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Lists of Species

Fishes (Osteichthyes: Actinopterygii) from the Penacho stream, upper Paraná River basin, Paraná State, Brazil

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Abstract: The focus of this work was to survey the ichthyofauna of the Penacho stream, a tributary of the Laranjinha River, northeastern Paraná State, in an area of the Upper Paraná River basin still devoid of ichthyofaunal studies. In general, the banks of the Penacho Stream are predominantly characterized by pasture or agricultural activities and may exhibit little riparian vegetation in few stretches. Fishes were collected at eight different locations, from its headwaters to its mouth, between February 2009 to March 2010. A total of seven orders, twelve families and thirty-three species, three of which not native to the basin, were reported. The fish species captured along the Penacho stream are those that still manage to stay in those environments, even in changed conditions. However, to better understand the effects of degradation on fish diversity, it is necessary to monitor it along time.

Introduction

The Upper Paraná River basin has one of the most accurately studied ichthyofauna of the Neotropical region, with 310 identified species. This number however, is probably underestimated, since only few rivers in the basin have been systematically assessed (Langeani *et al*. 2007). Galves *et al.* (2009) corroborate that there are few studies aimed at inventorying the fish fauna of small drainages, remarking that, only recently surveys have been done in the attempt to adequately characterize the regions of headwaters and small drainages that comprise the Upper Paraná River basin.

It is worth to emphasize that small drainages have great biological importance because in many cases they shelter species still unknown to science, generally with considerable rates of endemism (Castro 1999, Castro *et al*. 2003; Shibatta and Cheida 2003). It is clear that, if we aim to collect data on fish diversity from one river basin, we must consider these small water bodies, as they harbor a substantial and sometimes unique fraction of this biodiversity. In order to increase the knowledge about the ichthyofauna diversity from small drainages of the Upper Paraná River, this paper intends to describe and characterize the fish fauna of the Penacho stream, tributary of the Laranjinha River, which is one of major rivers in northeastern Paraná State lacking ichthyofaunal studies in its main channel and tributaries.

Materials and Methods

Study area

The Penacho stream is a small tributary on the right bank of the Laranjinha River, which flows into the Cinzas River, one of the major tributaries of the Capivara dam, in the Middle Paranapanema River, Upper Paraná River basin.

Located in the Ribeirão do Pinhal municipality on the third Paraná plateau over an array of basalt rock (Maack 1981), the Penacho stream has its headwaters at an altitude of approximately 541 m and its mouth at an altitude of approximately 445 m, totaling a declivity of approximately 96 m along its meandrine course of approximately 32.2 km. In general, the banks of the Penacho stream are predominantly characterized by pasture or agricultural activities and may present little riparian vegetation in a few parts (Personal observation).

Data Collection

Eight sampling sites (Figure 1) distributed from the headwater to the mouth of the stream were assessed (Figure 2). The collections were performed under license No. 23360/IAP (Instituto Ambiental do Paraná), from February 2009 to March 2010, totalizing seven samples for each site. For each site a 50 m stretch was delimited with 2 mm mesh nets to keep the specimens within the sampling area. Then, collection efforts of 45 minutes were performed using sieves, seines, and dip nets.

The collected material was fixed in 10% formalin and transported to the Laboratório de Genética e Conservação da Universidade Estadual do Norte do Paraná (UENP-CCP), where the samples were identified and subsequently transferred to 70% ethanol. The fishes were identified according to Castro *et al.* (2003) and Graça and Pavanelli (2007). Voucher specimens of each species were also cataloged in the ichthyological collection of the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL). The species richness and frequencies of capture of each species were represented by percentages of each species in relation to the total of individuals.

Constancy were calculated according to Dajoz (2005), that express the percent in which a species were sampled in relation to total samplings, where the constant species is present in over 50% of samples, accessory is present in 25% to 50% of samples and accidentally when present

Figure 1. Sampling sites (pointed by letters) in the Penacho stream, Ribeirão do Pinhal, Paraná State, Brazil. Each image corresponds to the respective letters from Figure 2.

in less than 25% of the samples. It was also calculated the relationship between number of species along the stream Penacho to verify the occurrence of longitudinal distribution pattern of richness.

