

## Ichthyofauna of Mundaú river basin, Ceará State, Northeastern Brazil

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**Abstract:** Mundaú river basin is located at Center-North Ceará State and occupies a total area of 2,227 km<sup>2</sup>, including Estuário do Rio Mundaú Environmental Protection Area. This study aimed to catalog the fishes of this basin. Collections were performed with active and passive gear in 35 sampling sites, between 2012 and 2014, in several habitats (main channels, streams, floodplains, permanent and temporary pools, ponds, and dams). A total of 2,545 specimens were collected, belonging to 55 species distributed in 10 orders, 31 families, and 50 genera; 30 of these are strictly freshwater species, and 25 estuarine-marine species. Three species (*Hemigrammus guyanensis* Gery, 1995, *H. rodwayi* Durbin, 1909 and *Poecilia sarrafae* Bragança & Costa, 2011) represent new records for the Mid-Northeastern Caatinga ecoregion. Besides, two cynolebiid species, *Hypsolebias* sp. and *Anablepsoides cearensis* (Costa & Vono, 2009), were found and the latter, currently classified as critically endangered, had its occurrence area widened.

**Keywords:** *intermittent river, semiarid, Mid-Northeastern ecoregion, freshwater neotropical fishes.*

## Ichthyofauna da bacia do rio Mundaú, Estado do Ceará, Nordeste do Brasil

**Resumo:** A bacia do Rio Mundaú está situada no centro-norte do Estado do Ceará, e drena uma área de 2.227 km<sup>2</sup> de Caatinga, incluindo a Área de Proteção Ambiental do Estuário do Rio Mundaú. Este estudo teve como objetivo realizar um inventário dos peixes desta bacia. As coletas foram realizadas com petrechos ativos e passivos, em 35 pontos amostrais entre 2012 e 2014 em diversos habitats (canal principal, córregos, alagados, poças permanentes e temporárias, lagoas e açudes) ao longo de toda a bacia. Um total de 2.545 indivíduos foram coletados, pertencentes a 55 espécies distribuídas em 10 ordens, 31 famílias e 50 gêneros; destas, 30 são estritamente de água doce e 25 estuarino-marinhas. Três espécies (*Hemigrammus guyanensis* Gery, 1995, *H. rodwayi* Durbin, 1909 e *Poecilia sarrafae* Bragança & Costa, 2011) constituem novas ocorrências para a ecorregião do Nordeste Médio-Oriental. Além disso, foram registradas duas espécies de cinolebídeos, *Hypsolebias* sp. e *Anablepsoides cearensis* (Costa & Vono, 2009), a última classificada como criticamente ameaçada de extinção, teve sua área de ocorrência ampliada.

**Palavras-chave:** *rios intermitentes, semiárido, ecorregião Nordeste Médio-Oriental, peixes de água doce neotropical.*

## Introduction

Freshwater ichthyofaunal studies in Brazil are mainly focused on South and Southeastern regions (Langeani et al. 2009). While these regions are well documented, the Northeastern region is in need of studies, especially the Mid-Northeastern Caatinga Ecoregion (MNCE) (Rosa et al. 2003; Ramos et al. 2005). This ecoregion includes coastal basins located between São Francisco and Paraíba river basins, draining Alagoas, Pernambuco, Paraíba, Rio Grande do Norte, Ceará, and a small portion of Piauí States (Rosa et al. 2003). Albert et al. (2011) listed 88 freshwater fish species from MNCE; however, new species are being found and described

(e.g. *Parotocinclus seridoensis* Ramos, Barro-Neto, Britski & Lima, 2013; *Serrapinnus potiguar* Jerep & Malabarba, 2014; and *Hypsolebias martinsi* Britzke, Nielsen & Oliveira, 2016). The estimative of freshwater fish species number at Brazilian Northeast may be premature, given the lack of taxonomic revisions and few representative regional collections (Rosa et al. 2003; Langeani et al. 2009, Ramos et al. 2014).

Ichthyofaunistic inventories at MNCE basins are scarce (Langeani et al. 2009) and the existing ones usually deal with small portions of bigger basins (e.g. Silva et al. 2014), or reservoirs (e.g. Gurgel-Lourenço et al. 2013, Sánchez-Botero et al. 2014). Few coastal basins in this hydrographical region were fully cataloged, for example Gramame river basin, in

Paraíba State, in which (Gomes-Filho & Rosa 2001) there were recorded 23 species; Curimataú river basin in Paraíba and Rio Grande do Norte States, 22 species (Ramos et al. 2005), and Pratagi river microbasin, also in Rio Grande do Norte State, 22 species (Paiva et al. 2014).

