Resource partitioning between two species of *Bryconamericus* Eigenmann, 1907 from the Iguaçu river basin, Brazil

Márcia Regina Russo, Norma Segatti Hahn* and Carla Simone Pavanelli

Departamento de Biologia/Nupélia/PEA, Universidade Estadual de Maringá, Av. Colombo, 5790, Bloco G-90, 87020-900, Maringá, Paraná, Brasil. Author for correspondence. e-mail:hahnns@nupelia.uem.br

ABSTRACT. Diets of two species of *Bryconamericus* Eigenmann, 1907 called *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2, were compared. Collections were made monthly, from March 1997 to February 1998, on the Iguaçu River, State of Paraná. Both species are insectivores, but *Bryconamericus* sp. 1 feed predominantly on larvae of aquatic insects and *Bryconamericus* sp. 2 feed on terrestrial insects. In *Bryconamericus* sp. 1, the mouth is sub-inferior with slightly thick upper lip, while in *Bryconamericus* sp. 2 the mouth is anterior with reduced lip; teeth are different in both species, confirming differences in feeding tactics. The length of the intestine is significantly longer in *Bryconamericus* sp. 1. This particularity and the low overlap values (<0.60) suggest that interspecific differences in feeding habits play an important role, allowing species coexistence.

Key words: resource partitioning, diet, trophic morphology, *Bryconamericus*, Neotropical.

RESUMO. Partição de recursos alimentares entre duas espécies de *Bryconamericus* Eingenmann, 1970 da bacia do rio Iguaçu, Brasil. As dietas de duas espécies de *Bryconamericus* Eigenmann, 1907 denominadas *Bryconamericus* sp. 1 e *Bryconamericus* sp. 2 foram comparadas. As coletas foram realizadas mensalmente, no período de março/97 a fevereiro/98, no rio Iguaçu, Paraná. Ambas são insetívoras, porém a primeira se alimenta predominantemente de larvas de insetos aquáticos e a segunda de insetos terrestres. Em *Bryconamericus* sp. 1 a boca é sub-terminal e o lábio superior é levemente mais espesso, enquanto em *Bryconamericus* sp. 2 a boca é terminal e os lábios são delgados. Além disso, a disposição dos dentes é desigual nas duas espécies, confirmando as diferenças encontradas em suas táticas alimentares. O comprimento do intestino é significativamente maior em *Bryconamericus* sp. 1. Estas particularidades, associadas aos baixos valores na sobreposição alimentar (<0.60), sugerem que diferenças interespecíficas na dieta desempenham um papel importante, permitindo a coexistência das duas espécies.

Palavras-chave: partição de recursos, dieta, morfologia trófica, *Bryconamericus,* neotropical.

Introduction

Diet investigations can indicate feeding habit of a fish, but other studies such as trophic morphology are necessary to understand fish distribution and behavior. Information about position, size and shape of mouth, teeth, gill rakers, and intestine allow inferences about diet and feeding strategies of species (Wootton, 1990). In addition, food overlap among species is a valuable measure aiding to understand the structure of fish assemblages. The most commonly used resources are food and space or microhabitats (Krebs, 1989). Therefore, studies dealing with food partitioning are among the best elucidating species relationships at a particular moment (Ross, 1986).

The genus *Bryconamericus* Eigenmann (family Characidae) consists of small fishes generally less than 10cm, which live in a diversity of habitats (Severi and Cordeiro, 1994). On the Iguaçu River basin, endemic species of *Bryconamericus* are abundant (Garavello *et al*., 1997). The effects of the dams on the Iguaçu River (dammed in October 1998) could result in species extinction before we can at least describe them, given the high fragility of fish assemblages. These species are supposedly new for science, thus there are not formal scientific names for them. Generally these small sized fishes form shoals and feed on small invertebrates and particles that float on the water. As these food items are apparently abundant, probably these species developed different feeding strategies and tactics. According to Labropoulou and Eleftheriou (1997) morphological differences that influence mechanisms used in the capture of food permit sympatric species to coexist by reducing interspecific competition.

Based on stomach contents analysis and trophic morphology, we presented here comparative data on *Bryconamericus* sp .1 and *Bryconamericus* sp. 2, to know how these species behave in relation to partition of food resources in the studied environment.

