

SHORT COMMUNICATION

First record of an annual endemic fish from a semiarid environment in northeastern Brazil

Primeiro registro de peixe anual endêmico de ambiente semiárido no Nordeste do Brasil

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Abstract

Studies focusing the biology of annual fish are still scarce, and in the case of threatened species, research, as well as the adoption of protective measures for these populations, are needed. We present herein the first record of *Hypsolebias antenori* (Cyprinodontiformes: Cynolebiidae) in temporary pools of Lajedo de Soledade, located in a semiarid region, in Northeastern Brazil. Five individuals (two males and three females) were captured in three temporary pools in May 2017. For the capture, a sieve (50 x 50 cm) with a 4 mm of mesh size was used. The males showed a total length ranging from 3.5 to 4.7 cm (average: 4.1 cm) and body mass amplitude between 0.38 to 0.94 g (average: 0.66 g). The females had a total length from 3.5 to 3.9 cm (average: 3.67 cm) and body mass amplitude of 0.55 to 0.70 g (average: 0.64). Considering that the collection area is one of the most important archaeological sites in Brazil, this endemic species of Caatinga demonstrates the importance of conservation of the environment and serves to support the preservation of the present area that is not recognized and registered as cultural and environmental patrimony.

Keywords: Karst, Jandaíra Formation, Caatinga, temporary pools, Cynolebiidae, *Hypsolebias antenori*.

Resumo

Estudos que enfocam a biologia de peixes anuais ainda são escassos e, no caso de espécies ameaçadas, são necessárias pesquisas, bem como a adoção de medidas de proteção para essas populações. Apresenta-se, neste trabalho, o primeiro registro de *Hypsolebias antenori* (Cyprinodontiformes: Cynolebiidae) em poças temporárias do Lajedo de Soledade, localizado em uma região semiárida, no Nordeste do Brasil. Cinco indivíduos (dois machos e três fêmeas) foram capturados em três piscinas temporárias em maio de 2017. Para a captura, foi utilizada uma peneira (50 x 50 cm) com 4 mm de tamanho de malha. Os machos apresentaram comprimento total variando de 3,5 a 4,7 cm (média: 4,1 cm) e amplitude de massa corporal entre 0,38 a 0,94 g (média: 0,66 g). As fêmeas tinham comprimento total de 3,5 a 3,9 cm (média: 3,67 cm) e amplitude de massa corporal de 0,55 a 0,70 g (média: 0,64). Considerando que a área de coleta é um dos mais importantes sítios arqueológicos do Brasil, essa espécie endêmica da Caatinga demonstra a importância da conservação do meio ambiente e serve para apoiar a preservação da área atual que não é reconhecida e registrada como patrimônio cultural e ambiental.

Palavras-chave: Carste, Formação Jandaíra, Caatinga, poças temporárias, Cynolebiidae, *Hypsolebias antenori*.

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Introduction

The Caatinga biome is exclusive to Brazil, covering approximately 800,000 km² of the Northeastern region (Ab'Saber, 2005) and is characterized by short periods and infrequent rains, interspersed with long periods of drought, high temperatures and high rate of evaporation (Chellappa *et al.*, 2006). This biome has an important role in maintaining macro-ecological processes of the region, and indirectly favors regions with diversity and endemism in Brazil (Leite and Machado, 2010). The Caatinga biodiversity conservation is still incipient. Most of the conservation strategies are almost completely lacking in regulatory legislation, public policies, legal incentive mechanisms, economic instruments and opportunities for the conservation of the biodiversity of this biome (Leal *et al.*, 2005; Lima *et al.*, 2017). Annual fish studies of the family Cynolebiidae contributed to increase the knowledge about the biodiversity of species present in this biome (Leal *et al.*, 2003).

Cynolebiidae Hoedeman, 1961 (Cyprinodontiformes) are found in both Africa and South America occupying temporary ponds that dried seasonally and are characterized by a relatively short adult life (Berois *et al.*, 2014). Such fishes can complete their life cycles in temporary aquatic habitats by having a few adaptations to deal with the limitations of ephemeral habitats (Schalk *et al.*, 2014). In temporary aquatic habitats, specimens of Cynolebiidae lay their eggs on the substrate, which remain in diapause during the dry seasons, and hatch in the next rainy season, starting a new life cycle (Nascimento *et al.*, 2014).

