Low feeding overlap between *Plagioscion squamosissimus* (Heckel, 1840) and *Cichla monoculus* (Spix & Agassiz, 1831), fishes introduced in tropical reservoir of South Brazil

Baixa sobreposição alimentar entre *Plagioscion squamosissimus* (Heckel, 1840) e *Cichla monoculus* (Spix & Agassiz, 1831), peixes introduzidos em reservatório tropical do sul do Brasil

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Abstract: Aim: This study was to compare the diets and the degree of feeding overlap between *Plagioscion squamosissimus* (corvina) and *Cichla monoculus* (tucunaré), native fish of the Amazon Basin which were introduced in the Capivara Reservoir of the Paranapanema River, Paraná, Brazil. **Methods:** In the Capivara Reservoir, the largest reservoir of the Paranapanema River, fishes were collected seasonally in a period from March/02 to April/03. Samples of the two introduced species were analyzed to select individuals with stomach contents. The gastric contents were analyzed by the percent composition method and the values obtained determined the diet composition. The feeding overlap was calculated using the percentage composition values of the food items in low taxonomic levels, calculate by the Pianka Index. **Results:** *Plagioscion squamosissimus* was first in number of individuals (25.2%) while *C. monoculus* came in sixth place (9%). The number and respective percentage of analyzed individuals with stomach content of *P. squamosissimus* was 96 (68.6%), with average size 21.4 cm, and 27 (69.2%) of *C. monoculus*, with average size 18.2 cm. It was demonstrated that the main feeding resources and the prey utilized by both species belong to the same categories (fish, insects, crustaceans). However, when the identified items were analyzed in low taxonomic levels, a low feeding overlap was demonstrated between them, with no significant statistical values, suggesting that feeding competition seems random. **Conclusion:** In time, a differential use of prey by these introduced species in Capivara Reservoir, may increase the impact on native species prey.

Keywords: food, feeding strategy, corvina, tucunaré, Capivara Reservoir.

Resumo: Objetivo: O estudo foi comparar as dietas e o grau de sobreposição alimentar de *Plagioscion squamosissimus* (corvina) e *Cichla monoculus* (tucunaré), peixes nativos da Bacia Amazônica, os quais foram introduzidos no Reservatório de Capivara, no Rio Paranapanema, Paraná, Brasil. **Métodos:** No reservatório Capivara, o maior reservatório do Rio Paranapanema, peixes foram coletados sazonalmente no período março/02 a abril/03. Amostras das duas espécies introduzidas foram analisadas para selecionar os indivíduos com conteúdo estomacal. Os conteúdos estomacais foram analisados pelo método de composição percentual e os valores obtidos permitiram comparar a dieta. A sobreposição alimentar foi calculada utilizando os valores da composição percentual dos itens alimentares identificados em categorias taxonômicas inferiores, pelo índice de Pianka. **Resultados:** *Plagioscion squamosissimus* ocupou o primeiro lugar em número de indivíduos (25,2%), enquanto *C. monoculus* o sexto lugar (9%). O número e a respectiva percentagem de indivíduos com conteúdo estomacal analisados de *P. squamosissimus* foi 96 (68,6%), com média de tamanho de 21,4 cm, e de *C. monoculus* foi 27 (69,2%), com média de tamanho de 18,2 cm. Verificou-se que os principais recursos alimentares e as presas utilizadas pelas duas espécies pertencem às mesmas categorias (peixes, insetos, crustáceos). No entanto, quando os alimentos foram analisados em níveis taxonômicos inferiores, registrou-se uma baixa sobreposição alimentar entre as duas espécies, sendo os valores estatisticamente não significativos, sugerindo que a competição alimentar entre ambas se dá ao acaso. **Conclusão:** A utilização diferenciada das presas por estas espécies predadoras introduzidas no Reservatório Capivara, poderá exercer, com o passar do tempo, um impacto amplificado sobre as presas de espécies de peixes nativas.

