ARTIGO ORIGINAL

ISSN 0102-2067 / doi: 10.7213/estud.biol.7848

On the diet of two endemic and rare species of Trichomycterus (Ostariophysi: Trichomycteridae) in the Jordão River, Iguaçu River basin, southern Brazil

Sobre a dieta de duas espécies endêmicas e raras de Trichomycterus (Ostariophysi: Trichomycteridae) no Rio Jordão, bacia do Rio Iguaçu, sul do Brasil

Almir Petersen Barreto[a], Fabiane Cristina Armiliato[b], Vanessa Maria Ribeiro[c], Vinícius Abilhoa[d]

[a] Biologist graduated at Universidade Federal do Paraná (UFPR), doctorate degree in Zoology at the same University, professor of the Biological Sciences department in the Pontifícia Universidade Católica do Paraná (PUCPR), Curitiba, PR - Brazil, e-mail:almir.barreto@pucpr.br

[b] Biologist graduated at Pontifícia Universidade Católica do Paraná (PUCPR), master degree in Fisheries Resources and Fishing Engineering from the Universidade Estadual do Oeste do Paraná (Unioeste), Toledo, PR - Brazil, e-mail: fabiane.armiliato@pucpr.br

[c] Biologist graduated at Universidade Federal do Paraná (UFPR), master degree in Ecology and Conservation at the same University, Curitiba, PR - Brazil, e-mail: vanessa.gpic@gmail.com

[d] Biologist graduated at Pontifícia Universidade Católica do Paraná (PUCPR), doctorate degree in Zoologia at Universidade Federal do Paraná (UFPR), Grupo de Pesquisas em Ictiofauna (GPIc), Museu de História Natural Capão da Imbuia, Prefeitura de Curitiba, Curitiba, PR - Brazil, e-mail: vabilhoa@uol.com.br

Abstract

The diet and the effect of body size on the feeding habits of Trichomycterus crassicaudatus and Trichomycterus stawiarski, collected in the Jordão River, an import tributary of the Iguaçu River basin, were investigated. Samples were collected in august 2003 during the Jordão River Energetic Complex Aquatic Fauna Rescue and Monitoring program. Stomach contents were evaluated through the frequency of occurrence, permutational multivariate analysis of variance (PERMANOVA), similarity percentage analysis (SIMPER) and non-metric multidimensional scaling analysis (MDS) methods. A total of 86 stomach contents of T. stawiarski and 36 of T. crassicaudatus were assessed. The species presented an insectivorous feeding habit, with differences in the diet composition of the "smallest" and the "largest" individuals. Ephemeroptera nymphs, larvae and pupae of Diptera, organic detritus and plant fragments were the most important food items. Both species feeding habits were based mainly in benthic aquatic immature insects.

Keywords*:* Catfish. Feeding ecology. Freshwater fish. Neotropics.

Resumo

Foi investigada a dieta e o efeito do tamanho corporal no hábito alimentar de exemplares de Trichomycterus crassicaudatus *e* Trichomycterus stawiarski *coletados no rio Jordão, um importante afluente do rio Iguaçu. Os exemplares foram coletados em agosto de 2003 durante o programa de Resgate e Monitoramento da Fauna Aquática do complexo Energético do rio Jordão (UHE Santa Clara). Os conteúdos estomacais foram analisados de acordo com o método de frequência de ocorrência, análise de variância multivariada permutacional (PERMANOVA), análise de percentual de similaridade (SIMPER) e escalonamento multidimensional não métrico (NMDS). Foram analisados 86 estômagos de* T. stawiarski *e 36 de* T. crassicaudatus. *As espécies apresentaram hábito alimentar predominantemente insetívoro, com diferenças na dieta entre indivíduos pequenos e grandes. Ninfas de Ephemeroptera, larvas e pupas de Diptera, detritos orgânicos e material de origem vegetal foram os itens mais importantes. Os resultados obtidos demonstram que a alimentação de ambas as espécies é baseada principalmente em estágios imaturos bentônicos de insetos*.

Palavras-chave*: Candiru. Ecologia alimentar. Peixes de água doce. Região neotropical*.

