Ichthyofauna of the Aiuruoca River basin, Minas Gerais, Brazil

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ABSTRACT: Although the Aiuruoca River is recognized as a very important area for fish fauna, the species composition of this river remains unknown or restricted to technical reports of licensing projects. The aim of this study was to describe the composition and distribution of the ichthyofauna in the Aiuruoca River basin. Fifty-eight collection points were sampled along the Aiuruoca River basin during 2010 and 2011, including 38 streams, 11 lagoons and 9 points along the Aiuruoca River main channel. A total of 8562 specimens were collected belonging to 6 orders, 15 families, 33 genera and 47 species. The pirapetinga fish (Brycon nattereri) is listed on Brazil’s endangered species, and the rainbow trout (Oncorhynchus mykiss) was the only exotic species captured. Altitude is one of the main factors that influence fish community structure in the Aiuruoca River basin, confirming its importance for fish conservation.

INTRODUCTION

There is a scientific consensus that the long-term maintenance of biodiversity would benefit greatly from conservation plans that act on a regional scale or include large tracts of land (Center for Applied Biodiversity Science 2000). The identification of areas with high species diversity is an essential component for protecting biodiversity (Allan and Flecker 1993).

The Aiuruoca River basin is considered as one of very high biological importance for conservation of the ichthyofauna in Minas Gerais State, Brazil (Biodiversitas 2005) because it is an important lotic remnant of the Upper Grande River basin and has high water quality. River damming is one of the major threats to the fish found in Grande River basin.

Although the Aiuruoca River is recognized as a very important area for fish fauna, practically all of the basic requirements for adequate conservation strategies are lacking, especially because the species composition remains unknown or restricted to technical reports of licensing projects. Therefore, the aim of this study was to describe the composition and distribution of the ichthyofauna in the Aiuruoca River basin.

MATERIAL AND METHODS

Study Area

The study basin is located in the Upper Grande River region in southern Minas Gerais. The Aiuruoca River has a drainage area of 2,094 km² and is located upstream of the Camargos Reservoir (Figure 1), and it drains areas designated as buffer zones for the Conservation Unit APA Mantiqueira (Environmental Protection Area of the Mantiqueira mountain) . (Lino and Albuquerque 2007). The streams and rivers in this region have cold, clean and well-oxygenated water, which are characteristics unique to headwaters (Uieda and Castro 1999).

Fish sampling

Fifty-eight sampling stations were evaluated along the Aiuruoca River basin during 2010 and 2011 (Table 1). The water bodies sampled included 38 streams, 11 lagoons and 9 points along the Aiuruoca River channel that were specifically selected to maximize the diversity of the sampled environments and to represent the complete composition of the basin’s ichthyofauna.

A 150-meter long section of each stream was sampled once during the dry season. Each section was subdivided into 10 cross-sections, and each cross-section covered 1/10 of the total length. Fish collections were performed downstream to upstream with sieves made from mosquito netting (80 cm in diameter; 1 mm mesh size). Two sieves were used for each stream, and collection time was standardized, in 12 minutes per each stream cross-section max.

Lagoons were also sampled once immediately after the Aiuruoca River flooding season between December 2010 and February 2011. Fish collection was performed using two sieves made from mosquito netting (1 mm mesh size) and trawling nets (50 mm mesh size).

Station along the Aiuruoca River were sampled during the rainy season (November 2010) and the dry season (May 2011). At each point in the river, a combination of gillnets (2.4 cm to 14 cm mesh size) was set in the afternoon and retrieved the next morning. Sieves and trawling nets were also used at these points whenever possible.

Sampling stations were defined based on a 1:250,000 cartographic map IBGE, and comprised all possible streams considering the possibility of access. The average altitude for each of the 58 points was measured using a GPS unit (Garmin Etrex Venture).

A species accumulation curve was created for all of the points sampled in the Aiuruoca River basin, where at least one fish species was recorded, based on 500
randomizations, and the total richness was compared via the Jackknife1 and Chao1 estimators, using the EstimateS 8.0 software (Colwell 2006).

Samples of the collected specimens were subsequently deposited in the Federal University of Lavras (UFLA) Fish Collection (Table 2). Fish were collected under the IBAMA license # 10 327.