MNCE is largely inserted in the Brazilian semi-arid, an area of Caatinga's phytophysionomy where rivers are mostly intermittent resulting in a simple hydrographical network (Rosa et al. 2003), except for headwaters and coastal areas in Alagoas, Pernambuco, Paraíba, and Rio Grande do Norte States, which are greatly nested within the Atlantic Forest (Rosa & Groth 2004, Paiva et al. 2014). Therefore, these semi-arid river systems are constantly being modified through their damming as an attempt to assure the inland population a hydric demand during long drought periods.

Except Jaguaribe river basin and a small portion of Paraíba river basin, Ceará hydrographic network is composed by small-sized coastal basins. Some of these basins may probably have an important role to the conservation of Caatinga's fishes, although they have been considered insufficiently known (MMA 2007). Among these, there is Mundaú river basin, located in Center-North Ceará State, whose freshwater ichthyofauna is virtually unknown. Soares-Filho et al. (2010) cataloged the estuarine portion of this basin and reported 53 estuarine and marine fish species. The Estuário do Rio Mundaú Environmental Protection Area (EPA) is located at the lower extent of the basin, covering 1,596.37 hectares of Ceará West coast, and it is considered a priority area for fish conservation (SEMACE 2014). Because of the basin's importance for the Caatinga fish fauna knowledge, this study aimed to survey the fishes of Mundaú river basin.