Material and methods

Study area

The section of the Iguaçu River under study, located in the Southwest region of the State of Paraná, Brazil (25º32'35"S/53º29'43"W), was dammed in October 1998, resulting in the filling of the Salto Caxias Reservoir. Samplings were done at three fixed sites, prior reservoir construction (Figure 1).

Figure 1. Partial map of Brazil and bordering countries showing the sampled region (star) and the Iguaçu Falls (rectangle).

Sampling and species description

Individuals of two species of *Bryconamericus*, called *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2, were sampled monthly from March 1997 to February 1998, with 20m (0.5cm mesh) seine in littoral areas, and gill nets (2.4cm mesh) in open waters. The identification of the former is based on Sampaio (1988) and Garavello *et al.* (1997) (called *Bryconamericus* sp. A), but the last species is not mentioned by these authors. Thus, we measured some morphological characters from both species to make sure they are different entities. Ten specimens of each species were taken for morphometric characterization. The measurements and counts are described in Fink and Weitzman (1974). Measurements are presented as percentages of standard length (SL) and head length (HL) (Tables 1 and 2).

Table 1. Morphomeristic data from ten specimens of *Bryconamericus* sp. 1. SD= standard deviation.

	Range			
Character	Minimum	Maximum	Mean	SD
Standard length (mm)	40.8	58.0	51.40	4.97
Percentages of standard length				
Head length	22.8	24.6	23.8	0.65
Body depth	31.9	37.8	35.2	1.77
Caudal peduncle length	12.0	16.4	14.5	1.47
Caudal peduncle depth	11.4	12.4	11.9	0.38
Percentages of head length				
Snout length	26.8	30.5	28.1	1.06
Eye diameter	35.2	41.9	39.3	1.87
Interorbital width	31.0	36.1	33.9	1.46
Upper jaw length	36.0	39.8	37.6	0.98
Counts				
Lateral line perforated scales	35	37	35.9	0.78
Rows of scales from dorsal fin origin to lateral line	5	6	5.6	0.53
Rows of scales from lateral line to anal fin origin	4	5	4.2	0.42
Epibranchial gill rakers	7	8	7.7	0.48
Ceratobranchial gill rakers	7	10	8.8	1.03
Total dorsal fin rays	9	--	--	--
Total pectoral fin rays	12	13	12.4	0.52
Total pelvic fin rays	8	9	8.1	0.32
Total anal fin rays	20	22	20.5	0.71

Table 2. Morphomeristic data from ten specimens of *Bryconamericus* sp. 2. SD= standard deviation.

	Range			
Character	Minimum	Maximum	Mean	SD
Standard length (mm)	48.0	64.6	54.9	6.00
Percentages of standard length				
Head length	21.1	22.1	21.6	0.34
Body depth	28.4	33.6	30.8	1.75
Caudal peduncle length	12.0	15.2	13.9	1.05
Caudal peduncle depth	10.0	11.2	10.5	0.36
Percentages of head length				
Snout length	25.5	28.6	27.3	1.00
Eye diameter	38.3	43.6	41.2	1.56
Interorbital width	35.8	40.5	38.3	1.44
Upper jaw length	39.9	46.2	43.5	2.50
Counts				
Lateral line perforated scales	35	37	35.8	0.75
Rows of scales from dorsal fin origin to lateral line	5	6	5.1	0.38
Rows of scales from lateral line to anal fin origin	3	4	3.6	0.52
Epibranchial gill rakers	7	8	7.1	0.32
Ceratobranchial gill rakers	10	12	10.5	0.71
Total dorsal fin rays	9	--	--	--
Total pectoral fin rays	11	12	11.8	0.42
Total pelvic fin rays	7	8	7.7	0.48
Total anal fin rays	23	27	25.8	1.55

The material examined is deposited at the ichthyological collection of the Center of Research in Limnology, Ichthyology and Aquaculture (Nupélia), Maringá State University, State of Paraná, Brazil. Voucher-specimens (both from Salto Caxias Reservoir, Iguaçu River basin, in the city of Capitão Leônidas Marques, State of Paraná, Brazil, 2001, collected by Nupélia staff. *Bryconamericus* sp. 1 - NUP 718 (118 specimens); *Bryconamericus* sp. 2 – NUP 719 (15 specimens) (Figure 2).