Palavras-chave: alimento, estratégia alimentar, corvina, tucunaré, Reservatório Capivara.

1. Introduction

The Neotropical fish species, except some cichlids, cannot find the ideal environments to survive and to reproduce in the lentic or semi-lotic waters of a reservoir (Fernando and Holcik, 1991). Therefore, these environments are virtually aquatic deserts, just inhabited by a small number of species, usually of small size, as a consequence of the reorganization of the ichthyofauna present in the original river (Agostinho, 1992). Besides, the reservoir construction results in an abrupt environmental change, which becomes fragmented with its hydrological regime altered, causing the interruption of feeding and reproductive migratory cycles. These changes increase the impact on the native species of the original basin (Carvalho and Silva, 1999; Agostinho et al., 1999).

Therefore, to increase fish stocks and improve the management of these aquatic systems, it is common to introduce allochthonous and/or exotic species. According to Reinthal and Kling (1994), indiscriminate introductions of new species often result in the extinction of native ones, mainly due to the increase in competition for space and food, increase in the predatory rate on the native species, alteration of the natural habitat and introduction of new pathogens and parasites in the environment.

The allochthonous species *Plagioscion squamosissimus* (corvina) and *Cichla monoculus* (tucunaré), both natives from Amazon River basin and predators on the top of food chains of the rivers and ponds they inhabit, naturally adapt survive and reproduce in these lentic or semi-lotic waters, being found in many reservoirs in and outside Brazil (Agostinho et al., 1999).

In the Paranapanema River basin, these two species are recorded in almost in all of the reservoirs, especially in those located in the middle courses, as in the case of the Capivara Reservoir, stretches of larger occurrence of these species (Hoffman et al., 2005; Suzuki et al., 2005).

In the studies conducted by Latini and Petrere (2004) in the Doce River basin (Minas Gerais State) and by Gomiero and Braga (2004) in the Volta Grande Reservoir (São Paulo State), damages were registered in the native ichthyofauna after the introduction of *C. monoculus*. *Plagioscion squamosissimus* was investigated by Bennemann and Shibatta (2002) and by Bennemann et al. (2006) in areas of influence of the Capivara Reservoir, from the Paranapanema and Tibagi Rivers. In these studies the introduced were considered responsible for the decrease in the abundance of native fish prey species.

In the Capivara Reservoir, the same stretch studied by Hoffman et al. (2005), from one anterior period (2001/2002), Teixeira and Bennemann (2007), in the first study about the feeding of *P. squamosissimus* and *C. monoculus* in this reservoir, found a substantial similarity in their feeding and ecomorphology. However, in spite of the apparent correspondence among the feeding resources used, in the last study the feeding overlap was not determined for the two predator species.

Since these species *P. squamosissimus* and *C. monoculus* have been characterized as potential threats to native ichthyofauna, the aim of this study was to compare these two allochthonous fish species, by investigating their diet and feeding overlap, to individuals collected in a subsequent period (2002/2003) studied by Hoffman et al. (2005) in the same stretch of Capivara Reservoir.

2. Material and Methods

2.1 Study area

At present, the Paranapanema River has 10 reservoirs of hydroelectric power plants distributed along its approximately 600 km extension. Among the reservoirs, the Capivara Reservoir stands out, being located in the middle stretches of the Paranapanema River, along the borderline between the States of Paraná and São Paulo. The reservoir was formed in 1975, as a result of the construction of the Escola Mackenzie hydroelectric plant. It has a surface area of 515 km^2 and drainage area of 84,500 km^2, being considered the largest reservoir of the Paranapanema River, with approximately 100 km of extension and stretches with depths usually greater than 70 m.

The stretch studied is located in the municipality of Porecatu, about 300 m from the dam, close to the mouth of the Vermelho River. This stretch has a depth varying between 15 and 70 m, semi-lotic waters of great transparency, and a predominantly rocky, alterned with a sandy and clay bottoms. The riparian vegetation is composed of patches of native forest in recovery, with few macrophyte plants along the banks. The location of the stretch sampling is indicated in Figure 1.