**RESULTS AND DISCUSSION**

A total of 8562 specimens were collected belonging to 6 orders, 15 families, 33 genera and 47 species (Table 2). One of them, the Pirapetinga (*Brycon nattereri*) is listed on Brazil’s endangered species official list as vulnerable (Machado *et al.* 2005). The distribution area for this species confirms its preference for small, protected rivers and headwaters (Pompeu *et al.* 2009). Additionally, the rainbow trout (*Oncorhynchus mykiss*) was the only exotic species captured. It was introduced by the hatchery industry in the cold-water regions of the Mantiqueira mountains. Due to its unique biological traits, such as being omnivorous and hiding its offspring from predators, this species is considered a pest that causes adverse ecological effects in the various countries and regions where it has been introduced (Magalhães *et al.* 2002). The majority of the biodiversity occurred in the Characiformes (53%) and Siluriformes (36%) orders, which also had the largest number of individuals collected (78% of the total catch). This pattern has been identified repeatedly throughout similar research in South America (Lowe-McConnell 1987). However, although Siluriformes from the Loricariidae and Trichomycteridae families were the most common fish in the streams, the most common species found in the river were from the Characidae family. The Characidae ichthyofauna consists of fish with very diverse feeding habits (i.e., herbivores, omnivores and carnivores) that exploit a wide range of habitats (Kavalco and Pazza 2007). Conversely, Siluriformes were preferential to rapids typical of headwater streams, which are characterized by high water velocity, low temperature and rocky bottoms (Casatti and Castro 2006).

Although 52 sampling stations had been sampled, the collector's curve was not totally stabilized (Figure 2). The estimated richness by Jackknife1 and Chao1 estimators indicated that the number of registered species represented 84% and 98% of the richness in the region, respectively. The areas where the majority of the species were recorded were lagoons, followed by streams and the Aiuruoca River. Thirty-four species had previously been identified in the Rio Grande (Cemig 2007), 41 species in the Capivari River (Pompeu *et al.* 2009) and 25 species in the Itutinga reservoir (Alves *et al.* 1998). With the addition of 16 species in this study, 88 species have been identified in the Rio Grande basin in Minas Gerais. Among the additional species, 11 were collected from streams and the other 5 species were collected from lagoons and the river channel, indicating that much of the unknown fauna in this basin is likely concentrated in small water bodies.

We also observed that only small species of the Loricariidae family, *Pareiorhina carrancas* and *Pareiorhaphis* sp. n., were recorded at altitudes above
Table 1. Geographic information of sampling stations in Aiuruoca River basin (* water bodies without denomination in the IBGE cartographic map).