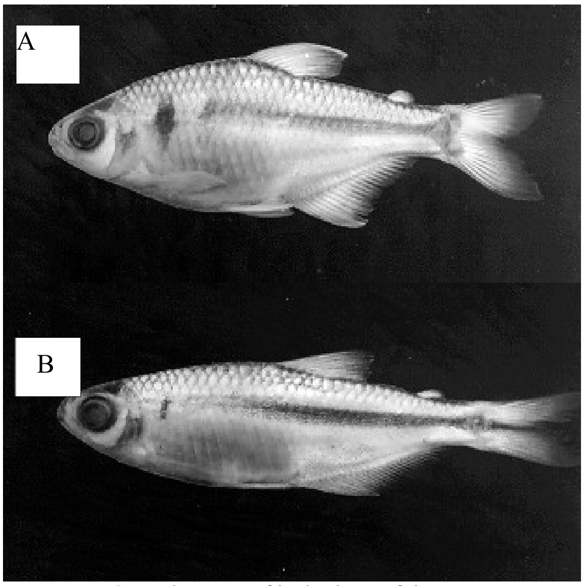

Figure 2. General aspects of body shape of the *Bryconamericus* sp. 1 (NUP 718; 60.8mm SL) and *Bryconamericus* sp. 2 (NUP 719; 66.8mm SL).

Diet analysis

Stomach contents were analyzed by frequency of occurrence and volumetric method, using graduated test tubes and a counting glass plate. These values (monthly obtained) were combined in the Feeding Index (IA_i) (Kawakami and Vazzoler, 1980): $\mathbf{IA_i=100\ F_i.V_i.(\sum.F_i.V_i)}$, where IA_i = Feeding Index; F = frequency of occurrence of item **i** in the diet (%); V = Volume of item **i** in the diet (%).

Food overlap was measured using the Schoener Index (Schoener, 1970) based on IA_i values (%) (monthly obtained) according to the formula: $\alpha = 1 - 0.5\ (\sum | P_{xi} - P_{xy} |)$; where α = food overlap, P_{xi} = proportion of food item **i** in the diet of species **x** and P_{xy} = proportion of food item **i** in the diet of species **y**.

Covariance analysis (ANCOVA) was applied to test differences in intestine length between species, using SL as co-variable (Huitema, 1980) all log transformed, to linearize relationships. Adjusted means for intestine length were compared using Scheffe's test, when statistical significance was observed.

Results

Diet analyses were based on 233 specimens of *Bryconamericus* sp. 1 (1.5 to 7.6cm SL) and 265 of *Bryconamericus* sp. 2 (1.3 to 7.0cm SL). Larval and adult insects predominated in the stomach contents. Diptera larvae (mainly Chironomidae) were present in the diet of both species during all study period. Other important preys were Trichoptera larvae, Coleoptera adults, and Homoptera and Hymenoptera (mainly Formicidae) adults (Table 3).

Bryconamericus sp. 1 consumed mostly Ephemeroptera larvae (53,7% mainly in July 1997), detritus/sediment (73.9 and 56.7% respectively in April and May 1997) and plant remains (40.3% in February 1998). *Bryconamericus* sp. 2 consumed mainly adult Diptera (60.0% especially in April 1997), macrophytes (Potamogetonaceae - 79.4% in August 1997), Hymenoptera (mainly wasps – 70.2, 54.8 and 58.8% respectively in September, November and December 1997) and adult Ephemeroptera (67.5 and 44.3% in May and October 1997) (Table 3).

Food overlap between *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2 was low, especially in April and May 1997. Highest overlap values were observed in March and June 1997 with 0.52 and 0.45, respectively (Figure 3).