Four seasonal collections were performed from May/02 to April/03. The capture of individuals was carried out using gill nets with 2.5-10 cm-knot gill nets. These were arranged perpendicular to the bank of the reservoir and set for 24 h exposure.

The collected fishes were preserved in 10% formalin, and transferred to 70% alcohol solution. Voucher specimens were deposited in the Museum of Zoology of the State University of Londrina (MZUEL 2234, 2622, 2848 and 3302, *P. squamosissimus*; 1982, *C. monoculus*).

The stomach contents of each individual were identified under a stereomicroscope. The importance of the food items consumed by both species were compared using the values of the percentage composition, defined as a percentage of the occurrence of each food item in relation to the total occurrences, calculated as follows (Equation 1):

$$Cp = (\Sigma Ni / \Sigma Nt) \times 100 \quad (1)$$

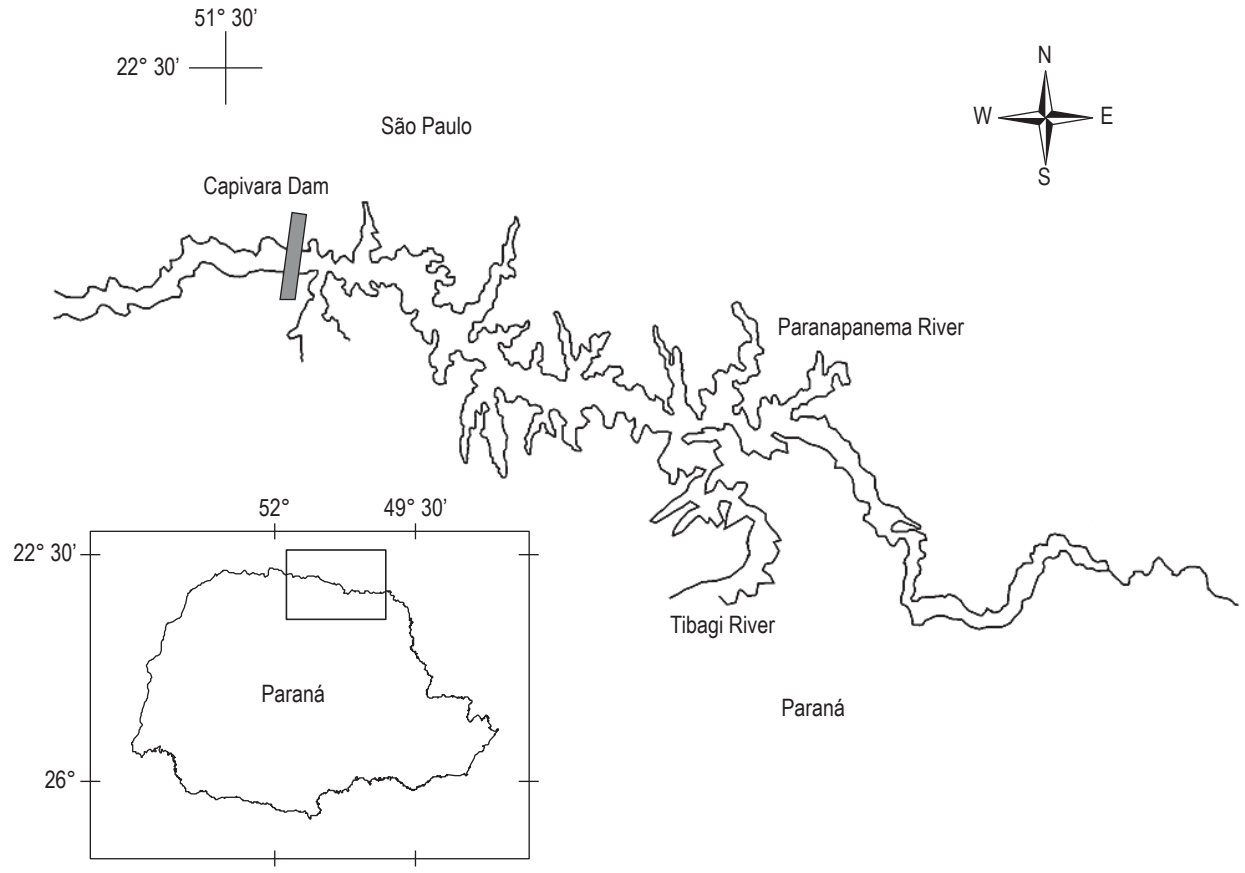

Figure 1. Location of the study area in the Paraná State, with detailed of the Capivara Reservoir, Porecatu Stretch.

where: Cp = percentage composition = Σ of the% cp = 100%; Ni = number of occurrence of item i ; Nt = total number of occurrences of all of the items.

The feeding overlap was calculated using the percentage composition values of the food items, as variable to be shared. The index used to calculate diet overlap (Pianka, 1973) is defined by the Equation 2:

$$O_{12} = O_{21} = \frac{\sum_{i-1}^{n} P_{2i}P_{1i}}{\sqrt{\sum_{i-1}^{n} \left(P_{2i}^{2}\right)\left(P_{1i}^{2}\right)}} \quad (2)$$

where: O = overlap index; P1i = proportion of the item i in the feeding of species 1; and P2i = proportion of the item i in the feeding of species 2.

