat decreased through October-December ($\sum\chi^2 = 21{,}72$; $\chi^2_{0{,}05,\ 10} = 18{,}\ 307$). The number of full stomachs remained relatively constant during the year ($\sum\chi^2 = 16{,}88$; $\chi^2_{0{,}05,\ 10} = 18{,}307$).

In the stomach contents of the catfish *P. maculatus* no diet item was classified as preferential; however, the most abundant were aquatic larvae of terrestrial insects, such as chironomids and Coleoptera. The fruit of *Sygyzium* sp. (Myrtacea), fragments of sponges, and snails also appeared sporadically in the diet of this species. From April to August we recorded the highest frequencies of full stomachs and visceral fat deposition. However, these values were not tested using the contingency tables since some of the observed values were not in accordance with some of the presuppositions for a correct contingency table analysis.

TABLE 1

Species composition of fishes in the total catches below the Volta Grande Dam from April 1998 to February 1999.

Species	Family	SLmin	SLmax	Biomass (kg)
Schizodon nasutus Kner, 1858	Anostomidae	14.2	37.5	66.18
Leporinus friderici Bloch, 1794	Anostomidae	13.7	32.2	11.06
Leporinus elongatus Valenciennes, 1849	Anostomidae	29.2	39.8	7.73
Leporellus vittatus Valenciennes, 1849	Anostomidae	25	28.9	0.813
Leporinuslacustris Campos, 1945	Anostomidae	12.3	12.3	0.056
Leporinus octofasciatus Steindachner, 1917	Anostomidae	16.1	25.3	7.16
Serrasalmus spilopleura Kner, 1858	Characidae	6.4	25	21.34
Myleus tiete Eigenmann & Norris, 1900	Characidae	8.9	16.3	2.12
Astyanax altiparanae Garutti & Britsky, 2000	Characidae	9.5	10.6	0.137
Astyanax fasciatus Cuvier, 1819	Characidae	8	12	0.387
Salminus maxillosus Valenciennes, 1840	Characidae	35.6	35.6	0.843
Galeocharax knerii Steindachner, 1879	Characidae	18.9	21.5	0.615
Hoplias ma/abaricus Bloch, 1794	Erythrinidae	26	26	0.199
Hoplias lacerdae Ribeiro, 1908	Erythrinidae	21.5	53	11
Apareiodon piracicabae Eigenmann, 1907	Parodontidae	9	12	0.125
Prochilodus lineatus Valenciennes, 1836	Prochilodontidae	24.6	61.5	246
Loricaria prolixa lentiginosa Insbrucker, 1978	Loricariidae	20.7	51.4	112.34
Mega/ancistrusparananus Peters, 1881	Loricariidae	21.4	58.8	49.74
Hypostomus sp. 1	Loricariidae	20	49.3	12.78
Hypostomus sp. 2	Loricariidae	22.9	44.8	8.98
Pimelodus maculatus Lacepede, 1803	Pimelodidae	11.2	36.8	36.14
Pinirampus pirinampu Spix & Agassiz, 1829	Pimelodidae	44	57.5	18.05
Rhinodoras dorbigny Kner, 1855	Doradidae	9.7	14.7	0.189
Plagioscion squamosissimus Heckel, 1840	Scienidae	15.4	51.5	57.34
Cichlasoma facetum Jenyns, 1842	Cichlidae	8.2	19.3	9.86
Cichla ocellaris Bloch & Schneider, 1801	Cichlidae	10.5	39	35.9
Cichla monoculus Spix & Agassiz, 1831	Cichlidae	9.9	38	6.29
Tilapia rendalli Boulanger, 1897	Cichlidae	28.5	36	13.48
Crenicichla britskii Kullander, 1982	Cichlidae	8.3	14.5	0.024

SL: Standard lenght.

TABLE 2

Results of the analysis of four fish species stomachs by the FPD (feeding preference degree) index.