Received: 08/07/2012
Recebido: 07/08/2012

Approved: 09/12/2012
Aprovado: 12/09/2012

Introduction

The Iguaçu River basin is considered a global biodiversity hotspot (Abell, Thieme, Revenga, Bryer, Kottelat, Bogutskaya, et al. 2008), because of the diverse, endemic, and endangered fish species (Abilhoa & Duboc, 2004; Rosa & Lima, 2008). The high degree of endemism of its ichthyofauna has been mentioned by several authors (e.g. Severi & Cordeiro, 1994; Garavello, Pavanelli & Suzuki, 1997), and is probably due to its geographic isolation imposed by the Iguaçu falls. In the Iguaçu River, ten species of *Trichomycterus* were recorded: *Trichomycterus stawiarski* — Miranda Ribeiro, 1968; *Trichomycterus castroi* — de Pinna, 1992; *Trichomycterus naipi* — Wosiacki & Garavello, 2004; *Trichomycterus papilliferus* — Wosiacki & Garavello, 2004; *Trichomycterus mboycy* — Wosiacki & Garavello, 2004; *Trichomycterus taroba* — Wosiacki & Garavello, 2004; *Trichomycterus plumbeus* — Wosiacki & Garavello, 2004; *Trichomycterus davisi* — Haseman, 1908; *Trichomycterus crassicaudatus* — Wosiacki & de Pinna, 2008; and *Trichomycterus igobi* — Wosiacki & de Pinna, 2008. The species *T. davisi* is the only non-endemic to the Iguaçu River basin.

The Neotropical catfish family Trichomycteridae comprises more than 200 species of small-sized fishes (de Pinna & Wosiacki, 2003) which in general inhabit fast-flowing rocky streams (Arratia, 1983; de Pinna, 1998). Despite the remarkable range of habitats and feeding habit, which includes trophic specializations such as haematophagy and lepidophagy, there is little information on trichomycterids natural feeding ecology. For the genus *Trichomycterus*, a probably non-monophyletic group of catfish with pronounced intraspecific variation in color pattern (de Pinna & Wosiacki, 2003), the few available data are greatly disproportional to the large number of species. Available evidences for the genus *Trichomycterus* suggest that the group is represented by generalized predators of aquatic invertebrates (Abilhoa, Duboc & Azevedo-Filho, 2008; Casatti, 2003; Chará, Baird, Telfer & Rubio, 2006; Habit, Victoriano & Campos, 2005; Manoni, Garelis, Tripole & Vallania, 2009; Manriquez, Huaquin, Arellano & Arratia, 1988; Rolla, Esteves & Ávila-da-Silva, 2009), Román-Valencia, 2001; Scott, Pardo & Vila, 2007; Trajano, 1997).

In the present work we describe the feeding habits of individuals of *T. crassicaudatus* and *Trichomycterus stawiarski* collected in Santa Clara hydroelectric power plant (downstream) in the Jordão River, an important tributary of the Iguaçu River basin. Considering the fact that most studies on the feeding ecology of tropical freshwater fish have shown that several species shift their diets according to the ontogenetic development (Abilhoa, Bastos & Wegbecher, 2007; Abilhoa, Bornatowski & Otto, 2009; Barriga & Battini, 2009; Vitule, Braga & Aranha, 2008), which seems to be related with morphological (e.g. buccal opening) and behavioral (e.g. locomotion capability) changes during development (Wooton, 1999), we also assessed the influence of size classes on the diet of each species.

Materials and methods

The field work was carried out in the Jordão River (25° 38´ S – 52° 00' W), an important tributary of the lower Iguaçu River basin with many rapids and waterfalls. All specimens were caught in August 2003 during the impoundment of Santa Clara hydroelectric power plant (downstream) as part of the Jordão River Energetic Complex Aquatic Fauna Rescue and Monitoring program, under the authorization of IBAMA (process number 02017.000523/03-18). Specimens were collected using manual sieves (5 mm mesh) and dip nets (5 mm mesh). Captured specimens were fixed in the field in 10% formalin solution and brought to the laboratory where were measured (mm) and dissected. Digestive tracts were removed and their contents analyzed and identified up to the lowest taxonomic level reached using a stereomicroscope. Voucher specimens were deposited in the fish collection of the Museu de História Natural Capão da Imbuia (MHNCI 12297 and MHNCI 12299).