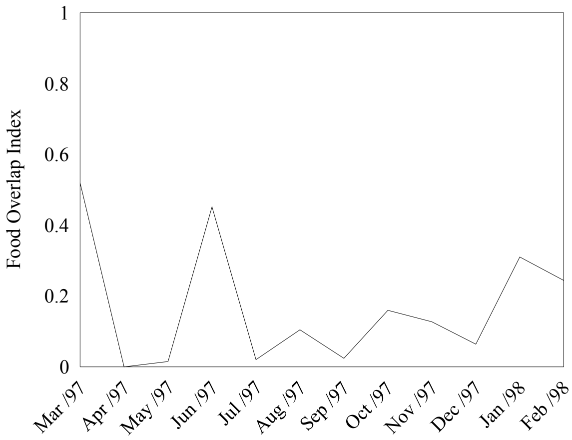

Figure 3. Monthly variation of Schoener's diet overlap Index based on IA_i data of *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2.

In *Bryconamericus* sp. 1 the mouth is sub-inferior, with slightly thick upper lip (Figure 4A). It has four teeth on inner series of each premaxillary with three to five pointed cusps, five on outer series, and one to four smaller teeth on each maxillary. In addition, four to five large teeth are observed on each side of jaw (Figure $4A_1$). In *Bryconamericus* sp. 2 the mouth is anterior, with reduced lip (Figure 4B). It has four to five teeth on inner series of each premaxillary with five slightly round cusps, three to five on outer series, and three to four smaller teeth on each maxillary. In addition, four to five large teeth are observed on each side of jaw (Figure $4B_1$).

Table 3. Monthly composition of the diet of *Bryconamericus* sp. 1 (B1) and *Bryconamericus* sp. 2 (B2) from the Iguaçu River basin from March 1997 to February 1998 by value of Feeding Index (IA_i). Shaded values= IA_i > 40%; * = values lesser than 0.001.

Items/month	Mar-97		Apr-97		May-97		Jun-97		Jul-97		Aug-97		Sep-97		Oct-97		Nov-97		Dec-97		Jan-98		Feb-98	
Species	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2	B1	B2

