Neotropical Biology and Conservation
8(3):115-120, september-december 2013

The use of an Atlantic Forest stream by the catfish *Scleromystax barbatus* (Quoy & Gaimard, 1824)

Uso de riacho costeiro da Mata Atlântica pelo limpa-fundo *Scleromystax barbatus* (Quoy & Gaimard, 1824)

Cristina da Silva Gonçalves[1]
cristina.silva.goncalves@gmail.com

César Cestari[2]
cesar_cestari@yahoo.com.br

Abstract

Habitat used by fish is often related with the requirements of the species, according to their morphological characteristics, feeding, and reproductive strategies. We describe the habitat preference, foraging behavior, and camouflage strategy of *Scleromystax barbatus* (Callichthyidae: Corydoradinae), an endemic catfish from coastal streams in the Atlantic Forest. The movement and foraging behavior of 11 individuals were observed using focal-fish method, and the habitat structure availability (i.e., depth, bottom type, and mesohabitat) was measured in a clearwater stream stretch with 40 m length and 2.8 m width (± 1.5 sd) in southeastern Brazil. In addition, six individuals were captured to verify stomach contents. Habitat selectivity of the species was assessed using the Ivlev electivity index that considers the frequency of occurrence of each habitat variable used by fish in relation to its environmental availability. *Scleromystax barbatus* selected pools and runs with sandy bottom in depths between 21 cm and 40 cm, and avoided gravel in shallower riffles (up to 10 cm). Individuals foraged close to the bottom in a head-down posture, speculating and revolving the substrate composed by sand, fallen leaves, and twigs. Their long snout and small barbels were used to dislodge the food items of the substrate, which were quickly sucked by the mouth. Aquatic immature insects (mainly trichopterans) were predominant in the stomach contents. Three fish species, *Deuterodon iguape* Eigenmann, 1907, *Mimagoniates microlepis* Steindachner, 1877, and *Geophagus brasiliensis* (Quoy & Gaimard, 1824), were firstly registered following *S. barbatus* during its foraging activity. The brilliant golden body color with darkish spots of *S. barbatus* strongly resembles the stream bottom, which indicates disruptive camouflage.

Key words: Corydoradinae, habitat use, feeding behavior, disruptive camouflage.

Resumo

O hábitat usado por peixes é frequentemente relacionado com as necessidades das espécies, de acordo com suas características morfológicas e estratégias alimentares e reprodutivas. Descrevemos a preferência de hábitat, forrageamento e a estratégia de camuflagem de *Scleromystax barbatus* (Callichthyidae: Corydoradinae), um bagre endêmico de riachos costeiros da Mata Atlântica. O deslocamento e o comportamento de forragear de 11 indivíduos foram observados pelo método animal-focal, e a disponibilidade da estrutura de hábitat (i.e., profundidade, tipo de substrato, e meso-hábitat) foi mensurada em um trecho de 40 m de comprimento por 2,8 m de largura (±1,5 dp) em um riacho de água clara no sudeste do Brasil. Além disso, seis indivíduos foram capturados para verificar seus conteúdos estomacais. A seletividade de hábitats por *S. barbatus* foi avaliada pelo índice de eletividade de Ivlev, que considera a frequência de ocorrência de cada variável do hábitat utilizada pelos peixes em relação à sua disponibilidade total no ambiente. *Scleromystax barbatus* selecionou poções e rápidos com fundo de areia e profundidades entre 21 cm e 40 cm, e evitou cascalhos

[1] Laboratório de Ictiologia, Universidade Estadual Paulista "Julio de Mesquita Filho" (UNESP). Rua Cristóvão Colombo, 2265, Jardim Nazareth, 15054-000, São José do Rio Preto, SP, Brasil.
[2] Departamento de Zoologia, Universidade Estadual Paulista "Julio de Mesquita Filho" (UNESP). Avenida 24A, 1515, Bela Vista, 13506-900, Rio Claro, SP, Brasil.

em ambientes rasos com menos de 10 cm de profundidade em corredeiras. Os indivíduos forragearam próximos do fundo com a cabeça inclinada em direção ao chão, especulando e revolvendo o substrato composto por areia, folhas e galhos caídos. O focinho longo e os pequenos barbilhões dos indivíduos foram usados para desalojar os itens alimentares do substrato, que eram rapidamente sugados pela boca. Insetos aquáticos imaturos (principalmente tricópteros) foram predominantes nos conteúdos estomacais. Três espécies de peixes, *Deuterodon iguape* Eigenmann, 1907, *Mimagoniates microlepis* Steindachner, 1877 e *Geophagus brasiliensis* (Quoy & Gaimard, 1824), foram registradas pela primeira vez seguindo *S. barbatus* durante sua atividade de forrageamento. A coloração dourado-brilhante com manchas escuras de *S. barbatus* se assemelha fortemente à cor do fundo do riacho e indica camuflagem disruptiva.