Species	Food item	n	%	SI	FPD	FPD classification
	Autumn/winter (N = 9)					
S. Nasutus	*Egeria* sp.	9	100	28	3.11	occasional
	Aquatic larvae and nymphs	6	66.7	6	0.67	occasional
	Grasshoper Nymph	2	0.22	2	0.22	occasional
	Sponges	1	0.11	1	0.11	occasional
	Mollusc (Bivalvia)	1	0.11	1	0.11	occasional
	Allochtonous insect	1	0.11	1	0.11	occasional
	Daphinia	1	0.11	1	0.11	occasional
	Spring/summer (N = 13)					
	Egeria sp.	13	100	42	3.23	high degree of preferencee
	Filamentous algae	6	0.46	16	1.23	secondary
	Aquatic larvae and nymphs	3	0.23	6	0.46	occasional
	Autumn/winter (N = 11)					
P. maculatus	Aquatic larcae and nymphs	11	100	27	2.25	preferencial
	Gastropoda	6	54.5	7	0.58	occasional
	Allochtonous insect	4	36.3	6	0.5	occasional
	Scales	2	18.2	3	0.25	occasional
	Sponges	1	9.1	2	0.16	occasional
	Seeds	1	9.1	1	0.08	occasional
	Spring/summer (N = 13)					
	Aquatic larvae and nymphs	3	75	8	2	secondary
	Fruits (Syzigium sp.)	1	25	4	1	occasional
	Gastropoda	1	25	1	0.25	occasional
	Scales	1	50	2	0.5	occasional
	Corn grain	2	25	3	0.75	occasional
	Autumn/winter (N = 12)					
L. prolixa	Periphyton	12	100	36	3	high degree of preferencec
	Gastropoda	7	58.3	11	0.92	occasional
	Aquatic larvae and nymphys	1	8.3	1	0.08	occasional
	Spring/summer (N = 9)					
	Periphyton	8	88.9	22	2.44	high degree of preference
	Gastropoda	7	77.8	16	1.78	secondary
	Bivalvia	1	11.1	1	0.11	occasional
	Autumn/winter (N = 27)					
S. spilopleura	Fish fragments	25	92.6	91	3.37	high degree of preferencee
	Allochtonous insect	5	18.5	6	0.22	occasional
	Aquatic larvae and nymphys	4	14.8	10	0.37	occasional
	Sponges	3	11.1	4	0.15	occasional
	Crustacean	1	3.7	3	0.11	occasional
	Spring/summer (N = 34)					
	Fish fragments	25	73.5	81	2.38	high degree of preference
	Allochtonous insect	13	38.2	29	0.85	occasional
	Crustacean	3	8.8	3	0.11	occasional
	Aquatic larvae and nymphys	3	8.8	3	0.11	occasional

n: number os stomachs with the respective food item; N: total of stomachs analyzed % percent of occurence; Si: sum of the FPD scores for all stomachs with the respective food item; FPD: numerical value resulting from Si/N.

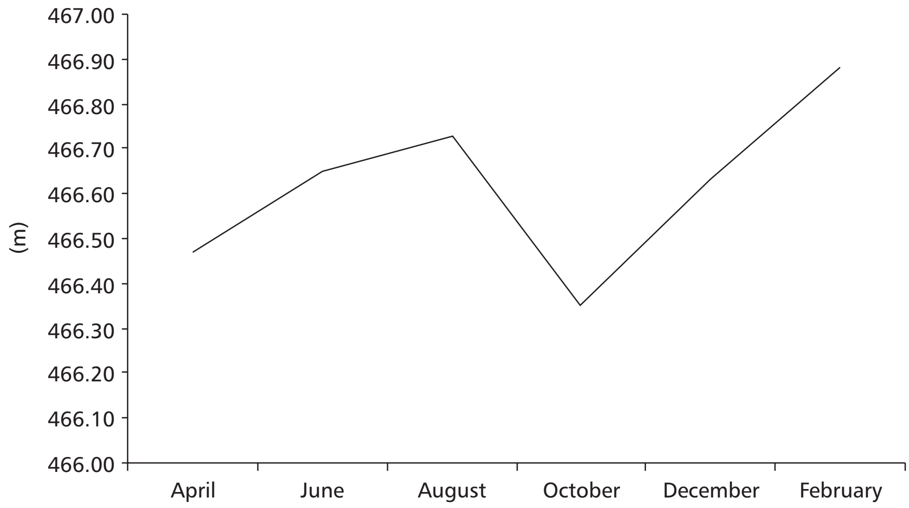

Fig. 1 — Variability in the water level in meters above sea level below the Volta Grande Dam, Rio Grande, Brazil.