Aquatic origin																								
Diptera	11.75	22.42	0.17	13.33	14.93	0.71	10.68	0.58	1.88	0.02	11.78	-	12.85	0.16	25.01	5.31	32.37	1.6	2.66	7.56	25.62	20.86	2.24	14.61
Coleoptera	0.03	-	-	-	-	-	0.13	0.08	*	0.002	5.73	-	0.01	-	0.002	0.07	0.51	-	0.004	-	0.01	-	0.29	-
Ephemeropte)	12.43	0.82	0.04	-	0.99	-	7.29	21.55	53.71	0.25	13.01	0.09	20.11	0.32	39.82	1.22	18.01	-0.01	32.58	0.003	13.03	0.56	4.66	0.004
Odonata	0.30	0.03	0.54	-	0.40	-	3.46	0.34	0.98	0.38	1.02	0.08	0.24	0.03	-	0.01	0.04	0.11	0.45	-	0.12	0.03	1.72	0.005
Plecoptera	-	-	-	-	-	-	0.44	0.26	2.69	-	0.21	-	0.08	-	0.14	0.03	0.34	0.04	0.03	-	0.11	0.02	0.13	-
Trichoptera	4.72	3.81	0.04	-	0.51	-	10.39	13.13	1.80	0.02	12.82	-	3.21	0.002	9.13	1.10	9.88	0.23	13.45	0.31	22.90	11.08	25.48	16.30
Decapoda	-	-	-	-	-	-	-	-	-	-	0.05	-	0.08	-	-	-	0.04	-	0.03	-	0.12	-	-	-
Oligochaeta	-	0.18	1.21	-	0.01	-	6.30	0.08	5.35	-	9.99	-	3.39	-	12.19	-	2.00	-	4.06	-	0.80	-	1.97	-
Mollusca	0.47	-	*	-	0.72	-	13.25	9.27	3.03	-	2.11	-	0.06	-	-	-	0.17	-	0.01	-	0.01	-	0.02	-
Other inv.	0.02	-	-	-	2.75	-	-	0.03	-	-	-	-	-	0.01	0.36	1.22	-	0.01	0.03	0.04	-	-	0.25	-
Algae	4.15	-	3.60	-	21.75	-	0.03	-	-	-	-	-	0.01	0.04	-	-	-	-	1.10	-	1.04	0.03	0.08	-
Bryophyta	0.31	2.05	*	-	-	11.31	11.94	14.91	4.09	0.30	2.79	0.28	0.02	-	0.001	-	0.02	-	0.03	-	1.09	2.75	1.11	1.64
Macrophytes	0.53	1.24	-	-	-	0.30	4.02	2.60	0.01	0.01	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamogeton.	-	-	-	-	-	-	-	-	-	0.16	4.66	79.40	1.18	7.93	0.05	-	0.03	-	1.15	0.03	1.64	-	0.54	-
Terrestrial origin																								
Araneae	-	0.16	0.003	-	-	-	0.002	-	-	2.05	0.001	0.15	0.25	*	0.13	0.75	0.05	0.04	0.03	0.20	0.22	0.23	0.91	0.04
Diptera	0.14	1.78	0.03	60.00	0.01	16.08	23.95	0.05	0.04	40.94	1.62	1.17	0.29	4.55	0.39	10.8	3.65	36.81	0.04	23.28	0.88	32.54	0.002	11.43
Coleoptera	0.03	1.10	0.01	-	0.04	-	1.76	0.94	0.43	26.02	1.17	-	0.04	0.68	0.27	1.78	0.72	1.63	0.25	3.66	0.07	11.62	1.42	34.90
Ephemeropte)	-	27.39	-	-	-	67.48	-	-	-	0.28	-	-	-	6.95	-	44.29	-	3.15	-	2.24	-	2.51	-	-
Hemiptera	-	-	-	20.00	0.4	-	0.02	-	-	2.63	0.50	0.04	0.28	1.50	0.36	3.40	0.04	0.16	0.00	1.45	0.04	0.02	0.38	1.11
Homoptera	0.04	0.01	0.003	-	-	-	0.05	0.02	0.01	0.69	0.01	0.01	0.02	2.71	0.33	1.62	0.24	0.48	0.08	0.19	0.01	1.27	0.13	0.37
Hymenoptera	0.77	2.29	18.99	3.33	0,05	-	1.64	0.51	0.07	24.2	0.13	2.21	0.42	70.21	4.18	25.0	5.44	54.81	3.36	58.83	5.27	15.49	2.86	19.36
Lepidoptera	0.12	-	-	-	0.91	3.08	3.78	0.16	0.48	-	4.94	-	0.50	0.002	2.41	2.02	11.10	0.73	3.63	0.01	0.40	0.21	0.78	-
Thysanoptera	-	-	-	3.33	-	-	0.01	-	-	0.03	-	-	0.001	0.01	0.04	0.002	0.05	-	*	0.001	-	0.03	0.002	0.001
Trichoptera	-	-	0.84	-	-	-	-	-	-	1.48	0.05	2.05	0.01	5.16	0.002	1.01	-	0.16	-	1.95	-	-	-	0.23
Insect remains	34.23	31.00	-	-	0.10	1.04	0.24	9.38	13.68	-	3.09	-	-	-	-	-	-	-	0.08	-	0.08	-	0.20	-
Unknow origin																								
Detritus	28.35	5.73	73.94	-	56.70	-	0.13	11.81	11.14	0.37	3.97	14.47	20.23	-	2.33	0.35	9.31	-	28.37	0.20	25.90	0.35	14.48	0.001
Plant remains	1.62	-	0.58	-	0.01	-	0.49	14.39	0.62	0.18	20.30	0.02	36.57	-	2.82	-	5.97	*	8.62	-	0.65	0.40	40.28	-
N analyzed	18	8	12	2	10	10	20	18	17	25	25	15	16	42	15	29	24	31	21	31	22	31	33	23

The ANCOVA assumption of parallelism for the relationship between intestine and fish lengths was accepted (F = 2.9; P = 0.092), which allowed going further on the comparison (Figure 5). Then, there was significant difference between the intestine lengths of both species (F = 22.9; P < 0.001). The intestine length of *Bryconamericus* sp. 1 was significantly longer than the intestine length of *Bryconamericus* sp. 2 (differences between adjusted means; Schefer's test P< 0.05).