The overlap values of the food items (percentage composition) were interpreted with a null model that allows the comparison of the observed values in the field with generated random values. The program EcoSim 7.0 (Gotelli and Entsminger, 2001) was employed for this purpose, where the algorithm used determines the niche breadth of each species and shows which food items are consumed. After 1000 simulations, the average and the variance of the simulated values were compared to the observed values, and the values of associated probabilities were computed.

3. Results

Plagioscion squamosissimus was first in number of individuals (25.2%) while *C. monoculus* came in sixth place (9%), from seasonally collected samples in a period from March/02 to April/03. The number and respective percentage of analyzed individuals with stomach content of *P. squamosissimus* was 96-68.6% (with average size 21.4 cm) and 27-69.2% of *C. monoculus* (with average size 18.2 cm).

Totaling the food items consumed by the two species, 16 food items were recorded and included into five major categories (Fishes, Insects, Crustaceans, Plants and Detritus (Table 1).

When the food items were grouped into the major categories, to compare the two predators was seen to have a diet based on prey of fishes, insects and crustaceans, consumed in similar proportions during the studied period (Figure 2).

The diet analyzed between the species, interpreted by the food overlap determined by the comparison of the values of the food items, in low taxonomic levels,

Table 1. Percentage composition values (Cp%) of each item consumed by *P. squamosissimus* and *C. monoculus*, in the period 2002/2003, from Capivara Reservoir, Paraná State.

Category	Item	*P. squamosissimus*	*C. monoculus*
Fishes	*C. monoculus*	15.52	14.29
	Fish scales		2.86
	Fish remains	17.24	11.43
Insects	Chironomidae	3.45	14.29
	Diptera	5.17	14.29
	Ephemeroptera		2.86
	Odonata	24.14	
	Coleoptera	1.72	
	Insect remains	1.72	
Crustaceans	Cladocera		2.86
	Ostracoda		2.86
	M. amazonicum	25.86	5.71
	Microcrustaceans Remains		11.43
Plants	Plant remains	5.17	2.86
	Algae		2.86
Detritus	Detritus		11.43