Palavras-chave: Corydoradinae, uso do hábitat, comportamento alimentar, camuflagem disruptiva.

Introduction

Habitat used by fish is often related with the requirements of the species according to their feeding (Sabino and Castro, 1990; Aranha *et al.*, 1998), reproductive habits (Aranha *et al.*, 1993), and morphological characteristics (Teixeira, 1989; Braga, 2004; Mazzoni *et al.*, 2011). Moreover, spatial resources (Gorman and Karr, 1978; Sheldon, 1968) and microhabitat availability (Carvalho *et al.*, 2006; Sazima *et al.*, 2006; Zuanon *et al.*, 2006) are also important to comprehend how fishes use habitats and how they are spatially distributed. In coastal streams of the Brazilian Atlantic Forest, studies have revealed fish species' preferences on the use of habitats. For instance, Gymnotidae and Synbranchidae species prefer vegetated sites near stream margins (Teixeira, 1989), while Characidae species are generally found near marginal vegetation with lentic or lotic waters (Sabino and Castro, 1990), and Loricariidae and Crenuchidae species are found at rocky lotic waters (Aranha *et al.*, 1998; Barreto and Aranha, 2005). The knowledge of habitat preferences and their different uses by freshwater streams fishes are of stronger interest to conservation due to the increase of deleterious human activities in such environments (Mazzoni *et al.*, 2011).

The genus *Scleromystax* Günther (Siluriformes, Callichthyidae, Corydoradinae) comprises four endemic species that inhabit small tributaries of Atlantic Forest coastal drainages: *S. barbatus* (Quoy & Gaimard, 1824), *S. macropterus* (Regan, 1913), *S. prionotos* (Nijssen & Isbrücker, 1980), and *S. salmacis* Britto & Reis, 2005 (Britto and Reis, 2005). *Scleromystax barbatus* is a small air-breathing callichthyid catfish that inhabits clearwaters (Gonçalves and Braga, 2013). Actually, it is subject to commercial interest by the aquarium trade industry (Reis, 2003) and few studies investigated its behavior in backwaters of shallow streams (Aranha *et al.*, 1998; Esteves and Lobón-Cerviá, 2001; Barreto and Aranha, 2005).

In the present paper, we studied the use of a clearwater coastal stream by *S. barbatus* in the Atlantic Forest, southeastern Brazil. We evaluated the species' habitat selectivity, its feeding behavior, and social interaction.

Material and methods

Study area

The study was conducted in Boguçá stream (24°28'54.71"S and 47°13'02.05"W) at Juréia-Itatins reserve, an undisturbed protected area in pristine conditions of Atlantic Forest in São Paulo state, southeastern Brazil. The climate is subtropical humid without a pronounced dry season. The hotter and rainier season occurs from October to April and the lesser pronounced wet season occurs from May to September. The average annual rainfall and temperature are 2,277 mm and 21.4 ºC, respectively (Marques and Duleba, 2004). The main river of Juréia-Itatins reserve is Una do Prelado, a lowland and medium-sized river (100 m length) which runs parallel to the seashore and surrounds the Juréia mountain range (Por, 1986, 2004). Boguçá is a 2nd order clearwater stream (considering a 1:50.000 scale map), tributary of the Una do Prelado River. In a previous survey (February 8th, 2010) using electrofishing gear, we recorded, in decreasing order of abundance, 12 fish species at the studied site: *Mimagoniates microlepis* (Steindachner, 1877) (Characidae), *Deuterodon iguape* Eigenmann, 1907 (Characidae), *Phalloceros reisi* Lucinda, 2008 (Poeciliidae), *Pimelodella* cf. *transitoria* Miranda Ribeiro, 1907 (Heptapteridae), *Characidium* cf. *pterostictum* Gomes, 1947 (Crenuchidae), *Gymnotus pantherinus* (Steindachner, 1908) (Gymnotidae), *Hollandichthys multifasciatus* (Eigenmann & Norris, 1900) (Characidae), *Pseudotothyris obtusa* (Miranda Ribeiro, 1911) (Loricariidae), *Scleromystax barbatus* (Quoy & Gaimard, 1824) (Callichthyidae), *Hoplias malabaricus* (Bloch, 1794) (Erythrinidae), *Geophagus brasiliensis* (Quoy & Gaimard, 1824) (Cichlidae), and *Rhamdia quelen* (Quoy & Gaimard, 1824) (Heptapteridae). Voucher specimens (except *R. quelen*) are deposited in the fish collection of Departamento de Zoologia, UNESP, São José do Rio Preto (SP), Brazil (DZSJRP 13236, 13238, 13242-45, 13249-50, 13253, 13255, 13258).