A similarity matrix with the presence/absence data of food items was generated using the *Jaccard* similarity coefficient. Two-way crossed permutational multivariate analysis of variance (PERMANOVA) examined the effects of species and size classes (factors) on the diet composition. Significant factors were further analyzed using a PERMANOVA pair-wise comparison. Similarity of percent contribution (SIMPER) analysis was employed to investigate prey categories most responsible for the separation among factors. Data were also investigated using non-metric multidimensional scaling analysis (NMDS) to visually assess the dispersion of samples. All analyses were performed using Primer v6 software (Clarke & Gorley, 2006). Because of the lack of information on *Trichomycterus* life history (size at first maturity, growth, and reproduction), size classes (total length) and corresponding length intervals were obtained from Sturges' formulation (Vieira, 1980).

Results

During the survey period, 36 specimens of *T. crassicaudatus* and 86 specimens of *T. stawiarski* were collected. Food items were grouped into broad taxonomic or ecological categories: Mollusk Bivalvia, aquatic immature insects (unidentified larvae and pupae of Diptera, Diptera – Chironomidae larvae, Diptera – Simulidae larvae, Diptera – Ceratopogonidae larvae, Plecoptera larvae, Trichoptera nymphs, Ephemeroptera nymphs, Lepidoptera – Pyralidae larvae), insect remains, fish, fish scales, fragments of plants and organic detritus. The category that showed the greatest diversity was aquatic immature insects. *T. crassicaudatus* diet was constituted by 11 feeding items whereas *T. stawiarski* feed on 13 items. Ephemeroptera nymphs, larvae and pupae of Diptera, organic detritus and plant fragments were the most representative food items for *T. crassicaudatus* and *T. stawiarski*. Table 1 shows all food items recorded.

A two-factor PERMANOVA indicated significant differences between species and between size classes (Table 2a). Pair-wise comparisons (Table 2b) designed to examine significant factors showed that *T. crassicaudatus* size class 2 (76 – 110 mm) had different diet from size class 5 (176 – 210 mm), whereas *T. stawiarski* size class 1 (25 – 45 mm) had different diet from individuals > 66 mm; and *T. stawiarski* size class 2 (46 – 65 mm) had different diet from individuals > 86 mm. These findings were supported by the NMDS analysis of diet composition according to size classes' categories (Figure 1). SIMPER analysis found that the highest contributors to dissimilarity (43.5%) between diets of *T. crassicaudatus* and *T. stawiarski* were fragments of plants (17.1%) and unidentified larvae and pupae of Diptera (16.3%). The highest contributors to dissimilarity (> 43%) of diet composition between the "smallest" and the "largest" individuals of *T. stawiarski* were unidentified larvae and pupae of Diptera (16%), Ephemeroptera nymphs (16%), fragments of plants (15%) and Plecoptera larvae (13%), whereas

Table 1 - Frequency of occurrence of items consumed by *T. crassicaudatus* and *T. stawiarski* in the Jordão River, Iguaçu River basin, according to each size class considered