Discussion

Stomach contents analysis showed that *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2 forage on a wide diversity of food items. However, the first species based its diet on authochthonous resources and the second on allochthonous resources. Both species were common in littoral zones of the river, but *Bryconamericus* sp. 1 feeding mainly on the bottom benthic fauna and *Bryconamericus* sp. 2 feeding more at the surface, on terrestrial insects and to a lesser extend on riparian vegetation. This behavior suggests spatial segregation (vertical) in the water column. Gascon and Leggett (1977) pointed out that food is often the resource involved in ecological segregation. Closely related species in Neotropical fish communities have shown to develop species-specific feeding tactics (Bowen, 1983; Esteves, 1996; Fugi, 1998; Delariva and Agostinho, 2001). Low food overlap values between *Bryconamericus* species corroborate this possible separation in feeding tactics. Mouth shape and position in the two species reflect divergent modes of food acquisition.

The more protruding upper lip in *Bryconamericus* sp. 1 probably acts as a tactile organ for food discrimination on the bottom. The anterior projected teeth with pointed cusp may also help on preying upon the benthic organisms or scrapping algae from the substratum (Winemiller, 1992). Mouth sub-anterior and inferior (narrow and small) might allow for some type of food selection, although small quantities of sediment may be ingested (Fugi *et al*., 1996).

Bryconamericus sp. 2 has an anterior mouth with shorter jaws, feeding more at the surface. The anterior mouth characterizes fishes that feed in any position (Drake *et al*., 1984), however several authors relate an anterior mouth with species that live close to the surface, like those that consume food of allochthonous origin (see e.g. Nico and Thomerson, 1989; Arcifa and Meschiatti, 1993; Esteves and Galetti Jr., 1995; Esteves and Lobón-Cerviá, 2001).

Intestine is directly related to diet and food digestibility (Kapoor *et al*., 1975; Bowen, 1983; Lobón-Cerviá and Rincón, 1994; Fugi *et al*., 2001; Delariva and Agostinho, 2001). *Bryconamericus* sp. 1 has a significantly longer intestine than *Bryconamericus* sp. 2 probably because the former eats more detritus and sediment. A similar pattern was described by Fugi (1998), which studied eight species of *Astyanax* (Characidae) from the Iguaçu River basin, and found that detritivores species had a significantly longer intestine than the fishes with other feeding habits.

In conclusion, small behavioral and morphological divergences among species reflect directly on the choice of food items. Such differences play an important role reducing interspecific competition in aquatic environments, allowing related species to coexist in a same area.

Acknowledgements

Thanks to Nupélia (Núcleo de Pesquisas em Limnologia, Ictiologia e Aqüicultura), Furnas Centrais Elétricas S/A and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) in terms of field study financial support and personal grants. This paper benefitted from comments and suggestions of K.O. Winemiller (Texas A&M University), L.M. Bini (Universidade Federal de Goiás), and R. Fernandes, L.C. Gomes and C.V. Minte-Vera (Universidade Estadual de Maringá).