| SAMPLING STATION         | CITY                  | ALTITUDE (M) | GEOGRAPHIC COORDINATES          |
|--------------------------|-----------------------|--------------|---------------------------------|
| Córrego Afuente Tamanduá| Aiuruoca              | 1155         | 44°33'29" W / 22°05'07" S      |
| Córrego Cangalhas        | Aiuruoca              | 1115         | 44°36'59" W / 22°05'26" S      |
| Córrego *                | São Vicente de Minas  | 921          | 44°24'10" W / 21°36'06" S      |
| Córrego Comunidade Penteado| Itamonte             | 1126         | 44°39'11" W / 22°11'26" S      |
| Corrego Catchoeira da Fragária| Itamonte            | 1570         | 44°42'07" W / 22°16'49" S      |
| Córrego Campina          | Alagoa                | 1118         | 44°37'28" W / 22°08'21" S      |
| Córrego Campo Redondo    | Itamonte              | 1534         | 44°41'42" W / 22°16'00" S      |
| Córrego da Cidreira      | Aiuruoca              | 1120         | 44°38'01" W / 22°11'40" S      |
| Córrego da Divisa        | Alagoa                | 1097         | 44°35'45" W / 22°03'48" S      |
| Córrego da Mata no Quilombo| Itamonte             | 1386         | 44°42'45" W / 22°13'06" S      |
| Córrego da Olaria        | Alagoa                | 1115         | 44°37'11" W / 22°08'14" S      |
| Córrego das Abelhas      | Itamonte              | 1426         | 44°42'34" W / 22°13'06" S      |
| Córrego das Cobras       | Alagoa                | 1112         | 44°38'04" W / 22°09'43" S      |
| Córrego do Corguinho     | Aiuruoca              | 1122         | 44°37'07" W / 22°10'24" S      |
| Córrego do Josué         | Itamonte              | 1471         | 44°41'56" W / 22°19'02" S      |
| Córrego do Mato Grosso   | Itamonte              | 1630         | 44°42'12" W / 22°19'47" S      |
| Córrego do Meio          | Itamonte              | 1367         | 44°42'40" W / 22°14'35" S      |
| Córrego do Ouro          | Itamonte              | 1680         | 44°41'03" W / 22°19'21" S      |
| Córrego do Quilombo      | Itamonte              | 1275         | 44°41'50" W / 22°11'34" S      |
| Córrego Duíns Irmaós     | Itamonte              | 1270         | 44°40'06" W / 22°14'43" S      |
| Córrego Fundo            | Alagoa                | 1088         | 44°35'50" W / 22°02'49" S      |
| Córrego *                | Itamonte              | 1357         | 44°42'04" W / 22°18'01" S      |
| Córrego Ingrid           | Itamonte              | 1332         | 44°41'29" W / 22°14'31" S      |
| Córrego João Veia         | Itamonte              | 1373         | 44°41'47" W / 22°17'41" S      |
| Córrego Martins          | Itamonte              | 1229         | 44°40'46" W / 22°11'40" S      |
| Córrego Mato Grosso      | Itamonte              | 1190         | 44°38'48" W / 22°12'49" S      |
| Córrego Quilombo         | Itamonte              | 1296         | 44°41'44" W / 22°12'15" S      |
| Córrego Vargem Grande   | Itamonte              | 1902         | 44°40'06" W / 22°14'43" S      |
| Córrego dos Quatro       | Aiuruoca              | 1098         | 44°34'23" W / 22°05'30" S      |
| Córrego *                | Itamonte              | 1283         | 44°40'08" W / 22°14'41" S      |
| Córrego Olaria           | Aiuruoca              | 973          | 44°36'29" W / 21°59'39" S      |
| Córrego Ouro 2           | Itamonte              | 1680         | 44°41'03" W / 22°19'21" S      |
| Córrego Ribeirão da Aberta| Itamonte             | 1630         | 44°41'03" W / 22°19'21" S      |
| Córrego Ribeirão do Condado| Aiuruoca             | 1132         | 44°37'02" W / 22°11'22" S      |
| Córrego Ribeirão do Papagai| Aiuruoca             | 1026         | 44°36'45" W / 22°00'41" S      |
| Córrego Ribeirão Vermelho| Itamonte              | 1136         | 44°40'29" W / 22°11'05" S      |
| Córrego Tamanduá         | Aiuruoca              | 1176         | 44°33'09" W / 22°05'14" S      |
| Córrego Trabanda         | Aiuruoca              | 1099         | 44°35'34" W / 22°05'39" S      |
| Rio Aiuruoca             | Aiuruoca              | 1372         | 44°41'47" W / 22°17'42" S      |
| Rio Aiuruoca             | Itamonte              | 1414         | 44°42'07" W / 22°18'30" S      |
| Rio Aiuruoca             | Aiuruoca              | 1052         | 44°36'29" W / 22°01'58" S      |
| Rio Aiuruoca             | São Vicente de Minas  | 923          | 44°24'26" W / 21°42'30" S      |
| Rio Aiuruoca             | São Vicente de Minas  | 920          | 44°24'16" W / 21°36'03" S      |
| Rio Aiuruoca             | São Vicente de Minas  | 926          | 44°24'15" W / 21°36'03" S      |
| Rio Aiuruoca             | Aiuruoca              | 977          | 44°36'20" W / 21°59'54" S      |
| Rio Aiuruoca             | Aiuruoca              | 980          | 44°36'21" W / 21°59'45" S      |
| Rio Aiuruoca             | Aiuruoca              | 974          | 44°36'26" W / 21°59'36" S      |
| Rio Aiuruoca             | Aiuruoca              | 1083         | 44°35'25" W / 22°05'29" S      |
| Lagoa *                  | São Vicente de Minas  | 921          | 44°24'10" W / 21°36'06" S      |
| Lagoa *                  | Aiuruoca              | 980          | 44°34'28" W / 21°55'29" S      |
| Lagoa Bela Vista         | São Vicente de Minas  | 931          | 44°23'11" W / 21°38'33" S      |
| Lagoa Furado             | São Vicente de Minas  | 918          | 44°23'16" W / 21°38'38" S      |
| Lagoa Pequena            | São Vicente de Minas  | 919          | 44°23'26" W / 21°38'58" S      |
| Lagoa do Brejo           | São Vicente de Minas  | 934          | 44°24'24" W / 21°42'14" S      |
| Lagoa Serena             | São Vicente de Minas  | 934          | 44°22'13" W / 21°39'44" S      |
| Lagoa do Trem            | São Vicente de Minas  | 926          | 44°23'57" W / 21°42'36" S      |
| Lagoa Draga              | Aiuruoca              | 933          | 44°24'27" W / 21°42'29" S      |
| Lagoa do Trem 2          | São Vicente de Minas  | 929          | 44°23'57" W / 21°42'32" S      |
1600 m (Figure 3). A total of 9 species were found above an altitude of 1050 m, while 25 where restrict to areas under 1000 m of altitude. Although the studies available considering the upper Rio Grande fish fauna do not cover the same altitudinal range, degree of conservation, altitude and width have been considered important parameters to explained fish species richness (Pompeu et al., 2009). In the same study, *P. carrancas* and *Pareiorhaphis* sp. n. were among those with higher distribution considering the altitudinal gradient.