Alimentary Items	*T. crassicaudatus*					*T. stawiarski*				
Size classes	**Tc_1**	**Tc_2**	**Tc_3**	**Tc_4**	**Tc_5**	**Ts_1**	**Ts_2**	**Ts_3**	**Ts_4**	**Ts_5**
Mollusk Bivalvia	-	-	-	-	-	8.3	-	-	-	-
Diptera (L/P)	75.0	100.0	58.8	40.9	16.7	66.7	77.8	55.6	33.3	-
Chironomidae (L)	-	20.0	23.5	22.7	33.3	-	-	-	-	50.0
Simulidae (L)	12.5	10.0	11.8	4.5	16.7	8.3	22.2	22.2	-	-
Ceratopogonidae (L)	-	-	-	9.1	16.7	-	-	-	-	-
Plecoptera (L)	6.3	-	5.9	13.6	50.0	33.3	44.4	33.3	33.3	-
Trichoptera (N)	6.3	-	5.9	4.5	-	8.3	-	-	-	-
Ephemeroptera (N)	56.3	80.0	94.1	86.4	100.0	83.3	88.9	77.8	66.7	50.0
Pyralidae (L)	6.3	20.0	23.5	18.2	16.7	16.7	22.2	44.4	-	-
Insect remains	31.3	30.0	5.9	13.6	16.7	16.7	-	11.1	-	50.0
Fish	-	-	-	-	-	-	-	-	-	50.0
Fish scales	-	-	-	-	-	-	-	-	-	100.0
Fragments of plants	25.0	-	35.3	77.3	50.0	41.7	55.6	66.7	100.0	100.0
Organic detritus	75.0	90.0	100.0	95.5	66.7	75.0	88.9	88.9	66.7	100.0

Legend: T. crassicaudatus size classes — Tc_1 = 40 – 75 mm, Tc_2 = 76 – 110 mm, Tc_3 = 111 – 145 mm, Tc_4 = 146 – 175 mm and Tc_5 = 176 – 210 mm; T. stawiarski size classes — Ts_1 = 25 – 45 mm, Ts_2 = 46 – 65 mm, Ts_3 = 66 – 85 mm, Ts_4 = 86 – 105 mm and Ts_5 = 106 – 125 mm; L = larvae; P = pupae; N = nymph.

Source: Research data.

Table 2 - Two-factor permutational MANOVA (PERMANOVA) results of items consumed by *T. crassicaudatus* and *T. stawiarski* in the Jordão River, Iguaçu River basin (a) and p-values of pair-wise comparisons of size classes (b)

(a) Two-factor PERMANOVA					
Factors	**d.f.**	**MS**	**Pseudo-F**	**P-value**	**Unique Perms**
Species	1	4788.3	2.8118	**0.016**	999
Size classes	4	4196.2	2.4641	**0.001**	997
Species x Size classes	4	1779.7	1.0451	0.401	998
Residual	95	1702.9			

(b) Pair-wise comparisons		
Size classes	***T. crassicaudatus***	***T. stawiarski***
1 v. 2	0.974	0.395
1 v. 3	0.793	**0.045**
1 v. 4	0.453	**0.003**
1 v. 5	0.057	**0.024**
2 v. 3	0.797	0.036
2 v. 4	0.317	**0.001**
2 v. 5	**0.024**	**0.007**
3 v. 4	0.553	0.076
3 v. 5	0.078	0.067
4. v. 5	0.276	0.114

Source: Research data.

Note: Items in bold represent significant pair-wise comparisons.

the highest contributors to dissimilarity (58%) of diet composition between the "smallest" and the "largest" individuals of *T. crassicaudatus* were fish scales (20%) and unidentified larvae and pupae of Diptera (10%).

Discussion

Considering the fact that this study represents a short-term survey on the feeding ecology of these poorly known trichomycterids, our findings suggest that *T. crassicaudatus* and *T. stawiarski* feed mostly on autochthonous food, and its feeding habit can be characterized as insectivorous, due to the high importance of benthic aquatic immature insects in the stomach contents. The exploitation of aquatic immature insects was already recorded for several *Trichomycterus* species (Russo, Ferreira & Dias, 2002; Habit, et al., 2005; Chará, et al., 2006; Scott, et al., 2007; Manoni, et al., 2009; Eutrópio & Gomes, 2010). Among these autochthonous items, in small to mid--order tropical streams the most representative item seem to be dipteran larvae (Casatti, 2002, 2003; Pinto & Uieda, 2007; Rolla, et al., 2009; Rondinelli, et al., 2009; Cetra, Rondinelli & Souza, 2011).

The presence of several groups of benthic invertebrates in the stomachs indicates a selective behavior of picking up items on the substrate, in the same way of other small-sized catfish (Aranha, Takeuti & Yoshimura, 1998; Casatti & Castro, 1998). In fact, members of Trichomycteridae were characterized as benthic substrate speculators (Casatti & Castro, 1998; Casatti, 2002), by having well-developed sensory barbells and mouth terminal or subterminal, allowing them to explore small spaces (microhabitats) where they found aquatic immature insects (Casatti & Castro, 2006).