Sampling procedures and data analysis

Data collection was conducted on February 24-25th, 2011 in a stretch of 40 m length and 2.8 m width (± 1.5 sd) in the Boguçá stream.

We used the focal-fish method (see Lehner, 1998) with observers positioned outside the water at the stream borders. The clearwaters of Boguçá stream provide sufficient transparency to observe fish behavior. We did not conduct underwater observations due to shallowness of the stream. The behavior of 11 individuals of *S. barbatus* was observed with naked eye on diurnal periods (from 09 a.m. to 03 p.m.). Individuals were also photographed and video-taped after observations. Each individual was observed interruptedly during one-hour (whenever possible), and the following variables were recorded in samplings conducted every five minutes: fish activity (foraging, moving without forage, or inactive), mesohabitat and bottom type used (see sampling description of the stream habitat structure below), fish position in the water column (surface, midwater, or bottom), and its social interaction (grouped or solitary).

At the end of observations, six individuals of *S. barbatus* were collected and immediately fixed in 10% formalin. This number was arbitrarily defined to avoid impact on local population, since two visual censuses conducted at the same time by three observers revealed 33 ± 5 individuals on the stream stretch. Caught specimens were measured to obtain the standard length (SL, in mm). Stomach contents were analyzed to verify fish's diet. Food items were identified up to the lowest taxonomic level possible under a stereomicroscope, according to Borror and Delong (1969).

The stream habitat structure was evaluated in 40 linear transects. For each one meter of each transect, we registered the following variables: stream depth (cm), predominant bottom type (clay: < 0.05 mm, sand: 0.05-2 mm, gravel: 2-10 mm, and plant debris), and mesohabitat type (pool, run, and riffle). These measures were realized at the end of the fish observations to avoid the habitat structure disturbance.

The selectivity of *S. barbatus* on habitat variables, such as mesohabitat, bottom type, and position on water column, was evaluated by Ivlev electivity index (E), according to: $E = (r_i - P_i)/(r_i + P_i)$, where r_i is the frequency of occurrence of each habitat variable i used by fishes, and P_i is the frequency of occurrence of each habitat variable i available on the stream stretch. This index varies from –1 (non-selective) to +1 (selective), and electivity is absent when $E = 0$ (Ivlev, 1961).

Results

General behavior and habitat use

We observed 11 individuals of *S. barbatus* in 615 min (55.9 ± 12.6 min per individual), which resulted in 134 samplings. The species was more frequently registered in an active way (N = 105 or 78.4% of samplings), than in an inactive one (N = 29 or 21.6 % of samplings). When active, *S. barbatus* was foraging (N = 99 or 76.7% of samplings), and rarely moved without foraging on the stream (N = 5 or 3.9%). Active and inactive individuals were recorded both solitary (N = 96 or 70.1% of samplings) and grouped with conspecific (2-6 individuals, mean = 2.5 ± 0.9 sd; N = 41 or 29.9% of samplings). Agonistic behavior was rarely recorded; only one individual demonstrated agonistic behavior with a conspecific in one sampling. *Scleromystax barbatus* specimens were most frequent at the stream bottom (N = 126 or 94% of samplings) and were rarely recorded in the middle of the water column (N = 8 or 6% of samplings).