The variation in the water level at the sampling site (Fig. 2) was very small, with only a 0.53 m difference between the lowest and highest levels.

DISCUSSION

According to a heuristic model (Lowe-McConnel, 1975), there are some characteristic food items such as allochthonous plants, insects and their aquatic larvae, and small fish embedded in mud and detritus that are exploited by the diverse piscivorous species in the food chains of tropical fish assemblages. Our results differ somewhat from those expected using this classic model by presenting a reduced significance of allochthonous vegetation and a decreased abundance of piscivorous species. These differences will be characterized as the food habits of the four species analyzed (*S. spilopleura, P. maculatus, S. nasutus*, and *L. prolixa*) and also commented upon and compared with results of other studies. We regard these to be important findings, since as an increasing number of ecosystems have been and are currently being researched in Brazil, it may be possible to generate better heuristic models for Brazilian ichthyofauna.

Although the piranha *S. spilopleura* is a species with a broad distributional range, its presence below the Volta Grande Dam had up until now not been registered (verbal communications from workers). In addition, the species was not listed among those in the censuses made in the Volta Grande Reservoir (Beaumord *et al.*, 1987; Santos, 1994; Braga & Gomiero, 1997). Some characteristics of this species, such as its aggressive behavior and generalist feeding mode, may facilitate its proliferation in reservoirs (Northcote *et al.*, 1986) and, therefore, the effects of its behavior could make of it a major problem in fish stocking and future aquaculture activities undertaken in reservoirs. According to the FID index, fish fragments were the main item in the diet of this species, which preyed upon fish caught in the gillnets, which is a type of food resource use already described for other locations (Sazima & Pombal Jr., 1988; Sazima & Machado, 1990; Bistoni & Haro, 1995). None of the fish found could have been ingested whole by *S. spilopleura* and, thus, indicated mutilation (Sazima & Machado, 1990). Therefore, this species has a renewable feeding resource in fins and even body parts of several fish species (Northcote *et al.*, 1995). The great abundance of Coleoptera in the October sample also illustrates the opportunistic behavior of *S. spilopleura*, which together with *P. maculatus* were the two species with the most diverse diet. Furthermore, the feeding habit of *S. spilopleura* suggests euriphagy, a characteristic of widely distributed species (Lowe-McConnel, 1975). According to a heuristic model (Wooton, 1992), some species are generalists and shift their diet as food resources change or when a sudden increase occurs, as exemplified by the amount of Coleoptera being ingested by *S. spilopleura*.

The third most abundant species, *S. nasutus*, is most likely being sustained by macrophyte growth in the study area. Below the Três Irmãos Dam, evidence suggests that there are extensive macrophyte beds that could serve as an abundant food resource for other fish species in addition to *S. nasutus* (Barrela, 1997). This was deduced, based on the amount of fish with macrophyte-filled stomachs year round. When a dam decreases the amount of sediment that is retained in the reservoir and reduces the water flow, the resulting conditions are favorable for the growth of macrophytes and periphyton (Ridley & Steel, 1975). Ferreti *et al*. (1996) found that grasses were the most characteristic food resource in the diet of two species of *Schizodon*; nevertheless, we found that the main diet item was aquatic macrophytes, mainly *Egeria* sp. In consonance with our findings, the diet of these other species of *Schizodon* (Ferreti *et al*., 1996) varied very little throughout the year. Because *Schizodon* selects the food item instead of eating it along with portions of substrate, the authors describe it as a browsing species. We found no grasses in the stomach contents of *S. nasutus*, probably because grasses were not as abundant due to the reduced water level accounted for by its yearly variation and the predominance of agricultural lands on the Grande River banks. Another similarity with the results found by Ferreti *et al*. (1996) is found in the very low abundance of allochthonous insects in the stomach contents. Therefore, *S. nasutus* may be classified as a specialist, at least in the area and span of time investigated here.