Aquatic insect larvae and pupae are common among fish food items because these insects are very

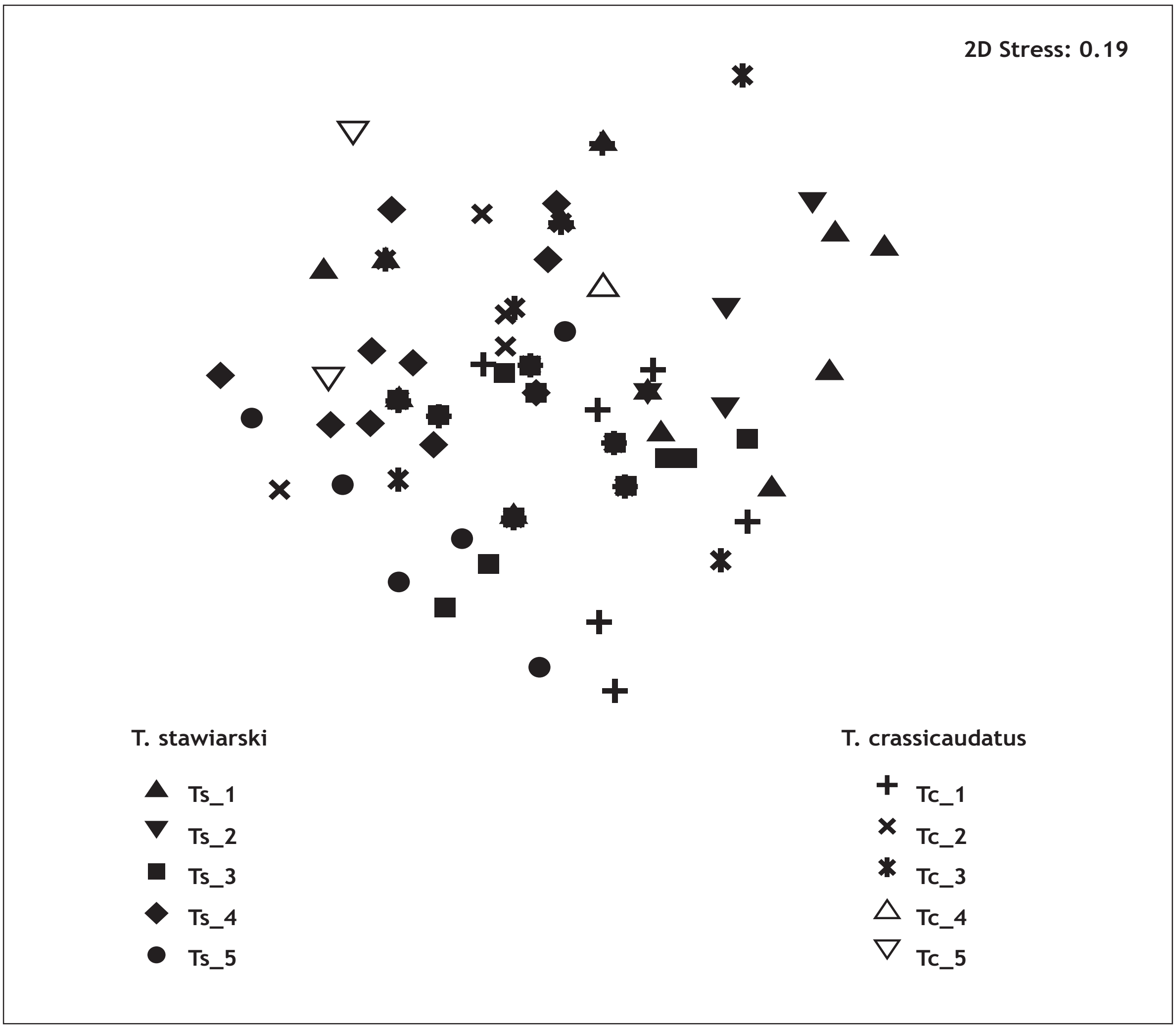

Figure 1 - Ordination resulting from Non-metric Multidimensional Scaling Analysis (NMDS), based on the presence/absence data of food items in each size class categories for *T. stawiarski* and *T. crassicaudatus*.