Scleromystax barbatus individuals were registered using almost all available habitats (Table 1), but this species preferred depths between 11 cm and 50 cm, clay and sandy bottoms, pools and runs. Depths up to 10 cm, riffles, gravel, and plant debris bottom were avoided (Table 1).

The brilliant golden body color with darkish spots of *S. barbatus* resembles the stream bottom coloration (Figure 1).This color resemblance allied to a stationary position of individuals in threatening situations, i.e. when we approached them with an object (piece of branch), indicate disruptive camouflage.

Diet and feeding behavior

The six individuals collected ranged from 37 to 58 mm SL. All specimens were females with full stomachs. Aquatic immature insects of autochthonous origin, mainly trichopterans, were predominant in the stomach contents (Table 2). Sand grains occurred in all stomachs, and unicellular algae (Bacillariophyta and Chlorophyceae) were also registered.

Scleromystax barbatus was observed foraging close to the bottom speculating the substrate (N = 95 or 96.9% of samplings), or picking up food items in drift (N = 3 or 3.1% of samplings). Individuals assumed a head-down position at stream bottom supported by the ossified spines of the pectoral fins. During substrate revolving (mainly sandy bottom with plant debris - composed by fallen leaves and twigs), they used the long snout and barbels assuming the head-down posture when food items were quickly sucked by the mouth. Substrate clouds frequently resulted from foraging movements. Four individuals of *Deuterodon iguape* Eigenmann, 1907 (Characidae), two individuals of *Mimagoniates microlepis* Steindachner, 1877 (Characidae), and one individual of *Geophagus brasiliensis* (Quoy & Gaimard, 1824) (Cichlidae) were registered following a group of six individuals of *S. barbatus*. This event occurred once and lasted seven minutes.

Table 1. Relative frequency (%) of depth, bottom type, and available mesohabitat categories and mesohabitat categories used by *Scleromystax barbatus*, indicating species selectivity according to Ivlev electivity index (*E*).

	Available (%)	Used (%)	*E*
Depth (cm)			
0-10	0,35	0,04	-0,81
11-20	0,16	0,18	0,07
21-30	0,18	0,43	0,4
31-40	0,09	0,22	0,44
41-50	0,11	0,13	0,08
51-60	0,04	0	-1
61-70	0,03	0	-1
71-80	0,01	0	-1
81-90	0,02	0	-1
Bottom			
Clay	0,01	0,04	0,67
Sand	0,37	0,55	0,19
Gravel	0,2	0,04	-0,69
Plant debris	0,43	0,38	-0,05
Mesohabitat			
Pool	0,43	0,54	0,12
Run	0,3	0,43	0,18
Riffle	0,28	0,02	-0,85

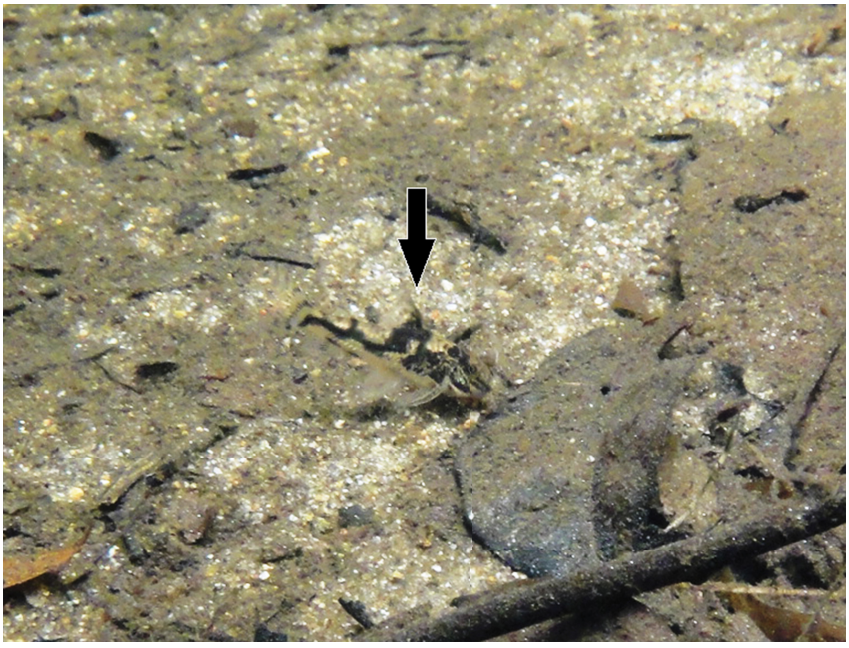

Figure 1. Disruptive camouflage of *Scleromystax barbatus* in a clearwater coastal stream of Brazilian Atlantic rainforest. The photo was taken during the study in their natural habitat, without flash. The arrow indicates an inactive individual of *S. barbatus*.