The catfish *P. maculatus* is a very common species in the reservoirs of southeastern Brazil, and is also important to regional commercial fisheries, as indicated by some of the censuses made of the Volta Grande Reservoir (Braga & Gomiero, 1997; CESP, 1993, 1996) and a review of Brazilian reservoirs (Petrere Jr., 1993). The diet of this species was essentially euryphagic, with most items being of animal origin. The most representative among the food items were aquatic larvae of Coleoptera and Chironomidae, and nymphs of Trichoptera and Odonata. None of the items preyed upon by *P. maculatus* were classified as preferential; therefore, this species has been classified as omnivorous (Nomura *et al*., 1972; Lima Jr., 2000). We found no fish remains in the stomach contents of *P. maculatus*; however, a former study considered this species as omnivorous with a tendency towards piscivory (Lolis & Andrian, 1996). The contrasts in the findings of several authors, covering a wide range of habitats and time scales, provide some indication of the feeding plasticity of *P. maculatus*. Another evidence of this characteristic found by us was the presence of a fruit, *Syzygium* sp. (Myrtacea), in the stomach of one individual. Previous studies at the Volta Grande Reservoir (Braga, 2000) have registered larvae of Diptera and nymphs of Trichoptera as the main food items of this catfish.

There is little information concerning food habits of the armored catfish *L. prolixa*, whose main food resource, periphyton, grows on the rocky bottom of the river; the snails, which were also found, might have been ingested together with the periphyton. Whether or not *L. prolixa* actively searches for patches with a maximum presence of snails is a question that remains to be investigated experimentally. The great amount of sand and organic debris in the stomach contents of *Loricariichthys platymetopon* indicates that this species may be classified as detritivorous (Fugi & Hahn, 1991). In spite of the resemblance of the feeding apparatus of *L. platymetopon* and *L. prolixa*, neither sand nor debris was found in the stomach contents of *L. prolixa*, lending additional weight to our conclusion, namely, that this species feeds on periphyton scratched from the rocky bottom surface. Favorable conditions for periphyton growth may be provided by factors such as water transparency due to the retention of sediments by the dam, and the presence of a shallow-depth rocky substrate.

In conclusion, our results show that the importance of aquatic macrophytes, the reduced abundance of piscivorous species, and the use of peryphyton are the main differences in relation to the Lowe-McConnel's model. Each one of these features may be related to the environmental modifications caused by the dam, which include sediment retention, reduced water level variation, and barriers to the migration of several fish species.

In addition to diet composition, the study of feeding chronology can be developed at several scales. Seasonal variation is a very important aspect to consider, since feeding dynamics are often related to the reproductive cycle of the different fish species, which is in turn controlled by environmental cues (Zavala-Camin, 1996).

A different response to environmental factors may be observed among two of the most abundant species, which had their feeding dynamics tested using contingency tables. *S. spilopleura* and *S. nasutus* showed different patterns of fat deposition throughout the year. One model of reproductive behavior of tropical fish (Braga, 1990) involves fat deposition at times of intense feeding, generally preceding the reproductive season, when the fish cease their feeding activities due to behavioral responses, exemplified by up-river migrating. The fat reserves can at that time be used as an energetic resource for gonad maturation. However, most of the individuals of *S. spilopleura* captured were immature, and thus did not require the fat reserves for that purpose. But there was an increase in the fat deposition for this species during the spring-summer. Notwithstanding, *S. nasutus* showed decreased fat reserves during the spring-summer season, coinciding with the onset of the reproductive season. In this case, one may assume that the reserves were used for the gonads, since this species was reproducing at the studied location. Our hypothesis concerning the reproductive season of this species during the spring-summer season is strengthened by the fact that Santos (1994) found that the reproduction of *S. nasutus* occurred during the months of December through February; furthermore, a review by Vazzoler & Menezes (1992) points to the same three months, a period with increased precipitation, as constituting the reproductive season for the Characiformes.

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