## Material and methods

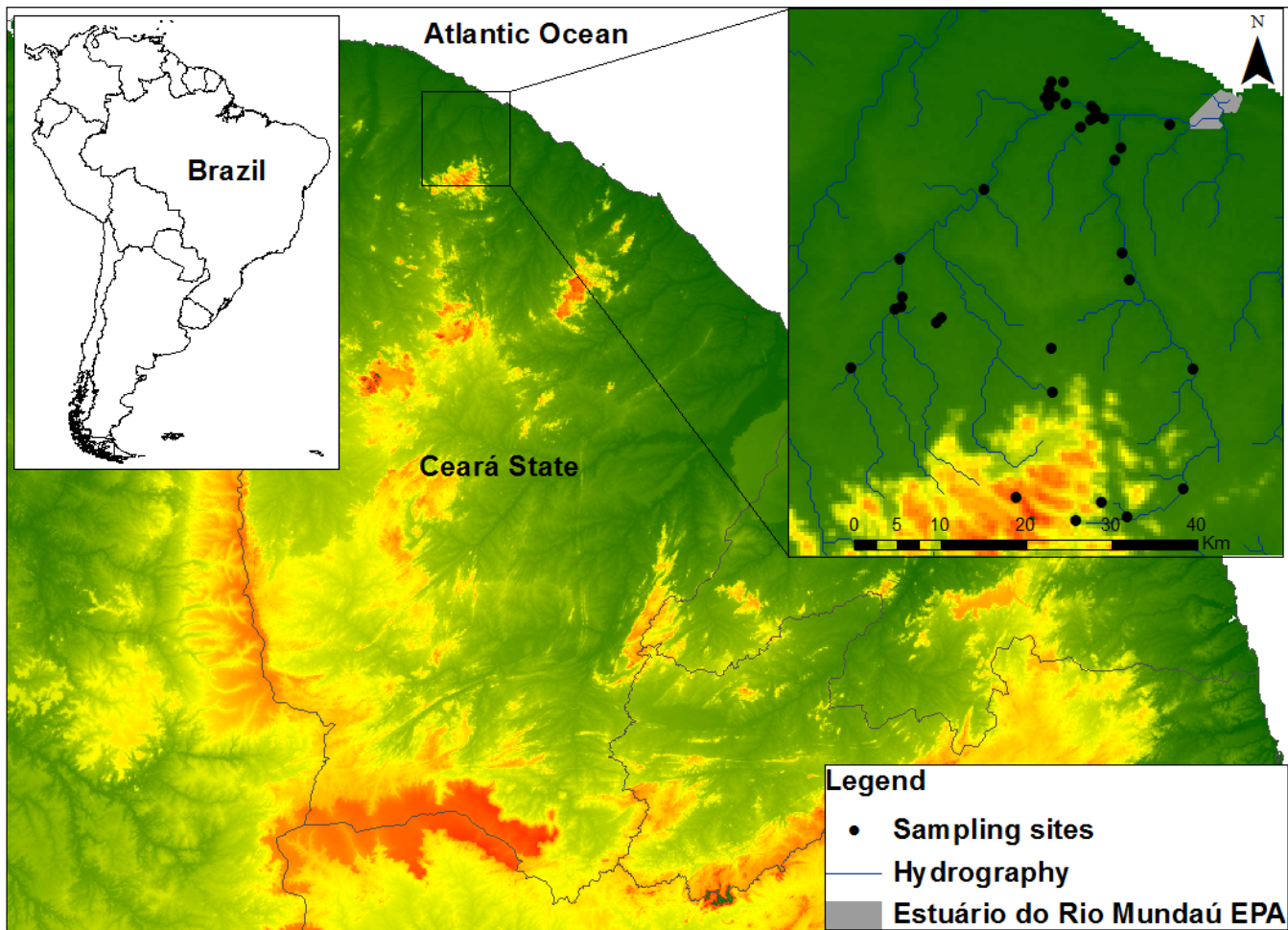
### 1. Study area

Mundaú river basin (Figure 1) covers, approximately, an area of 2,227 km<sup>2</sup> (COGERH 2014), draining regional residual massifs, backland depressions, and seaside plains (IPECE 2012). The two main tributaries of Mundaú river basin, Cruxati in the west and Mundaú in the east, emerge from Uruburetama Massif at elevations up to 970 m, and are intermittent. Along their courses, these rivers are fed by various first order waterbodies, like Sororô, Tabocas, Laginhas, and Torrados streams. Mundaú river main course runs 97.6 km north to south, and desembogues in the Atlantic Ocean, while Cruxati river runs 77.5 km from headwaters to Mundaú river's confluence (COGERH 2014).

The local climate is semi-arid with mean annual precipitation of 1,110.6 mm, and 1,914.7 mm evaporation; mean annual temperatures between 26°C and 28°C, and highest precipitations occurring from January to June (FUNCEME 2015).

#### 1.1. Sampling design

Acquisition of specimens was performed in 35 locations along the entire Mundaú river basin. For better coverage, collections were made at Cruxati and Mundaú rivers' main channels, as well as in streams, ponds, dams, and bogs (Table 1). Sampling took place during dry and wet seasons, between 2012 and 2014, covering localities from Mundaú river headwaters, 900 m



**Figure 1.** Mundaú river basin location in Ceará State, northeastern Brazil, evidencing the sampling sites. Hot colors represent higher altitudes.

**Table 1.** Geographic coordinates, elevation, tributary and main habitat of the sampling sites along the Mundaú river basin.

Geographic Coordinates	Elevation (m)	Tributary	Habitat
3.62527° S 39.49782° W	108	Mundaú	Main channel
3.21225° S 39.45283° W	11	Mundaú	Estuary
3.46911° S 39.42811° W	51	Mundaú	Main channel
3.59491° S 39.43911° W	89	Mundaú	Main channel
3.60494° S 39.61399° W	913	Mundaú	Headwater
3.62936° S 39.55111° W	273	Mundaú	Main channel
3.46814° S 39.78777° W	56	Cruxati	Stream
3.44799° S 39.57688° W	80	Cruxati	Pond
3.42094° S 39.69766° W	62	Cruxati	Stream
3.41619° S 39.69288° W	70	Cruxati	Rock pool
3.40675° S 39.74111° W	44	Cruxati	Main channel
3.40438° S 39.73577° W	43	Cruxati	Stream
3.39431° S 39.73433° W	41	Cruxati	Main channel
3.37569° S 39.49455° W	34	Mundaú	Dam
3.61006° S 39.52488° W	145	Mundaú	Headwater stream
3.35383° S 39.73588° W	37	Cruxati	Pool on the main channel
3.34763° S 39.50277° W	23	Mundaú	Pool on the main channel
3.28102° S 39.64833° W	17	Cruxati	Pool on the main channel
3.24950° S 39.51011° W	6	Mundaú	Estuary
3.23722° S 39.50433° W	8	Mundaú	Estuary
3.21582° S 39.54688° W	10	Mundaú	Floodplain
3.20777° S 39.53649° W	9	Mundaú	Floodplain
3.20650° S 39.52169° W	8	Mundaú	Estuary
3.20456° S 39.53277° W	9	Cruxati	Dam
3.19706° S 39.53098° W	9	Mundaú	Estuary
3.19319° S 39.53528° W	8	Cruxati	Floodplain
3.19197° S 39.57933° W	13	Cruxati	Estuary
3.19114° S 39.56165° W	7	Mundaú	Pool on the main channel
3.18395° S 39.58353° W	21	Cruxati	Stream
3.18297° S 39.57402° W	14	Cruxati	Pond
3.17528° S 39.57939° W	33	Cruxati	Stream
3.16827° S 39.56391° W	29	Cruxati	Floodplains
3.16748° S 39.57683° W	26	Cruxati	Floodplains
3.49422° S 39.57544° W	102	Cruxati	Stream
3.20361° S 39.52817° W	7	Mundaú	Estuary

higher than the estuary. Due to river intermittence, dry season samples were taken only in remaining pools at the main watercourse, while wet season sampling covered locations in the main flow and marginal environments.