Results and Discussion

We collected a total of 5,223 individuals from seven orders, 12 families, and 33 species, as shown in Table 1. The modal number of species by site was 15, with site A, which is located near the source, with the lower number of species (=14) and site H, near to the mouth, with the higher number (=25). Analyzing the correlation between species number and sample sites along the stream, it appears that there is a tendency to increase from the source to the mouth (r^2 = 0.73; Figure 3). This trend is consistent with what is expected from the theory of continuous river (Vanotte *et al.* 1980), and that has been observed in other studies in streams of Neotropical streams (Allan and Flecker 1993; Braga and Andrade 2005; Greathouse and Pringle 2006). In relation to the frequency of occurrence, more than 60% of the sampled fishes belong to the orders Characiformes (32.7%) and Siluriformes (31.1%) (Figure 4). For species richness, 71.9% belong to the same orders, i.e., 42.4% to Siluriformes and 30.3% to Characiformes (Figure 5). This predominance was expected with regard to the ichthyofauna of the Upper Paraná River streams, and had also been evidenced by Shibatta and Cheida (2003) for the Tibagi River basin and Castro *et al*. (2003; 2004) for the Paranapenema and Grande River basins.

Seven species were present in all sites of Penacho stream (Table 1): *Astyanax altiparanae*, *Astyanax paranae*, *Characidium zebra*, *Gymnotus sylvius*, *Rhamdia quelen*,