Temporary aquatic ecosystems are typical of semiarid climates and may be formed in the depressions of several kinds of surfaces or landforms, as alluvial plains, sand dunes and rocky outcrops, when they are fulfilled by rainwater. Leite *et al.* (2009) observed that these ecosystems are common in a semiarid region, in Northeastern Brazil, where they dry in periods of drought and return to the flood state in the rainy season, also serving as stopover places where migrant birds may rest and forage (Barbieri *et al.*, 2013). According to Sarmiento-Soares and Martins-Pinheiro (2017), temporary ponds and pools serve as nurseries for many species of animals, such as fishes, amphibians and insects, which depend on these environments for their early developmental stages (larvae and nymphs). These small ecosystems are important environments, which maintain unique sets of species contributing to the maintenance of biodiversity (Oertli *et al.*, 2002). Studies on temporary aquatic environments recognize that they offer a variety of opportunities that have been explored by different species, but this biodiversity is still poorly documented (Milani *et al.*, 2010). The anthropic impacts such as sedimentation, deforestation, pollution and drainage constitute a worrying factor to these environments (Nascimento *et al.*, 2012).

Hypsolebias antenori (TULIPANO, 1973) (Cyprinodontiformes: Cynolebiidae) was recorded for the first time in 1945 in Ceará state, northeastern Brazil, and is currently considered as an endangered annual endemic fish in the Brazilian semiarid (Nascimento *et al.*, 2012; Nascimento *et al.*, 2015). *Hypsolebias* comprises a species rich clade of annual fishes that can be found in the Brazilian Cerrado and Caatinga biomes, primarily in the Rio São Francisco basin, middle Rio Jequitinhonha basin, middle and upper Rio Tocantins basin, Rio Jaguaribe basin, Rio Apodi-Mossoró basin, smaller coastal drainages of northeastern Brazil, and Rio Parnaíba basin (northeastern and midwestern Brazil) (Costa *et al.*, 2014; Nascimento *et al.*, 2014; Britzke *et al.*, 2016). This species is not threatened according to the criteria from the Brazil's official list of endangered species of fishes and aquatic invertebrates (Brasil, 2014).

The Lajedo de Soledade, one of the most important archaeological sites of Brazil, placed in the city of Apodi, Rio Grande do Norte state, consists of an extensive carbonatic rock outcrop belonging to the Jandaíra Formation (Potiguar Basin). This formation has undergone an extensive karstification, as indicated by the occurrence of lapiez fields, small canyons (locally known as ravines) and caves, some presenting archeological remains such as paintings. Also remarkable is the presence of marine fossils from the Cretaceous period on the walls and pavements of some canyons and remains of the Pleistocene vertebrates (mostly mammals) in the clastic sediments that fill them (Porpino *et al.*, 2007).

In the dolines (rounded karstic depressions) and fissures (grykes) located in the small canyons of the Lajedo de Soledade, the study area in this work, temporary pools are formed during the rainy season. Besides providing water for wildlife, these small waterbodies can shelter different species of aquatic animals.

Studies focusing the biology of annual fish, mainly in karstic area, are still scarce, and since it is a threatened species, research is needed as well as the adoption of protective measures for these populations, among them the creation of protected areas in temporary aquatic environments where these species occur. Thus, the aim of this paper is to record *Hypsolebias antenori* in temporary pools in Lajedo de Soledade, municipality Apodi, Rio Grande do Norte, Brazil.

Material and methods

The fish were collected in the Lajedo de Soledade, located in Apodi-Mossoró River Basin, Apodi municipality, Rio Grande do Norte, Brazil (Figure 1). The catch of the fishes occurred on 14, 15 and 16 of May in 2017, both during the daytime (06h a.m. – 10h a.m.), in three temporary pools that were drying during the study period. The Lajedo de Soledade are not connected with the Apodi-Mossoró river (Figure 1), the temporary pools were formed during the rainy season.

The water of the temporary pools is transparent, allowing the fish to be visualized and captured using a sieve (50×50 cm) of 4 mm mesh. After capture, the specimens were transported alive to the laboratory in oxygenated aquariums and documented through a photographic camera aiming to record their natural coloration. Subsequently, they were anesthetized in a eugenol solution (Bittencourt *et al.*, 2012; Lucena *et al.*, 2013), then fixed in a 4% formaldehyde solution during at least eight-day period and conserved in 70% ethanol solution (Malabarba and Reis, 1987) and then identified according to Britzke *et al.* (2016).