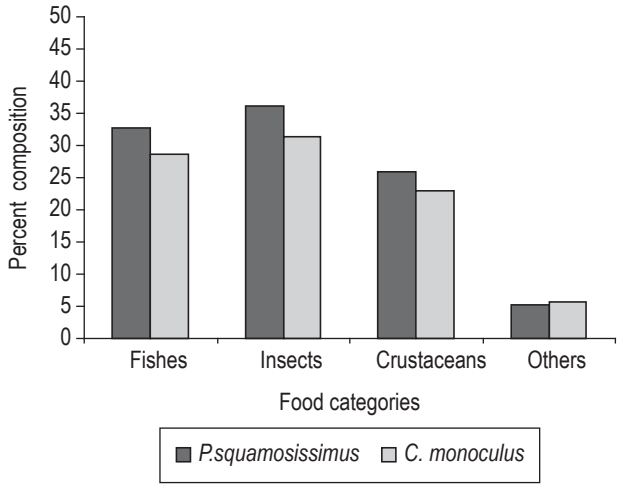

Figure 2. Percent composition of the feeding categories consumed by *P. squamosissimus* and *C. monoculus* in the period 2002/2003 in Capivara Reservoir, Paraná State.

revealed non-significant values (0.51805 observed average and 0.43475 simulated average, with 0.29700 probability, $p < 0,05$), suggesting that the food overlap observed for these species occurs at random, and not by feeding competition.

4. Discussion

In this study, 32 fish species were recorded in the Capivara Reservoir, where the most abundant based on the percentage of total captured was in decreasing order: *P. squamosissimus*, *Astyanax altiparanae*, *Iheringichthys labrosus*, *Loricariichthys platymetopon*, *Steindachnerina insculpta* and *C. monoculus*. In a previous period, 2001/2002, in the same stretch of this reservoir the position of these two species was different (Teixeira and Bennemann, 2007). These authors verified the tucunaré stood out, occupying the second position and the corvina the fourth position.

In reservoirs where *P. squamosissimus* and *Cichla* species coexist, the first has been shown to dominate in number of individuals, as also shown in the Marimbondo Reservoir, Rio Grande River (Santos et al., 1994), Guri Reservoir in Venezuela (Williams et al., 1998) and Avanhandava Reservoir, Tietê River (Vidotto, 2005). *Plagioscion squamosissimus* was recorded several years before *C. monoculus* in Paranapanema River, and nowadays, it is dispersed throughout the whole Paraná basin (Hahn et al., 1997, 1998, 1999; Agostinho et al., 1999; Freire and Agostinho, 2000).

These species impacts the environment into which they are introduced, as indicated by studies carried out in reservoirs by Santos et al. (1994), Agostinho et al. (1999) and Gomiero and Braga (2004). The effects of the introductions of the two species in the same reservoir and what happens with their populations, are still far from being understood, as studies conducted to date provide knowledge of just one or the other of them. The main difficulty is the lack of registration: when, where and the amounts of individuals are being placed in these enviromments.

The novelty of this study was to compare the diet of these two species in the Capivara Reservoir, where differences in the use of food resources were demonstrated. In the same stretch of the Capivara Reservoir, Teixeira and Bennemann (2007), in analyzing a previous annual period, found more than 70% similarity in diet between *P. squamosissimus* and *C. monoculus*, with about 50% of their diets composed of the shrimp. These differences can reflect the population dynamics of both predators and the variation in availability of their preys. For instance, the role of shrimp *Macrobrachium amazonicum* in the diet of the two species was reduced concomitant with the increased occurrence of fish in the stomach contents. Such differences in the comparison of these two studies may also be assigned, in part, to differences in the stomach contents methods of analysis and to the different size classes of the individuals analyzed.

When the prey species composition for each species is analyzed (Teixeira and Bennemann, 2007), it was possible to note different preferences for each species when fishes were consumed: the tucunaré consumed *Oreochromis niloticus* and *C. monoculus*, while the corvina consumed *A. altiparanae* and *Gymnotus carapo*. These results are similar to those obtained by Santos et al. (1994), who classified both predators as essentially piscivorous but also exploiting different prey: the tucunaré fed on bentonic species

(mainly cichlids), while corvina consumed prey of smaller size, especially characiforms.