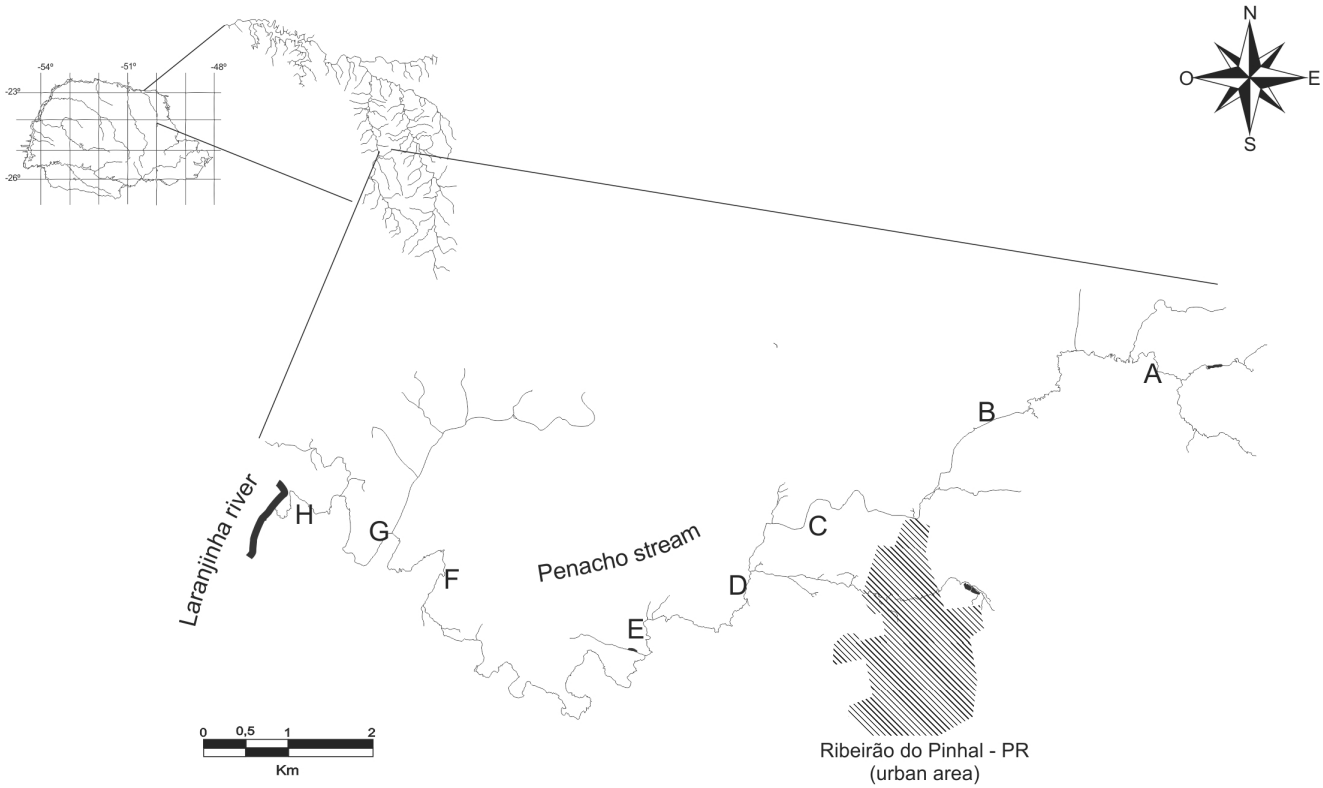

Figure 2. Map of sampling sites in Penacho stream, Ribeirão do Pinhal, Paraná State, Brazil. Each letter corresponds to the respective images from Figure 1.

Hypostomus ancistroides and *Geophagus brasiliensis*. Another seven species: *Bryconamericus iheringii*, *Hoplias malabaricus*, *Gymnotus sp*, *Imparfinis schubarti*, *Otothyropsis biamnicus*, *Hypostomus strigaticeps* and *Poecilia reticulata*, were present in 75% of sites and, together with anteriorly cited species, can be considered of the highest constancies.

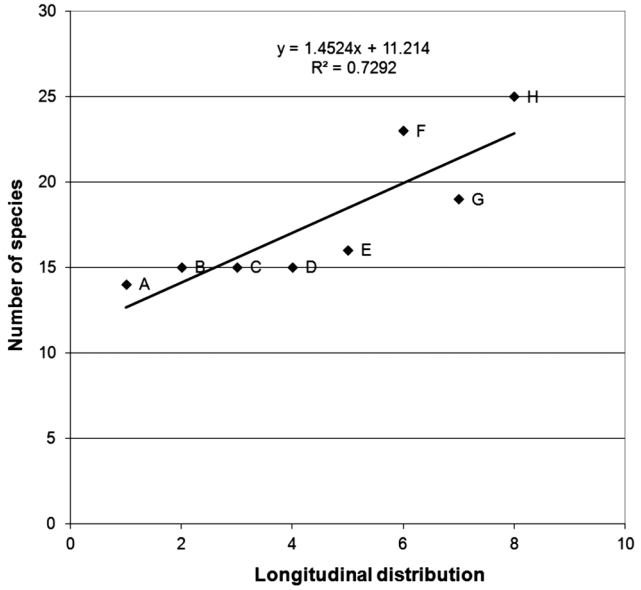

Figure 3. Correlation between number of species and longitudinal distribution (sample sites A to H), along Penacho stream, Ribeirão Pinhal, Paraná State, Brazil.

Already, *Apareiodon affinis*, *Apareiodon ibitiensis*, *Hypostomus albopunctatus*, *Hypostomus hermanni* and *Crenicichla jaguarensis*, can be considered accidentals, because they were present only in the site H (mouth) and in low frequencies (Table 1), that may result from the contributions of the Laranjinha River, or even by its environmental characteristics that are more closely to a large river. In relation to capture frequency (Table 1), five species accounted for 65.66% of all samples: *Hypostomus ancistroides* (19.34%), *Poecilia reticulata* (18.28%), *Geophagus brasiliensis* (11.66%), *Astyanax paranae* (7.91%), and *Astyanax altiparanae* (8.46%).