Discussion

Freshwater organisms may present strong preferences for local habitat variables (Lamouroux *et al.*, 1999) as verified to macroinvertebrates (Orth and Maughan, 1983), and fish (Grossman and Freeman, 1987; Robertson and Crook, 1999). Depth and stream flow (Buck and Sazima, 1995), temperature, dissolved oxygen, turbidity and conductivity (Fialho *et al.*, 2008), and bottom type (Mazzoni *et al.*, 2011) are environmental variables often related with habitat preferences by fish. In this study, *S. barbatus* selected pools and runs with sandy bottom and avoided gravels mostly in shallower riffles. The only one study about *S. barbatus* reported their habitat preference for lentic sites, however with predominance of plant debris in the bottom (Aranha *et al.*, 1998).

Our results indicated an active diurnal foraging of *S. barbatus* in addition to the usually crepuscular and/or nocturnal habits registered among Callichthyidae (Paxton, 1997). Most individuals of *S. barbatus* were registered foraging in an active way, i.e. hunting by speculation (*sensu* Curio, 1976) or using grubber excavation while moving (*sensu* Sazima, 1986), without signals of territoriality provoked by agonistic encounters. *Scleromystax barbatus* fed mainly on aquatic immature insects, mostly trichopterans buried in the sand. The presence of sand grains and unicellular algae in *S. barbatus* stomach contents is a consequence of the indirect ingestion of these items during foraging (Casatti *et al.*, 2009). Grubber excavation while moving also creates possibilities for *S. barbatus* to act as a nuclear species to diurnal species, such as *Deuterodon iguape*, *M. microlepis*, and *G. brasiliensis*. When foraging in the bottom, *S. barbatus* induces substrate clouds and the follower species took the advantage to feed on exposed items. Callichthyidae are potential species to perform the nuclear role due to their bottom-forage habit, however, as far

Table 2. Abundance (N) and frequency of occurrence (FO%) of food items recorded in stomach contents of *Scleromystax barbatus* (37 mm – 58 mm SL) from Boguçá stream, southeastern Brazil.

Food items	N	FO (%)
Algae (Bacillariophyta and Chlorophyceae)	-	33
Insects		
Diptera (larvae) - Ceratopogonidae	2	17
Diptera (larvae) - Chironomidae	2	17
Diptera (larvae) - Culicidae	2	17
Ephemeroptera (nymphs)	5	67
Hymenoptera (adults) - Formicidae	1	17
Trichoptera (larvae, cases)	68	100
Sand grains	-	100

as we know, no other study recorded *S. barbatus* as nuclear species in the Atlantic Forest. In a unique record to date, Sazima (1986) found *Astyanax bimaculatus* following *Corydoras polystictus*.

Camouflage associated with disruptive colors is one of the most displayed defense mechanism by bottom species (Carvalho *et al.*, 2006). Regarding the resemblance of the golden-and-black body color of *S. barbatus* with the color of the most available bottoms in the stream stretch, i.e. sand and plant debris, we suggest that this species strongly relies on disruptive camouflage during its foraging activity. In risky situations, individuals ceased the foraging activity and became inactive, 'mixing' their body with the stream bottom. Fishes returned to forage when disturbing conditions ceased. According to Sazima *et al.* (2006), disruptive camouflage is related to defense against visually oriented predators, mainly piscivorous fishes. Further, cryptic and sand-color patterns in fishes are advantageous for evasion from predators (Zuanon *et al.*, 2006).

The advance of deforestation in the Brazilian Atlantic rainforest may cause drastic negative effects to the endemic fish fauna (Nogueira *et al.*, 2010). We expect that our results concerning habitat preferences and behavior of *S. barbatus* in a pristine area of the Atlantic Forest serve as comparative data for future conservationist studies and management activities.