Fish were captured using seines (seine nets 20 x 2.5m, mesh size 10 mm and 4 x 2 m, mesh size 5 mm), castnets (2 m height, mesh size 15 mm), gillnets of various mesh sizes (15, 25, 35, 45 and 55 mm), and dip nets (mesh size 5 and 10 mm) and bottle traps. Fishes were anesthetized with 30 mL of a 10% clove oil solution (clove oil 10 mL; ethyl alcohol 90 mL) in 970 mL of water (Lucena et al. 2013), fixed in a 4% formaldehyde solution during a minimal eight-day period, and conserved in 70% ethanol solution. Fish surveys were conducted according to governmental laws (Permit n° 17632-2/ICMBio). Fishes were screened, identified, and deposited at the ichthyological collections of Universidade Federal do Rio Grande do Norte (UFRN) and Universidade Federal da Paraíba (UFPB). The fishes were identified to the lowest taxonomic level according to specialized sources, that is, group specific identification keys, systematic reviews, original descriptions (e.g. Araújo et al. 2004, Britski et al. 1984, Costa 2007, Marceniuk 2005, Kullander 1988, Ploeg 1991, Ramos 2012), and specialist support. Species classified as new occurrences were evaluated according to Reis et al. (2003), Rosa et al. (2003), and Buckup et al. (2007).

The nomenclature followed the recommendation by Eschmeyer (2015), and species habitat definition followed Fishbase (2014).

## Results

A total of 2,545 fish specimens were collected, belonging to 55 species, 50 genera, 31 families, and 10 orders (Table 2). Of those species, 30 (54.5%) are strictly freshwater, seven (12.7%) estuarine, and 14 (25.4%) marine (Table 2). *Astyanax* aff. *bimaculatus* (Linnaeus, 1758) was widely distributed, being present in 19 of 35 sampling sites. *Poecilia vivipara* Bloch & Schneider, 1801, *Awaous tajasica* (Lichtenstein, 1822), and *Dormitator maculatus* (Bloch, 1792) were the only species present in both fresh Bragança & Costa, 2011 and brackish waters. *Oreochromis niloticus* (Linnaeus, 1758) and *Poecilia reticulata* Peters, 1859 are exotic introduced species. *Poecilia sarrafae*, *Hemigrammus guyanensis* Géry, 1959, and *H. rodwayi* Durbin, 1909 are new occurrences for MNCE, and *Nannostomus beckfordi* Günther, 1872 and *Callichthys callichthys* (Linnaeus, 1758) are new records for Ceará State.

Among freshwater fishes, Characiformes was the most representative order in number of species (53.3%), while among marine and estuarine fishes it was Perciformes (80%). The orders Siluriformes and Cyprinodontiformes represent 10.9% and 9.1% of total species, with six and five species,

**Table 2.** List of fish species and information on physiology, habitat, abundance and voucher of the Mundaú river basin. Abbreviations: <sup>(E)</sup>Estuarine, <sup>(F)</sup> freshwater, <sup>(M)</sup> marine; <sup>(NR)</sup> new record for the MNCE; <sup>(CR)</sup> Critically endangered; <sup>(I)</sup> introduced; <sup>(\*)</sup> Photographed voucher.

ORDER/Family/Species	FISIOLOGY	MAIN CHANNEL	STREAM	FLOOD PLAIN	ROCK POOL	POND	DAM	TOTAL ABUNDANCE	VOUCHER
ELOPIFORMES (1)									
Elopidae (1)									
<i>Elops saurus</i> Linnaeus, 1766	M	6	0	0	0	0	0	6	UFRN 2612
CHARACIFORMES (16)									
Curimatidae (1)									
<i>Steindachnerina notonota</i> (Miranda Ribeiro, 1937)	F	122	22	20	0	8	25	197	UFRN 2642
Prochilodontidae (1)									
<i>Prochilodus brevis</i> Steindachner, 1875	F	42	8	0	5	15	29	99	UFRN 3530
Anostomidae (1)									
<i>Leporinus piau</i> Fowler, 1941	F	7	15	0	0	0	0	22	UFRN 1421
Erythrinidae (1)									
<i>Hoplias malabaricus</i> (Bloch, 1794)	F	14	4	2	0	3	4	27	UFRN 2582
Lebiasinidae (1)									
<i>Nannostomus beckfordi</i> Günther, 1872 <sup>(NR)</sup>	F	24	19	15	0	3	44	105	UFRN 2591
Characidae (10)									
<i>Astyanax</i> aff. <i>bimaculatus</i> (Linnaeus 1758)	F	204	36	4	23	8	24	299	UFRN 1420
<i>Astyanax</i> aff. <i>fasciatus</i> (Cuvier 1819)	F	114	15	0	0	20	0	149	UFRN 1432
<i>Cheirodon jaguaribensis</i> Fowler, 1941	F	5	0	0	0	0	0	5	UFRN 2523
<i>Compsura heterura</i> (Eigenmann, 1915)	F	101	12	11	0	8	0	132	UFRN 1430
<i>Hemigrammus guyanensis</i> Géry, 1959 <sup>(NR)</sup>	F	5	6	1	0	0	0	12	UFRN 2599
<i>Hemigrammus rodwayi</i> Durbin, 1909 <sup>(NR)</sup>	F	41	30	4	0	3	0	78	UFRN 2562
<i>Hyphessobrycon</i> sp.	F	0	32	0	0	0	4	36	UFRN 2602
<i>Phenacogaster calverti</i> (Fowler, 1941)	F	114	8	12	0	8	11	153	UFRN 2557
<i>Serrapinnus heterodon</i> (Eigenmann 1915)	F	187	39	11	12	17	22	288	UFRN 1431
<i>Serrapinnus piaba</i> (Lütken, 1875)	F	132	18	11	7	12	11	191	UFRN 1429
Crenuchidae (1)									
<i>Characidium bimaculatum</i> Fowler, 1941	F	10	5	0	0	0	0	15	UFRN 1439
SILURIFORMES (6)									
Ariidae (2)									
<i>Sciades herzbergii</i> (Bloch, 1794)	M	11	0	0	0	0	0	11	UFRN 3550
Auchenipteridae (1)									
<i>Trachelyopterus galeatus</i> (Linnaeus, 1766)	F	4	0	0	0	0	0	4	UFRN 3531
Callichthyidae (1)									
<i>Callichthys callichthys</i> (Linnaeus, 1758)	F	1	1	0	0	0	0	2	UFRN 2607
Loricariidae (2)									
<i>Hypostomus</i> cf. <i>pusarum</i> (Starks, 1913)	F	9	0	0	0	0	4	13	UFRN 2584
<i>Parotocinclus cearensis</i> Garavello, 1977	F	4	0	0	0	0	0	4	UFRN 1422