Relief is also probably one important factor that influences fish community structure in the Aiuruoca River basin. Its importance can be observed in the altitudinal distribution of species, which revealed the role of a large waterfall, located in the Aiuruoca River channel at an altitude of 1040 meters, as a barrier to species dispersal. A larger diversity of fish in the lower streams may be linked to increased habitat variability and more water volume. The headwater regions of river basins have less diverse habitats (both in volume and complexity) and unstable environmental variables (Schlosser 1990).
**Table 2.** Fish species collected from the Aiuruoca River basin, by sampled location (N = number of individuals, CI-UFLA = number of UFLA Fish Collection, *exotic species*).

| TAXON          | N | LAGOONS | RIVER | STREAMS |
|----------------|---|---------|-------|---------|
| **CHARACIFORMES** |   |         |       |         |
| Anostomidae    |   |         |       |         |
| Leporinus elongatus Valenciennes, 1850 | 6 | CI-UFLA 0381 |
| Leporinus friderici (Bloch, 1794) | 21 | CI-UFLA 0366 | CI-UFLA 0382 |
| Leporinus obtusidens (Valenciennes, 1837) | 1 | CI-UFLA 0383 |
| Leporinus octofasciatus Steindacher, 1915 | 6 | CI-UFLA 0367 |
| Leporinus striatus Kner, 1858 | 12 | CI-UFLA 0384 |
| Schizodon nasutus Kner, 1858 | 17 | CI-UFLA 0371 | CI-UFLA 0391 |
| **Characidae** |   |         |       |         |
| Astyanax altiparanae Garutti and Britski, 2000 | 365 | CI-UFLA 0355 | CI-UFLA 0374 | CI-UFLA 0153 |
| Astyanax fasciatus (Cuvier, 1819) | 511 | CI-UFLA 0356 | CI-UFLA 0375 | CI-UFLA 0399 |
| Astyanax scabripinnis paranae (Eigenmann, 1914) | 237 | CI-UFLA 0357 | CI-UFLA 0376 | CI-UFLA 0155 |
| Brycon nattereri Günther, 1864 | 4 | CI-UFLA 0377 |
| Bryconomericus stramineus (Eigenmann, 1908) | 20 | CI-UFLA 0358 | CI-UFLA 0393 |
| Hasemania aff. nana (Lütken 1875) | 2404 | CI-UFLA 0363 |
| Hyphessobrycon bifasciatus Ellis, 1911 | 925 | CI-UFLA 0365 |
| Piaiba argentea Reinhardt, 1867 | 29 | CI-UFLA 0369 | CI-UFLA 0387 |
| Salminus hiliarii Valenciennes, 1850 | 12 | CI-UFLA 0390 |
| Serrapinnus heterodon (Eigenmann, 1915) | 474 | CI-UFLA 0372 |
| **Crenuchidae** |   |         |       |         |
| Characidium gomesi Travassos, 1956 | 17 | CI-UFLA 0154 |
| Characidium oiticicai Travassos, 1967 | 2 | CI-UFLA 0150 |
| Characidium sp. (sensu Pavanelli, 2007) | 9 | CI-UFLA 0360 | CI-UFLA 0394 |
| Characidium aff. zebra Eigenmann, 1909 | 145 | CI-UFLA 0151 |
| **Erythrinidae** |   |         |       |         |
| Hoplias malabaricus (Bloch, 1794) | 32 | CI-UFLA 0364 |
| **Parodontidae** |   |         |       |         |
| Apareiodon affinis (Steindacher, 1879) | 9 | CI-UFLA 0353 |