Source: Research data.

Note: *T. crassicaudatus* size classes — Tc_1 = 40 – 75 mm, Tc_2 = 76 – 110 mm, Tc_ = 111 – 145 mm, Tc_4 = 146 – 175 mm, and Tc_5 = 176 – 210 mm; T. stawiarski size classes: Ts_1 = 25 – 45 mm, Ts_2 = 46 – 65 mm), Ts_3 = 66 – 85 mm), Ts_4 86 – 105 mm), and Ts_5 = 106 – 125 mm.

abundant and available in freshwater, and some of them can tolerate a wide variety of environmental factors (Allan, 1995). Although aquatic immature insects may represent an abundant food source for fish, differences in the diet composition of the "smallest" and the "largest" individuals of *T. crassicaudatus* and *T. stawiarski* were observed, a reflection of changes in feeding capabilities (e.g. mouth gap, locomotion ability), habit and/or behavioural shifts (Wooton, 1999). We believe that the sharing of this abundant resource and differences in the occupation of microhabitats allow the coexistence of both species in the studied area.

The relevance of aquatic immature stages of mosquitoes (Diptera) to the *Trichomycterus* natural diet highlights the importance of the marginal forest to the feeding habits of stream fishes, a result which has also been recorded for several other stream fishes (Abilhoa, Braga, Bornatowski & Vitule, 2011). The preservation of this vegetation is essential for maintaining the integrity of local habitats and fauna, since the marginal forest contributes to the input of organic material, forming the base of the trophic web in aquatic ecosystems (Barrella, Petrere, Smith & Montag, 2001).

Acknowledgements

We express appreciation to LACTEC – Instituto de Tecnologia para o Desenvolvimento and ELEJOR – Centrais Elétricas do rio Jordão S. A. for project financing and technical support.

References

Abell, R., Thieme, M. L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., et al. (2008). Freshwater ecoregions of the World: a new map of biogeographic units for freshwater biodiversity conservation. *BioScience*, *58*(5), 403-414.

Abilhoa, V., Bastos, L. P., & Wegbecher, F. (2007). Feeding habits of *Rachoviscus crassiceps* (Teleostei: Characidae) in a coastal Atlantic rainforest stream, southern Brazil. *Ichthyological Exploration of Freshwaters*, *18*(3), 227-232.

Abilhoa, V., Bornatowski, H., & Otto, G. (2009). Temporal and ontogenetic variations on feeding habits of *Hollandichthys multifasciatus* (Teleostei: Characidae) in coastal Atlantic rainforest streams, southern Brazil. *Neotropical Ichthyology*, *7*(3), 415-420.

Abilhoa, V., Braga, R. R., Bornatowski, H., & Vitule, J. R. S. (2011). Fishes of the Atlantic Rain Forest streams: ecological patterns and conservation. In O. Grillo (Ed.). *Changing diversity in changing environment* (pp. 259-282). Rijeka: InTech.

Abilhoa, V., & Duboc, L. F. (2004). Peixes. In S. B. Mikich & R. S. Bérnils (Ed.). *Livro Vermelho dos Animais Ameaçados de Extinção no Estado do Paraná* (pp. 581-678). Curitiba: Mater Natura e Instituto Ambiental do Paraná.

Abilhoa, V., Duboc, L. F., & Azevedo-Filho, D. P. A. A. (2008). Comunidade de peixes de um riacho de Floresta com Araucária, alto rio Iguaçu, sul do Brasil. *Revista Brasileira de Zoologia*, *25*, 238-246.

Allan, J. D. (1995). *Stream ecology: Structure and function of running waters*. London: Chapman and Hall.

Aranha, J. M. R., Takeuti, D. F., & Yoshimura, T. M. (1998). Habitat use and food partitioning of the fishes in a coastal stream of Atlantic Forest, Brazil. *Revista de Biología Tropical*, *46*(4), 951-959.