## Ichthyofauna of Mundaú River basin

Table 2. Continued...

ORDER/Family/Species	FISIOLOGY	MAIN CHANNEL	STREAM	FLOOD PLAIN	ROCK POOL	POND	DAM	TOTAL ABUNDANCE	VOUCHER
BATRACHOIDIFORMES (1)									
Batrachoididae (1)									
<i>Batrachoides surinamensis</i> (Bloch & Schneider, 1801)	M	1	0	0	0	0	0	1	UFRN 3545
MUGILIFORMES (1)									
Mugilidae (1)									
<i>Mugil curema</i> Valenciennes, 1836	M	24	0	0	0	0	0	24	UFRN 2611
CYPRINODONTIFORMES (5)									
Cynolebiidae (2)									
<i>Anablepsoides cearensis</i> (Costa & Vono, 2009) <sup>(CR)</sup>	F	0	9	20	0	0	0	29	UFRN 3046*
<i>Hypsoblebias</i> sp.	F	8	12	8	0	0	0	28	UFRN 1446
Poeciliidae (3)									
<i>Poecilia reticulata</i> Peters, 1859 <sup>(I)</sup>	F	36	31	0	0	0	0	67	UFRN 2581
<i>Poecilia sarrafae</i> Bragança & Costa, 2011 <sup>(NR)</sup>	F	0	20	26	0	0	0	46	UFRN 2574
<i>Poecilia vivipara</i> Bloch & Schneider, 1801	F	113	28	10	29	12	6	198	UFRN 1419
SYNBRANCHIFORMES (1)									
Synbranchidae (1)									
<i>Synbranchus marmoratus</i> Bloch, 1795	F	2	0	0	0	0	0	2	UFRN 3534
PERCIFORMES (20)									
Centropomidae (1)									
<i>Centropomus undecimalis</i> (Bloch, 1792)	M	5	0	0	0	0	0	5	UFRN 3546
Carangidae (2)									
<i>Hemicarax</i> sp.	M	4	0	0	0	0	0	4	UFRN 3541
<i>Oligoplites saurus</i> (Bloch & Schneider, 1801)	M	4	0	0	0	0	0	4	UFRN 3548
Lutjanidae (1)									
<i>Lutjanus</i> sp.	M	3	0	0	0	0	0	3	UFRN 3538
Gerreidae (3)									
<i>Eugerres brasiliensis</i> (Cuvier, 1830)	M	4	0	0	0	0	0	4	UFRN 3549
<i>Diapterus auratus</i> Ranzani, 1842	M	23	0	0	0	0	0	23	UFRN 3655
<i>Eucinostomus argenteus</i> Baird & Girard, 1855	M	8	0	0	0	0	0	8	UFRN 3654
Haemulidae (2)									
<i>Genyatremus luteus</i> (Bloch, 1970)	M	5	0	0	0	0	0	5	UFRN 3535
<i>Haemulopsis corvinaeformis</i> (Steindachner 1868)	M	8	0	0	0	0	0	8	UFRN 3542
Sparidae (1)									
<i>Archosargus probatocephalus</i> (Walbaum, 1792)	E	10	0	0	0	0	0	10	UFRN 4281
Sciaenidae (2)									
<i>Bairdiella ronchus</i> (Cuvier, 1830)	M	5	0	0	0	0	0	5	UFRN 3537
<i>Larimus breviceps</i> Cuvier, 1830	M	11	0	0	0	0	0	11	UFRN 3540
Ephippidae (1)									
<i>Chaetodipterus faber</i> (Broussonet, 1782)	M	15	0	0	0	0	0	15	UFRN 3547
Cichlidae (3)									
<i>Cichlasoma orientale</i> Kullander, 1983	F	41	8	5	0	6	8	68	UFRN 1426
<i>Crenicichla menezesi</i> Ploeg, 1991	F	11	12	0	0	0	6	29	UFRN 1442