Besides, there was the occurrence of cannibalism in the two species. This is a quite common behavior among freshwater fishes (Fox, 1975; Zaret, 1997). A high incidence of this behavior was evident among the tucunaré, in this study and also verified by Teixeira and Bennemann (2007). Among the factors that can unchain this behavior, a key one is a possible shortage of resources in the environment or a possible strategy for population control (Fox, 1975; Wooton, 1990). In the Capivara Reservoir, the two factors can be occurring simultaneously, with the tucunaré, and moreover, these fish would be consuming a food of great quality and of easy access, due to the absence of marginal aquatic vegetation, which would serve as shelter for the youngest forms.

The great trophic plasticity and the opportunism (see Gerking, 1994) of corvina have already been well documented and proven, in practically all of reservoirs where it has been introduced. In the Itaipu Reservoir, this species showed a basically piscivorous diet, but it was demonstrated that depending on the stretch of the reservoir studied, crustaceans and insects were included for dominant times in its feeding (Hahn et al., 1997). Bennemann et al. (2006) analyzed the trophic dynamics of this species in a stretch under the influence of the Capivara Reservoir in the periods of 1992/93, 1994/95 and 2001/02, and found that this species continued to be carnivorous but not always piscivorous, due to the marked availability of the shrimp, mainly starting since 2001.

The feeding of *C. monoculus* in reservoir environments studied by Durães et al. (2000) in the Itumbiara Reservoir - MG/GO, by Gomiero and Braga (2004) in the Volta Grande Reservoir - MG/SP and by Novaes et al. (2004) in the Serra da Mesa Reservoir - TO, showed that this species is a specialist piscivore. In the present study most of the individuals were small in size; this may explain, in part, the non-specialist piscivore diet we have found.

The results of this study demonstrated the ability of *P. squamosissimus* and *C. monoculus* to coexist in the same reservoir, perhaps due to their common natural history, inhabiting rivers, marginal ponds and floodplains of Amazon Basin. The use of space in natural environments also differs between these species. *P. squamosissimus* uses lentic and semi-lotic environments, mainly for reproduction, and seek food mainly in the lotic areas of rivers, while *C. monoculus* uses lentic and semi-lotic regions, for both reproduction and feeding (Rabelo and Araújo-Lima, 2002; Mérona and Mérona, 2004). Similarly, these species show different behaviors in the Capivara Reservoir, occupying different areas, which were also observed by Oliveira et al. (2003) in the Itaipu Reservoir. Another distinction is temporary segregation as shown by Teixeira and Bennemann (2007) in the Capivara Reservoir.

The low feeding overlap between them should be considered as a warning to caution regarding with management actions and avoidance non-native species introduction in reservoirs. In time, a differential use of prey by these introduced species may increase the impact on native species prey. In order to suggest appropriate actions in Capivara Reservoir, a research into the causes of the decrease of shrimp as part of the fish diet, is needed, as well as analyzing the dynamics of native fish species.

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References

AGOSTINHO, AA. Manejo de recursos pesqueiros em reservatórios. In: Agostinho, AA. and Benedito-Cecílio, E. (eds.). *Situação atual e perspectivas da ictiologia no Brasil.* Maringá: Eduem, 1992. p. 106-121.

AGOSTINHO, AA., MIRANDA, LE., BINI, LM., GOMES, LC., THOMAZ, SM. and SUZUKI, HI. Patterns of colonization in neotropical reservoirs and prognosis on aging. In: TUNDISI, JG. and STRASKRABA, M. (eds.). *Theoretical Reservoir Ecology and its Applications*. São Carlos: International Institute of Ecology, Backhuys Publishers, 1999. p. 227-265.