Acknowledgments

We are indebted to Ílson Prado, who helped us during the field work, Dr. Francisco Langeani for fish identification, IBAMA and COTEC for providing license for fish sampling. The authors received scholarship grants from CAPES (CSG) and CNPq (CC).

References

ARANHA, J.M.R.; CARAMASCHI, E.P.; CARAMASCHI, U. 1993. Ocupação espacial, alimentação e época reprodutiva de duas espécies de *Corydoras* Lacépède (Siluroidei, Callichthyidae) coexistentes no rio Alambari (Botucatu, São Paulo). *Revista Brasileira de Zoologia*, **10**(3):453-466.
http://dx.doi.org/10.1590/S0101-81751993000300013

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.

BARRETO, A.P.; ARANHA, J.M.R. 2005. Assembléia de peixes de um riacho da Floresta Atlântica: composição e distribuição espacial (Guaraqueçaba, Paraná, Brasil). *Acta Scientiarum.Biological Sciences*, **27**(2):153-160.

BORROR, D.J.; DELONG, D.M. 1969. *Introdução ao estudo de insetos*. São Paulo, Edgard Blücher Ltda, 653 p.

BRAGA, F.M.S. 2004. Habitat, distribuição e aspectos adaptativos de peixes da microbacia do ribeirão Grande, Estado de São Paulo, Brasil. *Acta Scientiarum.Biological Sciences*, **26**(1):31-36.

BRITTO, M.R.; REIS, R.E. 2005. A new *Scleromystax* species (Siluriformes: Callichthyidae) from coastal rivers of Southern Brazil. *Neotropical Ichthyology*, **3**(4):481-488.
http://dx.doi.org/10.1590/S1679-62252005000400005

BUCK, S.; SAZIMA, I. 1995. An assemblage of mailed catfishes (Loricariidae) in southeastern Brazil: distribution, activity and feeding. *Ichthyological Exploration of Freshwaters*, **6**(4):325-332.

CARVALHO, L.N.; ZUANON, J.; SAZIMA, I. 2006. The almost invisible league: crypsis and association between minute fishes and shrimps as a possible defence against visually hunting predators. *Neotropical Ichthyology*, **4**(2):219-224.
http://dx.doi.org/10.1590/S1679-62252006000200008

CASATTI, L.; VERONEZI JR., J.L.; FERREIRA, C.P. 2009. Dieta do cascudo *Aspidoras fuscoguttatus* (Ostariophysi, Callichthyidae) em riachos com diferentes características limnológicas e estruturais. *Biota Neotropica*, **9**(1):113-121.
http://dx.doi.org/10.1590/S1676-06032009000100013

CURIO, E. 1976. *The ethology of predation*. New York, Springer-Verlag, 250 p.
http://dx.doi.org/10.1007/978-3-642-81028-2

ESTEVES, K.E.; LOBÓN-CERVIÁ, J. 2001. Composition and trophic structure of a fish community of a clear water Atlantic rainforest stream in southeastern Brazil. *Environmental Biology of Fishes*, **62**(4):429-440.
http://dx.doi.org/10.1023/A:1012249313341

FIALHO, A.P.; OLIVEIRA, L.G.; TEJERINA-GARRO, F.L.; MERONA, B. de. 2008. Fish-habitat relationship in a tropical river under anthropogenic influences. *Hydrobiologia*, **598**(1):315-324.
http://dx.doi.org/10.1007/s10750-007-9165-3

GONÇALVES, C.S.; BRAGA, F.M.S. 2013. Checklist of freshwater ichthyofauna from coastal streams of Juréia-Itatins reserve, southeastern Brazil. *Check List*, **9**(2):175-185.

GORMAN, O.T.; KARR, J.R. 1978. Habitat structure and stream fish communities. *Ecology*, **59**(3):507-515.
http://dx.doi.org/10.2307/1936581

GROSSMAN, G.D.; FREEMAN, M.C. 1987. Microhabitat use in a stream fish assemblage. *Journal of Zoology*, **212**(1):151-176.
http://dx.doi.org/10.1111/j.1469-7998.1987.tb05121.x

IVLEV, V.S. 1961. *Experimental ecology of the feeding of fishes*. New Haven, Yale University Press, 302 p.