Table 2. Continued...

ORDER/Family/Species	FISIOLOGY	MAIN CHANNEL	STREAM	FLOOD PLAIN	ROCK POOL	POND	DAM	TOTAL ABUNDANCE	VOUCHER
<i>Oreochromis niloticus</i> (Linnaeus, 1758) <sup>(1)</sup> Eleotridae (2)	F	23	3	0	0	8	12	46	UFRN 2588
<i>Dormitator maculatus</i> (Bloch, 1792)	E	6	0	5	0	0	0	11	UFRN 2613
<i>Eleotris pisonis</i> (Gmelin, 1789) Gobiidae (2)	E	13	0	0	0	0	0	13	UFRN 2577
<i>Awaous tajasica</i> (Lichtenstein, 1822)	F	2	0	0	0	0	0	2	UFPB 10028
<i>Gobionellus oceanicus</i> (Pallas, 1770) PLEURONCTIFORMES (3) Paralichthyidae (1)	M	3	0	0	0	0	0	3	UFRN 3415
<i>Citharichthys</i> sp. Achiridae (2)	E	4	0	0	0	0	0	4	UFRN 3553
<i>Achirus achirus</i> (Linnaeus, 1758)	E	3	0	0	0	0	0	3	UFRN 3552
<i>Trinectes paulistanus</i> (Miranda Ribeiro, 1915) TETRAODONTIFORMES (1) Tetraodontidae (2)	E	4	0	0	0	0	0	4	UFPB 10030
<i>Lagocephalus laevigatus</i> (Linnaeus, 1766)	M	4	0	0	0	0	0	4	UFRN 3544
<i>Sphoeroides testudineus</i> (Linnaeus, 1758)	E	10	0	0	0	0	0	10	UFRN 3543
<b>Total of species (n = 55)</b> <b>New record (n = 4)</b>		<b>1,570</b>	<b>393</b>	<b>165</b>	<b>76</b>	<b>131</b>	<b>210</b>	<b>2,545</b>	

respectively. The most diverse families were Characidae, with 10 species, representing 18.2% of total, followed by Cichlidae and Poeciliidae with three species each (5.5%) (Table 2). Of the five Cyprinodontiformes species listed, two belong to the family Cynolebiidae (*Anablepsoides cearensis* and *Hypsolebias* sp.). The non-annual killifish *A. cearensis* (Figure 2a and 2b) was the only threatened species in Mundaú river basin, listed as Critically Endangered (CR) in the Brazilian threatened fauna Red List (ICMBio 2014, Brasil 2014). This species was collected in two oxbow lakes (Figure 2d and 2e) and in a shallow perennial stream, located in an Arbustive Caatinga forest fragment (Figure 2 c), with similar features to the described type locality of the species (Costa & Vono 2009).