Araújo (1998) considers that *P. reticulata* (Sites A, C, D, F, G and H), a non-native species, is tolerant to environmental changes, which may favor their stable presence along the Penacho stream. Its occurrence in water bodies of the Upper Paraná River basin has been reported by several authors in recent years, such as Cunico *et al*. (2006), Vieira and Shibatta (2007), Araujo *et al.* (2011), and Pagoto *et al.* (2012), who suggested that its occurrence in the basin is mediated by its frequent use in aquariophily. Due to the proximity of this stream to the urban region, it is possible that its introduction in this drainage is also due to aquariophily activity.

Two other non-native species previously recorded to the Upper Paraná River basin, *Oreochromis niloticus* and *Cyprinus carpio*, were also collected in the Penacho stream, however, their occurrence were restricted to the first sampling site "A", which has excavated fishponds on

Figure 4. Frequency of capture by order of fishes, during the period of February 2009 to March 2010, in Penacho stream, Ribeirão do Pinhal, Paraná State, Brazil.

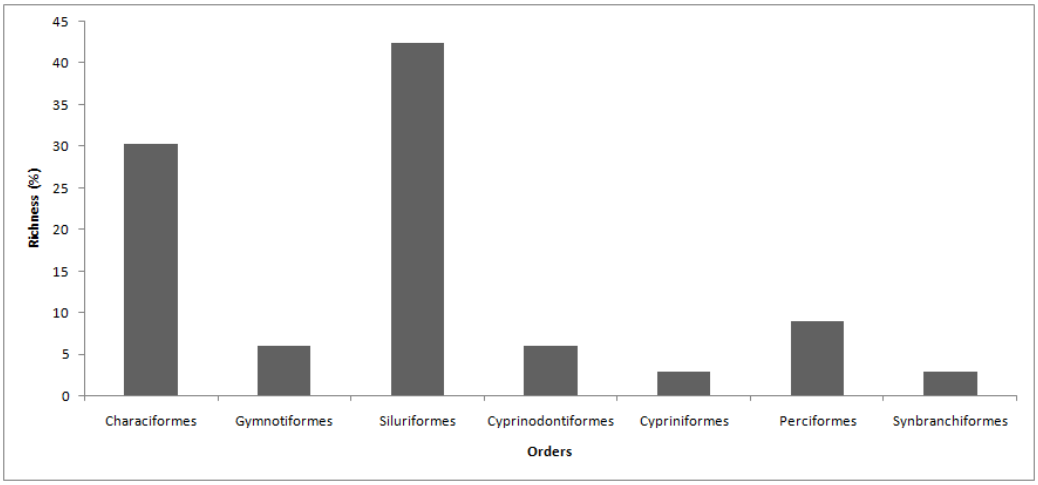

Figure 5. Richness (%) of fishes by order, from Penacho stream, Ribeirão do Pinhal, Paraná State, Brazil.

its upstream side. This fact suggests that the presence of such species in this environment is due to escapes from fishponds. Azevedo-Santos *et al*. (2011) noted that these species are widely used by farmers in the Upper Paraná River basin, and that reports on escapes in tributaries are frequent. The introduction of exotic species in aquatic environments can cause irreversible damage to biodiversity, once introduced species can compete for food resources with native wildlife, spread parasites, and develop other behaviors that modify the habitat in ways that are harmful to other species (Lima-Junior *et al*. 2012).

Table 1. List of fish species and frequency of capture during the period of February 2009 to March 2010, in Penacho stream, Ribeirão do Pinhal, Paraná State, Brazil. The taxonomic classification of orders and families follows Reis *et al.* (2003).