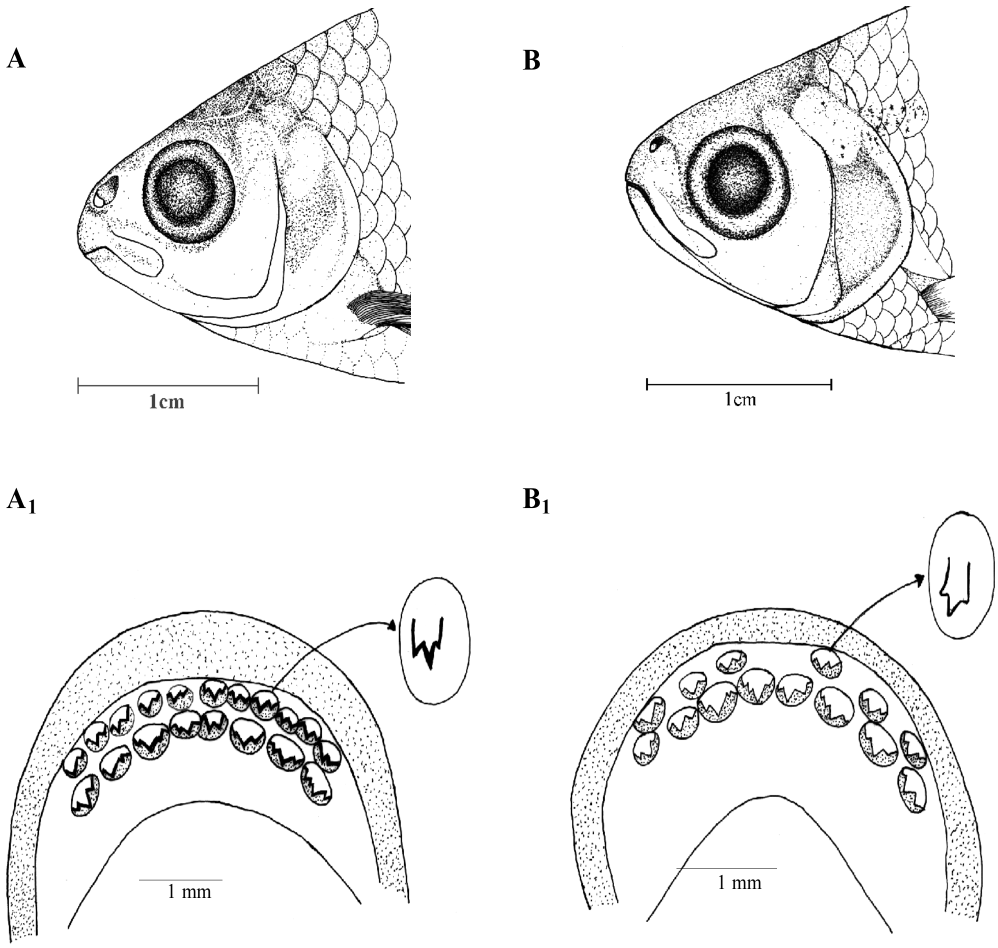

Figure 4. Mouth position, shape and distribution of the teeth: **A**= mouth position and shape and, $\mathbf{A_1}$= distribution of teeth on the premaxillary of *Bryconamericus* sp. 1; **B**= mouth position and shape and, $\mathbf{B_1}$= distribution of the teeth on the premaxillary of *Bryconamericus* sp. 2.

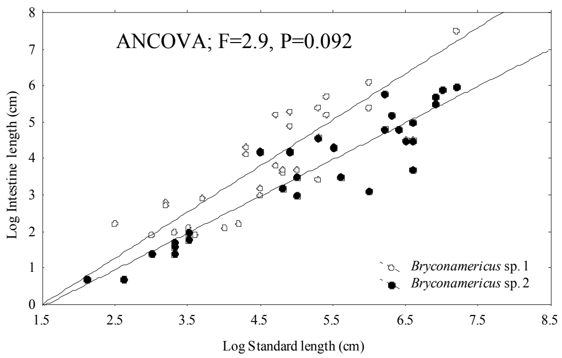

Figure 5. Relations between intestine length and standard length of *Bryconamericus* sp. 1 and *Bryconamericus* sp. 2.

References

ARCIFA, M. S.; MESCHIATTI, A.J. Distribution and feeding ecology of fishes in a Brazilian reservoir: Lake Monte Alegre. *Interciência,* Caracas, v. 18, p. 302-313, 1993.

BOWEN, S. H. Detritivory in neotropical fish communities. *Env. Biol. Fishes,* Dordrecht, v. 9, p. 137-144, 1983.

DELARIVA, R. L.; AGOSTINHO, A. A. Relationship between morphology and diets of six neotropical loricariids. *J. Fish Biol.,* London, v. 58, p. 832-847, 2001.

DRAKE, P. *et al.* Biología de los mugilideos (Osteichthyes, Mugilidae) en los esteros de las salinas de San Fernando (Cádiz). III. Habitos alimentarios y su relación com la morfometria del aparato digestivo. *Invest. Pesq.*, Barcelona, v. 48, n. 2, p. 337-367, 1984.

ESTEVES, K. E.; GALETTI Jr. P. M. Food partitioning among some characids of a small Brazilian floodplain lake from the Paraná River basin*. Env. Biol. Fishes,* Dordrecht, v. 42, p. 375-389, 1995.

ESTEVES, K. E. Feeding ecology of three *Astyanax* species (Characidae, Tetragonopterinae) from a floodplain lake of Mogi-Guaçú River, Paraná River basin, Brazil. *Env. Biol. Fishes,* Dordrecht, v. 46, p. 83-101, 1996.