After identification, the specimens were separated, and the routine biometric data, total length (mm) and weight (g), were collected. The identification of the material was confirmed by a taxonomist from the Federal University of Paraíba (Universidade Federal da Paraíba – UFPB) and deposited in the ichthyological collection of the institution (catalogue number UFPB 11302). Sampling was authorized by the Chico Mendes Institute for Biodiversity Conservation (SISBIO permit n. 56416-1).

The approximate diameter and depth of each temporary pools were measured. The three temporary pools presented different lengths, widths and depths, which were drying due to lack of rain in the region. The length varied from 2.70 to 4.00 m (average: 3.22 m). The width varied from 1.10 to 1.25 m (average: 1.18 m) and the depth from

0.08 to 0.52 cm (average: 0.33 cm). The point 1 (Latitude: $05^{\circ}59'359''$ Longitude: $37^{\circ}82'677''$) has similar characteristics as the point 3 (Latitude: $05^{\circ}59'343''$ Longitude: $37^{\circ}82'650''$). The point 2 (Latitude: $05^{\circ}59'363''$ Longitude: $37^{\circ}82'672''$) has a smaller width and showed aquatic vegetation, which is absent in the other points (Figure 2).

Results and discussion

The only fish species recorded in Lajedo de Soledade was *Hypsolebias antenori* (Cyprinodontiformes: Cynolebiidae) (Figure 3). In total, five specimens of *H. antenori* were collected, of which two males and three females. The amplitude of the total length of males ranged from 3.5 to 4.7 cm (average: 4.1 cm) and that of females from 3.5 to 3.9 cm (average: 3.67 cm). The range of male body mass ranged from 0.38 to 0.94 g (average: 0.66 g) and female body mass from 0.55 to 0.70 g (average: 0.64 g).

These results are similar to the ones found for specimens of *H. antenori* in regions adjacent to several river basins in the states of Rio Grande do Norte (Rio Apodi-Mossoró basin) and Ceará (Rio Jaguaribe basin), with a range of total length between 2.6 to 7.1 cm (average: 4.1 cm) for males and 2.2 to 5.4 cm (average: 3.6 cm) for females, and a range of weight between 0.25 and 7 g (average: 1.4 g) for males and 0.12 to 2.1 g (average: 0.5 g) for females (Nascimento

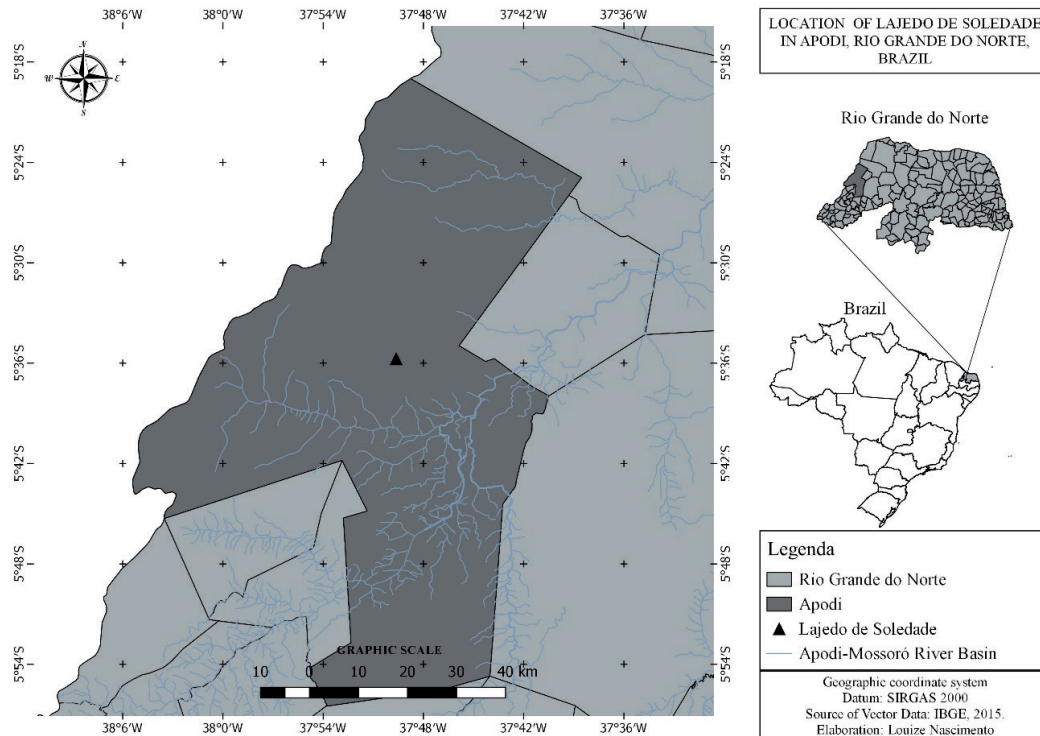


Figure 1. Location map showing the study area Lajedo de Soledade, Apodi-Mossoró River Basin, Apodi municipality, Rio Grande do Norte, northeastern Brazil, where the endemic fish *Hypsolebias antenori* was collected.