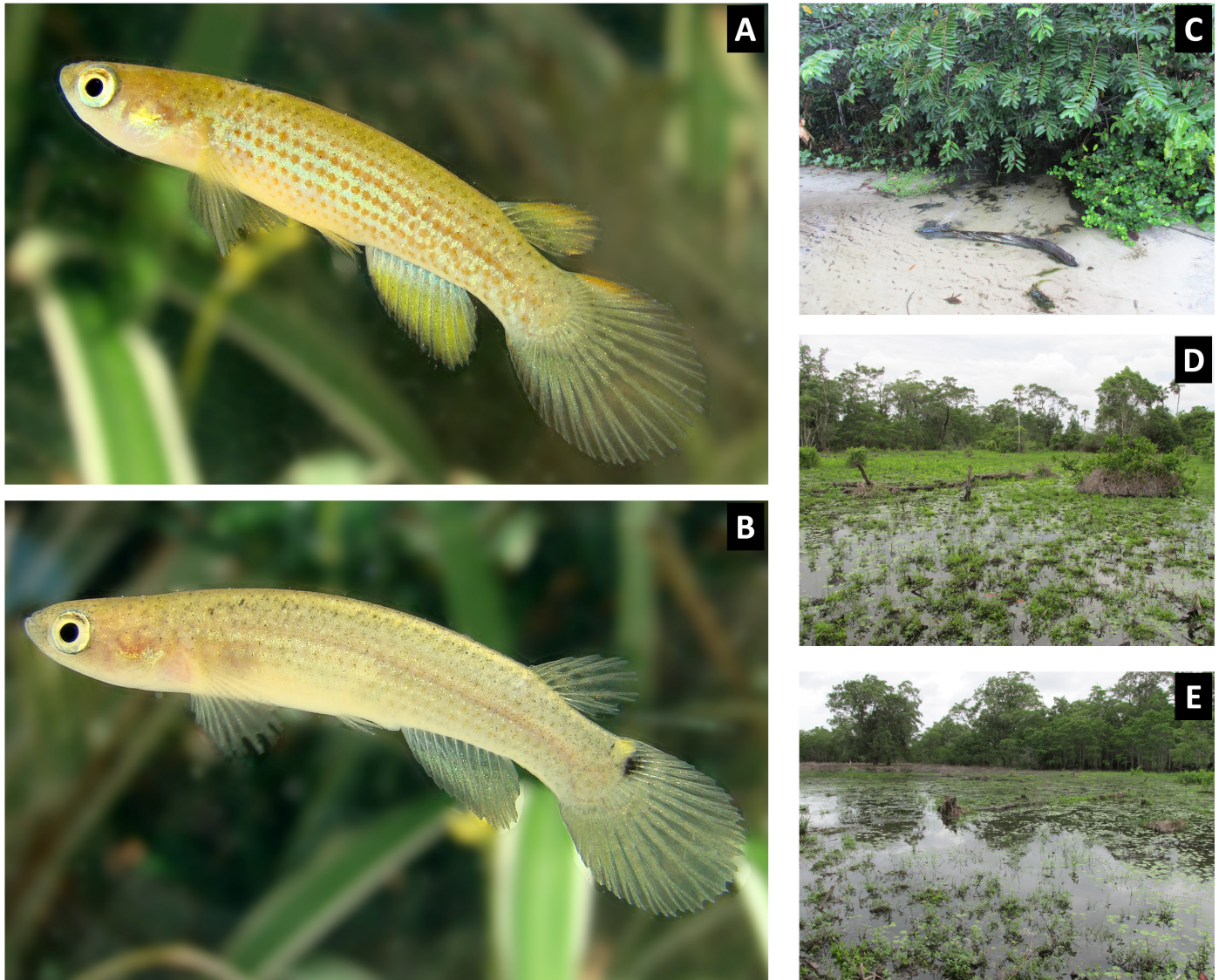
## Discussion

The predominance of the orders Characiformes and Siluriformes in the freshwater ichthyofauna of Mundaú river basin follows the pattern found among freshwater fishes in Brazilian Northeast (Ramos et al. 2005, Nascimento et al. 2014, Ramos et al. 2014, Silva et al. 2014), in Brazil (Buckup et al. 2007), and in Neotropical region (Reis et al. 2003, Lévêque et al. 2008). However, when estuarine and marine species are also considered, the order Perciformes is the most abundant, corroborating with other MNCE species listings (Soares-Filho et al. 2010, Paiva et al. 2014).

*Astynax* aff. *bimaculatus* was recorded in 54% of sampling sites, being the most abundant species. It belongs to the *Astynax bimaculatus* group composed by 22 valid species distributed along almost all drainages in South America, representing one of the most abundant morphotypes (Lucena & Soares 2016). Together with *Poecilia vivipara*, *Serrapinus heterodon*, *S. piaba*, and *Steindachnerina notonota*, they represented the most common species and could exhibit small sized body, generalist ecophysiological habits, and partitioned or all year reproduction. These

features, likewise others related to anthropic disturbances, such hypoxia and eutrophic habitats, are usually present in the most frequent and abundant species in freshwater community studies in MNCE (Sánchez-Botero et al. 2014, Silva et al. 2014). However, most of the species were restricted to a few habitats, reflecting narrow ecological conditions for their occurrence. The estuarine-marine fishes were mainly juveniles of species previously recorded in Mundaú Estuary, including some important ones for artisanal fisheries (Soares-Filho et al. 2010). Of the 25 non-freshwater species registered in the basin in our study, six are not mentioned in Soares-Filho et al. (2010): *Citharichthys* sp., *Hemicaranx* sp., *Genyatremus luteus*, *Haemulopsis corvinaeformis*, *Larimus breviceps*, and *Sciades herzbergii*. The same authors also observed the goliath grouper *Epinephelus itajara* (Lichtenstein, 1822) at Mundaú Estuary, a critically endangered marine species (Brasil 2014).