BENNEMANN, ST., CAPRA, LG., GALVES, W. and SHIBATTA, OA. Dinâmica trófica de *Plagioscion squamosissimus* (Perciformes, Scianidae) em trechos de influência da represa Capivara (rios Paranapanema e Tibagi). *Iheringia, Sér. Zool.*, 2006, vol. 96, no. 1, p. 115-119.

BENNEMANN, ST. and SHIBATTA, OA. Dinâmica de uma assembléia de peixes do rio Tibagi. In: MEDRI, ME., BIANCHINI, E., SHIBATTA, OA. and PIMENTA, JA. (eds.). *A bacia do rio Tibagi*. Londrina: EDUEL, 2002. p. 433-442.

CARVALHO, ED. and SILVA, VEB. Aspectos ecológicos da ictiofauna e da produção pesqueira do reservatório de Jurumirim (Alto rio Paranapanema – SP). In: HENRY, R. (ed.). *Ecologia de Reservatórios:* Estrutura, Função e Aspectos Sociais. Botucatu: FUNDIBIO, 1999. p. 771-799.

DURÃES, R., SANTOS, GB. and FORMAGGIO, PS. Observações sobre a alimentação do tucunaré *Cichla monoculus* (Pisces, Cichlidae) em um reservatório do Sudeste Brasileiro. *Rev. Ictiol.*, 2000, vol. 8, no. 1/2, p. 53-56.

FERNANDO, CH. and HOLCIK, J. Fish in reservoirs. *Hydrobiologia*, 1991, vol. 76 no. 2, p. 149-167.

FOX, L. Cannibalism in natural populations. *Annu. Rev. Ecol. Syst.,* 1975, vol. 6, p. 87-106.

FREIRE, AG. and AGOSTINHO, AA. Distribuição espaço-temporal de oito espécies dominantes da ictiofauna da bacia do Alto rio Paraná. *Acta Limnol. Bras.*, 2000, vol. 12, no. 2, p. 105-120.

GERKING, SD. *Feeding ecology of fish*. San Diego: Academic Press, 1994. 416 p.

GOMIERO, LM. and BRAGA, FMS. Feeding of introduced species of *Cichla* (Perciformes, Cichlidae) in Volta-Grande reservoir, river Grande (MG/SP). *Braz. J. Biol.*, 2004, vol. 64, no. 4, p. 787-795.

GOTELLI, NJ. and ENTSMINGER, GL. EcoSim: Null models software for ecology. Version 7.0. Acquired Intelligence Inc. & Kesey-Bear. 2001. Access in: <http://homepages.together.net/~gentsmin/ecosim.htm>.

HAHN, NS., AGOSTINHO, AA. and GOITEIN, R. Feeding ecology of Curvina *Plagioscion squamosissimus* (Heckel, 1840) (Osteichthyes, Perciformes) in the Itaipu reservoir and Porto Rico floodplain. *Acta Limnol. Bras.*, 1997, vol. 9, p. 11-22.

HAHN, NS., AGOSTINHO, AA., GOMES, LC. and BINI, L.M. Estrutura trófica da ictiofauna do reservatório de Itaipu (Paraná-Brasil) nos primeiros anos de sua formação. *Interciencia*, 1998, vol. 23, no. 5, p. 299-305.

HAHN, NS., LOUREIRO, VE. and DELARIVA, RS. Atividade alimentar da curvina *Plagioscion squamosissimus* (Heckel, 1840) (Perciformes, Scianidae) no rio Paraná. *Acta Sci. Biol. Sci.*, 1999, vol. 21, no. 2, p. 309-314.

HOFFMANN, AC., ORSI, ML. and SHIBATTA, OA. Diversidade de peixes do reservatório da UHE Escola Engenharia Mackenzie (Capivara), rio Paranapanema, bacia do alto rio Paraná, Brasil, e a importância dos grandes tributários na sua manutenção. *Iheringia, Sér. Zool.*, 2005, vol. 95, no. 3, p. 319-325.