| Apareiodon piracicabae (Eigenmann, 1907) | 21 | CI-UFLA 0354 | CI-UFLA 0373 |
| Parodon nasus Kner, 1859 | 3 | CI-UFLA 0386 |
| **Prochilodontidae** |   |         |       |         |
| Prochilodus lineatus (Valenciennes, 1837) | 2 | CI-UFLA 0389 |
| **CYPRINODONTIFORMES** |   |         |       |         |
| Poeciliidae |   |         |       |         |
| Phalloceros harpagos Lucinda, 2008 | 1045 | CI-UFLA 0368 | CI-UFLA 0147 |
| **GYMNOTIFORMES** |   |         |       |         |
| Gymnotidae |   |         |       |         |
| Gymnotus carapo Linnaeus, 1758 | 3 | CI-UFLA 0378 | CI-UFLA 0378 |
| **PERCIFORMES** |   |         |       |         |
| Cichlidae |   |         |       |         |
| Geophagus brasiliensis (Quoy and Gaimard, 1824) | 846 | CI-UFLA 0362 |
| Cichlasoma paranaense Kulander, 1983 | 1 | CI-UFLA 0361 |
| **SALMONIFORMES** |   |         |       |         |
| Salmonidae |   |         |       |         |
| Oncorhynchus mykiss (Walbaum, 1792) * | 5 | CI-UFLA 0156 |
| **SILURIFORMES** |   |         |       |         |
| Callichthyidae |   |         |       |         |
| Callichthys callichthys (Linnaeus, 1758) | 2 | CI-UFLA 0359 | CI-UFLA 0401 |
| **Heptapteridae** |   |         |       |         |
| Cetopsorhamdia iheringi Schubart and Gomes, 1959 | 32 | CI-UFLA 0148 |
| Phenacorhamdia tenebrosa (Schubart, 1964) | 1 | CI-UFLA 0395 |
| Pimelodella gracilis (Valenciennes, 1835) | 1 | CI-UFLA 0396 |
| Rhamdioglanis sp. | 4 | CI-UFLA 0397 |
| Rhamdiopsis microcephala (Lütken, 1874) | 8 | CI-UFLA 0149 |
| **Loricariidae** |   |         |       |         |
| Hypostomus sp. (sensu Pavanelli, 2007) | 4 | CI-UFLA 0380 |
| Harttia cf. gracilis (Oyakawa, 1993) | 31 | CI-UFLA 0379 |
| Neoplecostomus paranensis Langeani, 1990 | 83 | CI-UFLA 0385 | CI-UFLA 0157 |
| Pareiorhapis sp. n. | 117 | CI-UFLA 0158 |
Table 2. Continued.

| TAXON | N  | LAGOON | RIVER | STREAM |
|-------|----|--------|-------|--------|
| Pareiorhina carrancas Bockmann and Ribeiro, 2003 | 945 | CI-UFLA 0160 |          |        |
| Pimelodidae |          |        |        |        |
| Pimelodus maculatus Lacepède, 1803 | 23 | CI-UFLA 0370 | CI-UFLA 0388 | |
| Trichomycteridae |          |        |        |        |
| Trichomycterus brasiliensis Lütken, 1874 | 77 | CI-UFLA 0392 | CI-UFLA 0159 | |
| Trichomycterus itaiayae Miranda Ribeiro, 1906 | 3 | CI-UFLA 0398 |          |        |
| Trichomycterus maracayoi Bockmann and Saxima 2004 | 35 | CI-UFLA 0161 |          |        |
| Trichomycterus pauciradiatus Alencar and Costa 2006 | 5 | CI-UFLA 0146 |          |        |
| Trichomycterus sp. (sensu Pavanelli 2007) | 7 | CI-UFLA 0340 |          |        |
| TOTAL | 8562 |          |        |        |