Arratia, G. (1983). Preferencias de habitat de peces Siluriformes de aguas continentales de Chile (Fam. Diplomystidae y Trichomycteridae). *Studies on Neotropical Fauna and Environment*, *18*, 217-237.

Barrella, W., Petrere, M. Jr., Smith, W. S., & Montag, L. F. A. (2001). As relações entre matas ciliares, os rios e os peixes. In R. R. Rodrigues & H. L. Leitão-Filho (Ed.). *Matas ciliares: Conservação e recuperação*. (pp. 187-207). São Paulo: Edusp/Fapesp.

Barriga, J. P., & Battini, M. A. (2009). Ecological significances of ontogenetic shifts in the stream-dwelling catfish, *Hatcheria macraei* (Siluriformes, Trichomycteridae), in a Patagonian river. *Ecology of Freshwater Fish*, *18*, 395-405.

Casatti, L. (2002). Alimentação dos peixes em um riacho do Parque Estadual Morro do Diabo, Bacia do Alto Rio Paraná, sudeste do Brasil. *Biota Neotropica*, *2*(2), 1-14.

Casatti, L. (2003). Biology of Cattfish, *Trichomycterus* sp. (Pisces, Siluriformes), in a Pristine Stream in the Morro do Diabo State Park, Southeastern Brazil. *Studies on Neotropical Fauna and Environment*, *38*(2), 105-110.

Casatti, L., & Castro, R. M. C. (1998). A fish community of the São Francisco River headwaters riffles, southeastern Brazil. *Ichthyological Exploration of Freshwaters*, *9*(3), 229-242.

Casatti, L., & Castro, R. M. C. (2006). Testing the ecomorphological hypothesis in a headwater riffles fish assemblage of the Rio São Francisco, southeastern Brazil. *Neotropical ichthyology*, *4*(2), 203-214.

Cetra, M., Rondinelli, G. R., & Souza, U. P. (2011). Compartilhamento de recursos por duas espécies de peixes nectobentônicas de riachos na bacia do rio Cachoeira (BA). *Biota Neotropica*, *11*(2), 87-95.

Chará, J. D., Baird, D. J., Telfer, T. C., & Rubio, E. A. (2006). Feeding ecology and habitat preferences of the catfish genus *Trichomycterus* in low-order streams of the Colombian Andes. *Journal of Fish Biology*, *68*, 1026-1040.

Clarke, K. R., & Gorley, R. N. (2006). *PRIMER v6: User Manual/Tutorial* (p. 190). Plymouth (USA): PRIMER-E.

de Pinna, M. C. C. (1998). Phylogenetic relationships of ne-tropical Siluriformes (Teleostei: Ostariophysi): Historical overview and synthesis of hypotheses. In L. R. Malabarba, R. E. Reis, R. P. Vari, Z. M. S. Lucena & C. A. S. Lucena (Ed.). *Phylogeny and Classification of Neotropical Fishes*. (pp. 279-330). Porto Alegre: EDIPUCRS.

de Pinna, M. C. C., & Wosiacki, W. B. (2003). Family Trichomycteridae (Pencil or parasitic catfishes). In R. E. Reis, S. O. Kullander & C. J. Ferraris (Ed.). *Check list of the freshwater fishes of South and Central America*. (pp. 270-290). Porto Alegre: EDIPUCRS.

Eutrópio, F. J., & Gomes, L. C. (2010). Dieta alimentar de *Trichomycterus longibarbatus* Costa, 1992 e *Pimelodella transitoria* Miranda Ribeiro, 1905 (Siluriformes): Um caso de competição interespecífica. *Natureza on line*, *8*(2), 67-70.

Garavello, J. C., Pavanelli, C. S., & Suzuki, H. I. (1997). Caracterização da ictiofauna do rio Iguaçu. In A. A. Agostinho & L. C. Gomes, (Ed.). *Reservatório de Segredo: Bases ecológicas para o manejo*. (pp. 61-84). Maringá: EDUEM.