ESTEVES, K. E.; LOBÓN-CERVIÁ, J. Composition and trophic structure of a fish community of a clear water Atlantic rainforest stream in southeastern Brazil. *Env. Biol. Fishes,* Dordrecht, v. 62, p. 429-440, 2001.

FINK, W. L.; WEITZMAN, S. H. The so-called cheirodontin fishes of Central America with descriptions of two new species (Pisces: Characidae). *Smithson Cont. Zool.*, Washington, DC, v. 172, p. 1-46, 1974.

FUGI, R. *Ecologia alimentar de espécies endêmicas de lambaris do trecho médio da bacia do rio Iguaçu.* 1998. Tese (Doutorado) – Universidade Federal de São Carlos., São Carlos, 1998.

FUGI, R. *et al.* Feeding styles of five species of bottom – feeding fishes of the high Paraná River. *Env. Biol. Fishes*, Dordrecht, v. 46, p. 297-307, 1996.

FUGI, R. *et al.* Trophic morphology of five benthic-feeding fish species of a tropical floodplain. *Rev. Bras. Biol.*, São Carlos, v. 6, p. 27-33, 2001.

GARAVELLO, J. C. *et al.* Caracterização da ictiofauna do rio Iguaçu. *In:* AGOSTINHO, A. A.; GOMES, L. C. *Reservatório de Segredo:* bases ecológicas para o manejo. Maringá: Eduem, 1997. cap. 4 , p. 61-84.

GASCON, D.; LEGGETT, W. C. Distribution, abundance and resource utilization of littoral zone fishes in response to a nutrient/production gradient in Lake Memphremagog. *J. Fish. Res. Board. Can.,* Ottawa, v. 34, n. 8, p. 1105-1117, 1977.

HUITEMA, B. E. *The analysis of covariance and alternatives*. New York: J. Wiley & Sons, 1980.

KAPOOR, B. G. *et al*. The alimentary canal and digestion in teleosts. *Adv. Mar. Biol.,* London, v. 13, p. 109- 239, 1975.

KAWAKAMI, E.; VAZZOLER, G. Método gráfico e estimativa de índice alimentar aplicado no estudo de alimentação de peixes. *Bol. Inst. Oceanogr.,* São Paulo, v. 29, p. 205-207, 1980.

KREBS, C. J. *Ecological methodology*. New York: Harper Collins, 1989.

LOBÓN-CERVIÁ, J.; RINCÓN, P. A. Trophic ecology of red roach (*Rutilus arcasii*) in a seasonal stream: an example of detritivory as a feeding tactic. *Fresh. Biol.*, Oxford, v. 32, p. 123-132, 1994.

LABROPOULOU, M.; ELEFTHERIOU, A. The foraging ecology of two pairs of congeneric demersal fish species: importance of morphological characteristics in prey selection. *J. Fish Biol.,* London, v. 50, p. 324-340, 1997.

NICO, L. G.; THOMERSON, J. E. Ecology, food habitats and spatial interactions of Orinoco basin annual Killifish. *Acta. Biol. Venez*., Caracas, v. 12, n. 3-4, p. 106-120, 1989.

ROSS, S. T. Resource partitioning in fish assemblages: A review of field studies. *Copeia*, Flórida, v. 2, p. 352-388, 1986.

SAMPAIO, F. A. A. *Estudos taxonômicos preliminares dos Characiformes (Teleostei, Ostariophysi) da bacia do rio Iguaçu, com comentários sobre o endemismo dessa fauna*. 1988. Dissertação (Mestrado) – Universidade Federal de São Carlos, São Carlos, 1988.

SCHOENER, T. W. Non-synchronous spatial overlap of lizards in patchy habitats. *Ecology,* Washington, DC, v. 51, p. 408-418, 1970.

SEVERI, W.; CORDEIRO, A. A. M. *Catálogo de peixes da bacia do rio Iguaçu*. Curitiba: IAP/GTZ, 1994.

WINEMILLER, K. O. Ecomorphology of freshwater fishes. *Res. Explor.*, Washington, DC, v. 8, n. 3, p. 308-327, 1992.

WOOTTON, R. L. *Ecology of teleost fishes.* London: Chapman and Hall, 1990.

Received on May 13, 2004.
Accepted on December 13, 2004.