Acknowledgments: We thank the Project BIOTAMINAS/FAPEMIG and CNPq for funding and providing logistical support for sampling and analyzing material. We also thank Francisco Langeani, Edson H. L. Pereira and Flávio A. Bockmann for helping to identify the species, and Julio C. Louzada for the suggestions in this manuscript.

Literature Cited

Allan, J.D. and A.S. Flecker. 1993. Biodiversity conservation in running waters. BioScience 43(1): 32-43.
Alves, C.B.M., A.L. Godinho, H.P. Godinho and V.C. Torquato. 1998. A ictiofauna da Represa de Itutinga, Rio Grande (Minas Gerais - Brasil). Revista Brasileira de Biologia 58(1): 121-129.
Biodiversitas. 2005. Lista da fauna brasileira ameaçada de extinção. Belo Horizonte: Fundação Biodiversitas. 222 p.
Casatti, L. and R.M.C. Castro. 2006. Testing the ecomorphological hypothesis in a headwater riffles fish assemblage of the rio São Francisco, southeastern Brazil. Neotropical Ichthyology 4(2): 203-214.
Cemig. 2007. Guia Ilustrado de Peixes da Bacia do Rio Grande. Belo Horizonte. 142 p.
Colwell, R.K. 2006. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.
Center for Applied Biodiversity Science. 2000. Designing sustainable landscapes - the Brazilian atlantic forest. Washington: Conservation International and Instituto de estudos sócio-ambientais do sul da Bahia. 29 p.
Kavalco, K.F. and R. Pazza. 2007. Aspectos biogeográficos de componentes da ictiofauna da América Central. ConScienCia e Saúde 6(1): 147-153.
Lino, F.C. and J.L. Albuquerque. 2007. Mosaicos de unidades de conservação no corredor da Serra do Mar. Cadernos da Reserva do Biosfere da Mata Atlântica. Conservação e Áreas Protegidas. São Paulo: Conselho Nacional da Reserva do Biosfera da Mata Atlântica. Série Nº 1. 96 p.
Lowe-McConnell, R.L. 1987. Ecological studies in tropical fish communities. London: Cambridge University Press. 382 p.
Machado, A.B.M., C.S. Martins and G.M. Drummond. 2005. Lista da fauna brasileira ameaçada de extinção: incluindo as espécies quase ameaçadas e deficientes em dados. Belo Horizonte: Fundação Biodiversitas. 160 p.
Magalhães, A.L.B., R.F. Andrade, F.T. Ratton and M.F.G. Brito. 2002. Ocorrência de truta arco-íris Oncorhynchus mykiss (Walbaum, 1792) (Pisces: Salmonidae) no Alto rio Aiuruoca e tributários, bacia do rio Grande, Minas Gerais, Brasil. Boletim Museu Mello Leitão 14: 33-40.
Pompeu, P.S., L.S. Reis, C.V. Gandini, R.C.R. Souza and J. M. Favero. 2009. The ichthyofauna of upper Rio Capivari: defining conservation strategies based on the composition and distribution of fish species. Neotropical Ichthyology 7(4): 659-666.
Schlosser, I.J. 1990. Environmental variation, life history, attributes, and community structure in stream fishes: Implications for environmental management and assessment. Environmental Management 14(5): 621-628.
Uieda, V.S. and R.M.C. 1999. Castro. Coleta e fixação de peixes de rios: p. 1-22 In E.P. Caramaschi, R. Mazzoni and P.R. Peres-Neto (ed.). Ecologia de Peixes de Riachos. Oecologia Brasiliensis. Volume VI. Rio de Janeiro: PPGE-UFRJ.

Received: February 2012
Accepted: October 2012
Published Online: December 2012
Editorial responsibility: Sérgio Maia Queiroz Lima