Habit, E., Victoriano, P., & Campos, H. (2005). Ecología trófica y aspectos reproductivos de *Trichomycterus areolatus* (Pisces, Trichomycteridae) en ambientes lóticos artificiales. *Revista de Biología Tropical*, *53*, 195-210.

Hyslop, E. J. (1980). Stomach contents analysis a review of methods and their application. *Journal of Fish Biology*, *17*, 411-429.

Manoni, R. A., Garelis, P. A., Tripole, E. S., & Vallania, E. A. (2009). Diet and feeding preferences of *Trichomycterus corduvensis* Weyenbergh, 1877 (Siluriformes, Trichomycteridae) in two rivers of the Quinto River basin (San Luis, Argentina). *Acta Limnológica Brasileira*, *21*(2), 161-167.

Manriquez, A., Huaquin, L., Arellano, M., & Arratia, G. (1988). Aspectos reproductivos de *Trichomycterus areolatus* Valenciennes, 1846 (Pisces: Teleostei: Siluriformes) em Rio Angostura, Chile. *Studies on Neotropical Fauna Environment*, *23*, 89-102.

Pinto, T. L. F., & Uieda, V. S. (2007). Aquatic insects selected as food for fishes of a tropical stream: are there spatial and seasonal differences in their selectivity? *Acta Limnologica Brasiliensia*, *19*(1), 67-78.

Rolla, A. P. P., Esteves, K. E., & Ávila-da-Silva, A. O. (2009). Feeding ecology of a stream fish assemblage in an Atlantic Forest remnant (Serra do Japi, SP, Brazil). *Neotropical Ichthyology*, *7*(1), 65-76.

Román-Valencia, C. (2001). Ecología trófica y reproductiva de *Trichomycterus caliense* y *Astroblepus cyclopus* (Pisces: Siluriformes) en el río Quindio, Alto Cauca, Colômbia. *Revista de Biología Tropical*, *49*(2), 657-666.

Rondinelli, G. R., Carmassi, A. L., & Braga, F. M. S. (2009). Population biology of *Trichomycterus* sp. (Siluriformes, Trichomycteridae) in Passa Cinco stream, Corumbataí River sub-basin, São Paulo State, southeastern Brazil. *Brazilian Journal of Biology, 69*(3), 925-934.

Rosa, R. S., & Lima, F. C. (2008). Os peixes brasileiros ameaçados de extinção. In A. B. M. Machado, A. M. Drummond, & A. P. Paglia (Ed.). *Livro vermelho da fauna brasileira ameaçada de extinção.* (pp. 9-275). Belo Horizonte: Fundação Biodiversitas.

Russo, M. R., Ferreira, A., & Dias, R. M. (2002). Disponibilidade de invertebrados aquáticos para peixes bentófagos de dois riachos da bacia do rio Iguaçu, Estado do Paraná, Brasil. *Acta Scientiarum Biological Sciences*, *24*(2), 411-417.

Scott, S., Pardo, R., & Vila, I. (2007). Trophic niche overlap between two Chilean endemic species of *Trichomycterus* (Teleostei: Siluriformes). *Revista Chilena de Historia Natural*, *80*, 431-437.

Severi, W., & Cordeiro, A. M. M. (1994). *Catálogo de peixes da bacia do rio Iguaçu*. Curitiba: Instituto Ambiental do Paraná/GTZ.

Trajano, E. (1997). Food and reproduction of *Trichomycterus itacarambiensis*, cave catfish from southeastern. *Journal of Fish Biology*, *51*, 53-63.

Vieira, S. (1980). *Introdução à bioestatística.* Rio de Janeiro: Campus.

Vitule, J. R. S., Braga, M. R., & Aranha, J. M. R. (2008). Ontogenetic, spatial and temporal variations in the feeding ecology of *Deuterodon langei* Travassos, 1957 (Teleostei: Characidae) in a Neotropical stream from the Atlantic rainforest, southern Brazil. *Neotropical Ichthyology*, *6*(2), 211-222.

Wooton, J. H. (1999). *Ecology of teleost fish*. Dordrecht (Netherlands): Kluwer Academic Publishers.