LATINI, AO. and PETRERE, MJR. Reduction of a native fish fauna by alien species: an example from Brazilian freshwater tropical lakes. *Fish. Manag. Ecol.*, 2004, vol. 11, no. 2, p. 71-79.

MÉRONA, B. and MÉRONA, JR. Food resource partitioning in a fish community of the central Amazon floodplain. *Neotropical Ichthyology*, 2004, vol. 2, no. 2, p. 75-84.

NOVAES, JLC., CARAMASCHI, ER. and WINEMILLER, KO. Feeding of *Cichla monoculus* Spix, 1829 (Teleostei: Cichlidae) during and after reservoir formation in the Tocantins River, Central Brazil. *Acta Limnol. Bras.*, 2004, vol. 16, no. 1, p. 41-49.

OLIVEIRA, EF., GOULART, E. and MINTE-VERA, CV. Patterns of dominance and rarity of fish assemblage along spatial gradients in the Itaipu reservoir, Paraná, Brazil. *Acta Sci. Biol. Sci.*, 2003, vol. 25, no. 1, p. 71-78.

PIANKA, ER. The structure of lizard communities. *Annu. Rev. Ecol. Syst.,* 1973, no. 4, p. 53-74.

RABELO, H. and ARAÚJO-LIMA, CARM. A dieta e o consumo diário de alimento de *Cichla monoculus* na Amazônia central. *Acta Amazonica,* 2002, vol. 32, no. 4, p. 707-724.

REINTHAL, PN. and KLING, GW. Exotic species, trophic interactions, and ecosystem dynamics: A case study of lake Victoria, In: STOUDER, DJ., FRESH, KL. and FELLER, RJ. (eds.). *Theory and Application in Fish Feeding Ecology*. Columbia: University of South Carolina Press, 1994. p. 295-313.

SANTOS, GB., MAIA-BARBOSA, PM., VIEIRA, F. and LÓPEZ, CM. Fish and zooplancton community structure in reservoirs of southeastern Brazil: effects of the introduction of exotic predatory fish. In: PINTO-COELHO, RM., GIANI, A. and Von SPERLING, E. (eds.). *Ecology and Human impact on Lakes and Reservoirs in Minas Gerais with Special Reference to Future Development and Management Strategies*. Belo Horizonte: SEGRAC, 1994. p. 115-132.

SUZUKI, HI., BULLA, CK., AGOSTINHO, AA. and GOMES, LC. Estratégias reprodutivas de assembléias de peixes em reservatórios. In: RODRIGUES, L., THOMAZ, SM., AGOSTINHO, AA. and GOMES, LC. (eds.). *Biocenoses em Reservatórios:* Padrões Espaciais e Temporais. Maringá: Eduem, 2005. p. 224-242.

TEIXEIRA, I. and BENNEMANN, ST. Ecomorfologia refletindo a dieta dos peixes em um reservatório no sul do Brasil. *Biota Neotropica*, 2007, vol. 7, no. 2, p. 67-76.

VIDOTTO, AP. *Estrutura da comunidade de peixes do reservatório de Nova Avanhandava (baixo rio Tietê, SP.), com ênfase na dinâmica populacional e dieta das espécies introduzidas*. Botucatu: Universidade Estadual Paulista, 2005. (Master thesis in Zoology).

WILLIAMS, JD.,WINEMILLER, K., TAPHORN, DC. and BALBAS, L. Ecology and status of piscivores in Guri, an oligotrophic tropical reservoir. *North Am. J. Fish. Manag.*, 1998, no. 18, p. 274-285.

WOOTON, RJ. *Ecology of teleost fishes*. London: Chapman & Hall, 1990. 404 p.

ZARET, TM. Inhibition of cannibalism in *Cichla ocellaris* and hypotesis of predator mimicry among South American fishes. *Evolution*, 1997, vol. 31, p. 421-437.

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