Figure 2. Collecting sites of *Hypsolebias antenori*: pools formed during the rainy season in dolines (A and C) and in fissures (B) located in small canyons of the Lajedo de Soledade, Apodi-Mossoró River Basin, Apodi municipality, Rio Grande do Norte, northeastern Brazil.

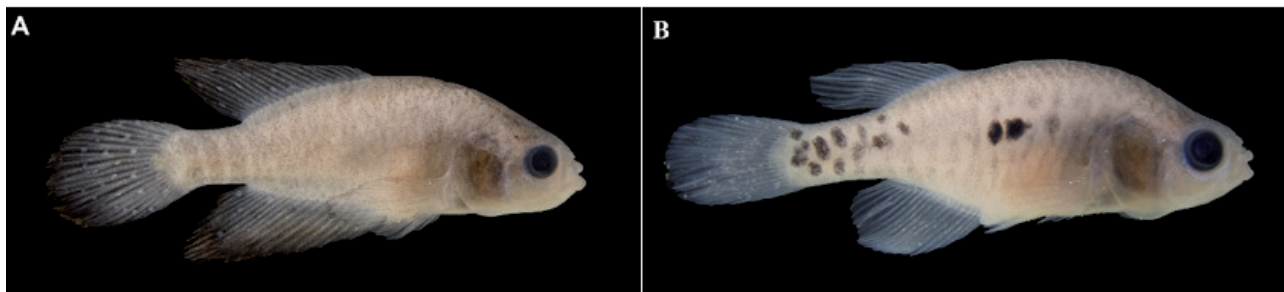


Figure 3. Endemic fish *Hypsolebias antenori* (Cyprinodontiformes: Cynolebiidae) of Caatinga, male (4.7 cm) (A) and female (3.9 cm) (B), registered in Lajedo de Soledade, Apodi-Mossoró River Basin, Apodi municipality, Rio Grande do Norte, northeastern Brazil.

et al., 2015). The largest body size is usually an attribute that allows males to gain an advantage in competition by their partner and by breeding sites (Cacho *et al.*, 2006).

Hypsolebias antenori presents sexual dimorphism, where males show a gray-blue coloration with vertical white stripes along the body. Females have a yellowish body, with the white ventral region and black spots along the body, the number of spots of which does not follow a pattern among females. The fins of the males are more developed than those of the females. The dorsal, caudal and anal fins of the male are larger, with red/orange coloration, black edges and several white dots. The female's fins are transparent (Figure 3). Most Cynolebiidae present sexual dimorphism, with males exhibiting bright coloration and having relatively larger body sizes than females (Gonçalves *et al.*, 2011), a pattern that was observed for *H. antenori* in Lajedo de Soledade. In fishes, the body size of females is favored by increased fertility, whereas in males, size is affected by sexual selection (Schalk *et al.*, 2014).

The change in rainfall regime caused by climatic change and the construction of dams in Semiarid Brazilian Northeast threaten the annual fishes of the Caatinga biome. These constructions flood large areas causing the destruction of temporary pools and the species inhabiting them (Nascimento *et al.*, 2015). Temporary pools ex-

ist only during rainy season, drying completely in a short time after the end of the rain. Despite of that, such environments, as the ones founded in Lajedo de Soledade, show an expressive biodiversity in Caatinga. Hence, there is a concern in preserving these small waterbodies (Lima *et al.*, 2017). In addition, in Lajedo da Soledade the caves are under heavy pressure from the lime extraction (Gurgel and Pinto Filho, 2012), which destroys the upper limestone layer of the slabs, causing intense disturbances to the fauna associated with it. This mining activity also causes the suppression and destruction of the cavities (Ferreira *et al.*, 2010). Therefore, it is possible to say that *Hypsolebias antenori* can be threatened by mining activities developed in Lajedo de Soledade.

Considering that the description of an endemic species is important for the conservation of the environment in which it occurs, the first record of the annual endemic and endangered fish *H. antenori* supports the preservation of the Lajedo de Soledade, which is not recognized and listed as cultural and environmental heritage.

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