The occurrence of cynolebiids at temporary pools in the main channel and floodplains in the medium and lower ranges of Mundaú river basin may reinforce the biological importance of this drainage as a priority area for Caatinga conservation, as suggested by Brasil (2007) and in the recent reevaluation (Brasil 2016). *Anablepsoides cearensis* was only known from the type locality, a shallow stream in São Gonçalo do Amarante, Ceará (Costa & Vono 2009). Thus, its distribution record was increased about 77 km west, to the lower portion of Mundaú river, in Itapipoca. Morphological differences between *Hypsolebias* sp. and its Caatinga congeners (Costa 2007) suggests that it may be a new species. The only species of the genus described for MNCE are: *H. antenori* (Tulipano, 1973), which occurs at the coastal basins east of Mundaú drainage, between Messejana municipality, in Ceará State, and Areia Branca municipality, in Rio Grande do Norte State (Costa 2007); *H. longignatus* Costa 2008 from Pacoti river basin, in Aquiraz municipality (Costa 2008), and *H. martinsi* from Icaraizinho river, in Amontada municipality (Britzke et al. 2016),



**Figure 2.** *Anablepsoides cearensis*, a critically endangered freshwater fish species collected in permanent pools in the lower portion of the Mundaú river basin. A = male, B = female, C, D, E = sampling sites.

both from small basins in Ceará State. Geographically, our record of *Hypsolebias* sp. is between the type locality of *H. longignatus* and *H. martinsi*, being the former eastern from Mundaú river basin and distant 140 km, while the latter is on the northwest and closer, about 25 km in the adjacent Aracatiaçu river basin. However, *Hypsolebias* sp. seems to belong to the *H. antenori* group, and thus very distinct from *H. longignatus*, which belongs to the *H. flammeus* group. The species collected in Mundaú river basin differs from *H. martinsi* by the presence of vertical bars in body, and from *H. antenori* by the virtual absence of round blotches on caudal peduncle. Additional morphological and molecular studies should be done in order to determine its specific status. This record emphasizes the classification of MNCE as a freshwater ecoregion with a high percentage of endemic species (Albert et al. 2011).

Among the species labeled as new occurrences for MNCE, *P. sarrafae* was considered as endemic to Parnaíba river basin (Bragança & Costa 2011, Ramos et al. 2014), and this is the first record outside Maranhão-Piauí ecoregion. *Hemigrammus guyanensis* was putatively endemic to Guiana

Shield, while *H. rodwayi* and *Nannostomus beckfordi* are considered as native from Amazon-Orinoco-Guianas Core (Albert et al. 2011) occurring in the Guiana, Suriname, French Guiana, and Northern Brazil (Reis et al. 2003, Buckup et al. 2007). *H. rodwayi* is also found in several MNCE coastal rivers: Mamanguape (UFPB 5685) and Abiaí (UFPB 9384) river basins, in Paraíba State, and Doce (UFRN 2483) and Jundiá drainages (UFRN 2595), in Rio Grande do Norte State (unpublished data). The occurrence of those Amazonian species in Brazilian Northeast might be an indicative of a past connection between the Atlantic and Amazon forests in more humid periods (Wang et al. 2004).

Menezes et al. (2007) reported that *Nannostomus beckfordi*, recorded from Bahia and Alagoas states, was introduced in the Brazilian Northeast due to aquarism. However, the presence of this species in Mundaú river basin in Ceará State is the northern and westernmost record in MNCE, and it could be a relictual distribution and another evidence of the preterit connection between the Neotropical forested biomes. Currently, *N. beckfordi* is considered a poorly defined species complex, which needs a taxonomic

review (Benzaquem et al. 2015). The native or introduced status of this taxon needs to be addressed once endemic undescribed species could be unprotected.

The introduction of *Poecilia reticulata* in Brazilian Northeast rivers can also be a result of aquarism. However, this species has been introduced in several countries for mosquito larvae control, such as *Aedes aegypti* (Lindholm et al. 2005). Meanwhile, larger species, such as tilapia *Oreochromis niloticus*, were introduced to fish farming in the reservoirs of the northeastern Brazil by the Departamento Nacional de Obras Contra Seca (DNOCS) in the 1970 (Paiva & Mesquita 2013). In addition to competing for resources with native species, tilapias are quite resistant, easily surviving in disturbed environments (Leão et al. 2011).

A total of 55 species were found in Mundaú river basin, of which only two are introduced. The high species richness, together with new records for MNCE, which includes two cynolebiids, one of them a critically endangered species (*Anablepsoides cearensis*), highlights the importance of preserving this basin, mainly the lowland stretches. However, some anthropic impacts were observed along Mundaú river basin waterbodies, mainly associated to riparian forest removal for agriculture and cattle raising in many stretches of the rivers and streams sampled; river sand extraction; damming; irregular occupation of river margins by human habitation; and domestic sewage discharge. The ichthyological survey of Mundaú river basin contributes to the knowledge of Caatinga fish fauna, and corroborates its importance as a priority area for the conservation of aquatic biota of this semiarid region.

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