LAMOUROUX, N.; CAPRA, H.; POUILLY, M.;SOUCHON, Y. 1999. Fish habitat preferences in large streams of southern France. *Freshwater Biology*, **42**(4):673-673.
http://dx.doi.org/10.1046/j.1365-2427.1999.00521.x

LEHNER, P.N. 1998. *Handbook of ethological methods*. New York, Cambridge University Press, 672 p.

MARQUES, O.A.V.; DULEBA, W. 2004. *Estação Ecológica Juréia-Itatins: ambiente físico, flora e fauna*. Ribeirão Preto, Holos, 384 p.

MAZZONI, R.; NOVAES, V.C.; IGLESIAS-RIOS, R. 2011. Microhabitat use by *Phalloceros harpagos* Lucinda (Cyprinodontiformes: Poeciliidae) from a coastal stream from Southeast Brazil. *Neotropical Ichthyology*, **9**(3):665-672.
http://dx.doi.org/10.1590/S1679-62252011005000027

NOGUEIRA, C.; BUCKUP, P.A.; MENEZES, N.A.; OYAKAWA, O.T.; KASECKER, T.P.; RAMOS NETO, M.B.; SILVA, J.M.C. 2010. Restricted-range fishes and the conservation of Brazilian freshwaters. *PlosOne*, **5**(6):e11390. http://dx.doi.org/10.1371/journal.pone.0011390

ORTH, D.J.; MAUGHAN, O.E. 1983. Microhabitat preferences of benthic fauna in a woodland stream. *Hydrobiologia*, **106**(2):157-168. http://dx.doi.org/10.1007/BF00006748

PAXTON, C.G.M. 1997. Shoaling and activity levels in *Corydoras*. *Journal of Fish Biology*, **51**(3): 496-502.

POR, F.D. 1986. Stream type diversity in the Atlantic lowland of the Juréia area (Subtropical Brazil). *Hydrobiologia*, **131**(1):39-45. http://dx.doi.org/10.1007/BF00008322

POR, F.D. 2004. Hidrobiologia da Juréia e da baixada do Ribeira - rios e manguezais. *In*: O.A.V. MARQUES; W. DULEBA (eds.), *Estação Ecológica Juréia-Itatins: ambiente físico, flora e fauna*. Ribeirão Preto, Holos, p. 51-57.

REIS, R.E. 2003. Family Callichthyidae (Armored catfishes). *In*: R.E. REIS; S.O. KULLANDER; C.J. FERRARIS JR. (eds.), *Check list of the freshwater fishes of South and Central America*. Porto Alegre, EDIPUCRS, p. 291-309.

ROBERTSON, A.I.; CROOK, D.A. 1999. Relationships between riverine fish and woody debris: implications for lowland rivers. *Marine and Freshwater Research*, **50**(8):941-953. http://dx.doi.org/10.1071/MF99072

SABINO, J.; CASTRO, R.M.C. 1990. Alimentação, período de atividade e distribuição espacial dos peixes de um riacho da floresta Atlântica (sudeste do Brasil). *Revista Brasileira de Biologia*, **50**(1):23-36.

SAZIMA, I. 1986. Similarities in feeding behavior between some marine and freshwater fishes in two tropical communities. *Journal of Fish Biology*, **29**(1):53-65. http://dx.doi.org/10.1111/j.1095-8649.1986.tb04926.x

SAZIMA, I.; CARVALHO, L.N.; MENDONCA, F.P.; ZUANON, J. 2006. Fallen leaves on the water-bed: diurnal camouflage of three night active fish species in an Amazonian streamlet. *Neotropical Ichthyology*, **4**(1):119-122. http://dx.doi.org/10.1590/S1679-62252006000100013

SHELDON, A.L. 1968. Species diversity and longitudinal succession in stream fishes. *Ecology*, **49**(2):193-198. http://dx.doi.org/10.2307/1934447

TEIXEIRA, R.L. 1989. Aspectos da ecologia de alguns peixes do arroio Bom Jardim, Triunfo-RS. *Revista Brasileira de Biologia*, **49**(1):183-192.

ZUANON, J.; BOCKMANN, F.A.; SAZIMA, I. 2006. A remarkable sand-dwelling fish assemblage from central Amazonia, with comments on the evolution of psammophily in South American freshwater fishes. *Neotropical Ichthyology*, **4**(1):107-118. http://dx.doi.org/10.1590/S1679-62252006000100012

Submitted on January 9, 2013
Accepted on September 30, 2013