TAXON	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Frequency of capture	Voucher specimens
CHARACIFORMES										
Characidae										
Astyanax altiparanae Garutti and Britski, 2000	X	X	X	X	X	X	X	X	8.46%	MZUEL 6453
Astyanax bockmanni Vari and Castro, 2007		X	X			X	X	X	1.09%	MZUEL 6445
Astyanax paranae Eigenmann, 1914	X	X	X	X	X	X	X	X	7.91%	MZUEL 6446
Bryconamericus iheringii (Boulenger, 1887)		X	X		X	X	X	X	6.11%	MZUEL 6429
Bryconamericus stramineus Eigenmann, 1908						X	X	X	1.38%	MZUEL 6438
Piabina argentea Reinhardt, 1867				X		X	X	X	0.61%	MZUEL 6439
Parodontidae										
Apareiodon affinis (Steindachner, 1879)								X	0.04%	MZUEL 6431
Apareiodon ibitiensis Campos, 1944								X	0.02%	MZUEL 6430
Crenuchidae										
Characidium zebra Eingenmann, 1909	X	X	X	X	X	X	X	X	6.59%	MZUEL 6441
Erythrinidae										
Hoplias malabaricus (Bloch, 1794)	X	X	X			X	X	X	0.52%	MZUEL 6449
GYMNOTIFORMES										
Gymnotidae										
Gymnotus sylvius Albert and Fernandes-Matioli, 1999	X	X	X	X	X	X	X	X	4.25%	MZUEL 6455
Gymnotus sp.	X	X			X	X	X	X	0.36%	MZUEL 6452
SILURIFORMES										
Heptapteridae										
Cetopsorhamdia iheringi Schubart and Gomes, 1959						X			0.04%	MZUEL 6424
Imparfinis mirini Haseman, 1911	X	X				X			0.19%	MZUEL 6436
Imparfinis schubarti (Gomes, 1956)	X	X		X	X	X	X		6.93%	MZUEL 6437
Rhamdia quelen (Quoy and Gaimard, 1824)	X	X	X	X	X	X	X	X	0.82%	MZUEL 6440
Trichomycteridae										
Trichomycterus davisi (Haseman, 1911)				X					0.02%	MZUEL 6426
Trichomycterus diabolus Bockmann, Cassati and de Pinna, 2004			X	X	X	X			0.19%	MZUEL 6428
Loricariidae										
Otothyropsis biamnicus Calegari, Lehmann and Reis, 2013		X	X		X	X	X	X	2.01%	MZUEL 6444
Hypostomus albopunctatus (Regan, 1908)								X	0.04%	MZUEL 6448
Hypostomus ancistroides (Ihering, 1911)	X	X	X	X	X	X	X	X	19.34%	MZUEL 6454
Hypostomus hermanni (Ihering, 1905)								X	0.02%	MZUEL 6447
Hypostomus nigromaculatus (Schubart, 1964)					X			X	0.06%	MZUEL 6427
Hypostomus paulinus (Ihering, 1905)					X			X	0.02%	MZUEL 6425
Hypostomus strigaticeps (Regan, 1908)			X	X	X	X	X	X	0.82%	MZUEL 6432
Rineloricaria pentamaculata Langeani and de Araujo, 1994				X		X	X	X	0.67%	MZUEL 6422
CYPRINODONTIFORMES										
Poeciliidae										
Phalloceros harpagos Lucinda, 2008						X	X	X	0.78%	MZUEL 6443
Poecilia reticulata Peters, 1859	X		X	X		X	X	X	18.2%	MZUEL 6442
CYPRINIFORMES										
Cyprinidae										
Cyprinus carpio Linnaeus, 1758	X								0.02%	MZUEL 6423
PERCIFORMES										
Cichlidae										
Crenicichla jaguarensis Haseman, 1911								X	0.02%	MZUEL 6433
Geophagus brasiliensis (Quoy and Gaimard, 1824)	X	X	X	X	X	X	X	X	11.66%	MZUEL 6451
Oreochromis niloticus (Linnaeus, 1758)	X								0.48%	MZUEL 6435
SYNBRANCHIFORMES										
Synbranchidae										
Synbranchus marmoratus Bloch, 1795		X	X	X	X	X			0.25%	MZUEL 6434
Total of species	**14**	**15**	**15**	**15**	**16**	**23**	**19**	**25**		

The fish species captured along the Penacho stream are those that still manage to stay in those environments, even in changed conditions. However, to better understand the effects of degradation on fish diversity, it is necessary to monitor it along time.

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