A new, narrowly distributed, and critically endangered species of *Characidium* (Characiformes: Crenuchidae) from the Distrito Federal, Central Brazil

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A new species of *Characidium* is described from the Cerrado biome, in Brasília, Distrito Federal, Central Brazil. The new species can be readily diagnosed by the presence of two or three longitudinal rows of dots along the body sides, absence of bars, by the short pectoral fin, which does not reach the vertical through the dorsal fin origin. Additional useful diagnostic characters are the scaled isthmus, absence of the adipose fin, and the terminal mouth. The new species is only known from the córrego Taquara and its tributaries, a tributary of ribeirão do Gama, upstream from lago Paranoá, in the upper rio Paraná basin. In accordance to the IUCN Red List Categories and Criteria, the new species is categorized as Critically Endangered.

Keywords: Endangered species, IUCN, Lago Paranoá, Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística, Rio Paraná basin.

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INTRODUCTION

Characidium Reinhardt, 1867 is a genus of Neotropical fishes currently including 79 valid species, distributed between Panamá and northern Argentina (Agudelo-Zamora et al., 2020a,b; Flausino Junior et al., 2020; Fricke et al., 2020; Zanata et al., 2020a; Zanata, Ohara, 2020; Teixeira, Melo, 2021). The genus is considered to be monophyletic based on a single synapomorphy, the presence of a basicaudal spot, which is not present in all species (Buckup, 1993a).

The Brazilian Cerrado has high endemism of freshwater fishes because this biome contains the watersheds of some of the major South-American hydrological basins (Nogueira et al., 2010; Reis et al., 2016). In the past 20 years, the taxonomic knowledge regarding the diversity of Characidium in the Brazilian Cerrado has received increased attention, resulting in descriptions of eight species: C. barbosai Flausino Junior, Lima, Machado & Melo, 2020, endemic to the tributaries of the upper rio Guaporé, Serra da Borda; C. cacah Zanata, Ribeiro, Araújo-Porto, Pessali & Oliveira-Silva, 2020, from the rio das Velhas, rio São Francisco basin; C. mirim Netto-Ferreira, Birindelli & Buckup, 2013, endemic to tributaries of the upper rio das Mortes, rio Tocantins basin, Chapada dos Guimarães; C. nupelia da Graça, Pavanelli & Buckup, 2008, from the rio Cuiabá upstream from the Pantanal Matogrossense, rio Paraguay basin; C. satoi Melo & Oyakawa, 2015, from rio Curral das Éguas, rio São Francisco basin; C. stignosum Melo & Buckup, 2002, from rio Paraná, rio Tocantins basin Chapada dos Veadeiros; C. xanhoeterum Silveira, Langeani, da Graça, Pavanelli & Buckup, 2008, widespread in the upper rio Paraná and upper rio Tocantins basins; and C. xavante da Graça, Pavanelli & Buckup, 2008, from rio Culuene, upper rio Xingu, Amazon basin (Melo, Buckup, 2002; Da Graça et al., 2008; Netto-Ferreira et al., 2013; Melo, Oyakawa, 2015; Mendonça, Netto-Ferreira, 2015; Flausino Junior et al., 2020; Zanata et al., 2020b).

A new Characidium species is herein described from Brasília, Distrito Federal, based on specimens collected in the córrego Taquara and its tributaries, in the headwaters of the ribeirão do Gama, upstream from the lago Paranoá, rio São Bartolomeu drainage, in the upper rio Paraná basin. Most specimens used for the present description were...
collected at the Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística (RECOR). In addition, the conservation status of the species is also discussed.

**MATERIAL AND METHODS**

Morphometric and meristic data were obtained from the left side of specimens, under a binocular stereomicroscope, according to Buckup (1993b), with modifications proposed by Melo, Oyakawa (2015). Measurements were taken using a digital caliper to 0.1 mm. Meristic data are given along the description, followed by the frequencies of each count in parentheses, and an asterisk (*) indicating the values for the holotype. Terminology for pigmentation of body follows Leitão, Buckup (2014) and Flausino Junior et al. (2020). Osteological features were observed in cleared-and-stained specimens (cs), prepared according to Taylor, Van Dyke (1985). Osteological nomenclature follows Weitzman (1962) and Vari, Harold (2001), with the addition of posterior cleithral process. The vertebral counts included the four anterior-most elements modified into the Weberian Apparatus counted individually and the compound element of caudal fin was counted as a single element. Supernumerary elements in dorsal and anal fins were counted only from cleared and stained individuals. Osteological illustrations were made on a Zeiss Discovery V12 stereomicroscope connected to a camera with auto-montage mechanism.

The gonads examined macroscopically through a small incision made in the flank, and sex and stage of gonadal development were evaluated according to Vazzoler (1996).

General abbreviations are as follows: SL, Standard Length; HL, Head Length; cs, cleared and stained. Acronyms for fish collections are as follows: MNRJ, Museu Nacional, Rio de Janeiro; MZUSP, Museu de Zoologia da Universidade de São Paulo; ZUEC, Museu de Zoologia da Universidade de Campinas; IBGE, Reserva Ecológica do Instituto Brasileiro de Geografía e Estatística fish collection. Abbreviations of main areas of conservation are as follows: EEJBB – Estação Ecológica Jardim Botânico de Brasília; FAL–UNB, Estação Experimental Fazenda Águas Limpas da Universidade de Brasília; EEC–UNB, Estação Ecológica da Universidade de Brasília; RECOR – Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística. Only specimens in good conditions were selected as types. Maps presented in figure 4 were produced using Quantum GIS (QGIS.org, 2020), with the QuickMapServices plugin. Maps presented in Figure 5 were produced using Google Earth Pro (Google, 2020), with the aid of the timeline function. The extent of occurrence was calculated with the aid of Google Earth Pro (Google, 2020), drawing the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence (IUCN Standards and Petitions Subcommittee, 2019). A regression analysis was performed using the computer program Microsoft Excel (MICROSOFT, 2020), comparing the standard length with the ratio between standard length and body depth at dorsal-fin origin.
RESULTS

**Characidium onca**, new species

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(Figs. 1–5; Tab. 1)

**Holotype.** MZUSP 125807, 40.1 mm SL, Brazil, Distrito Federal, Brasília, córrego Taquara at Reserva Ecológica do IBGE, tributary of ribeirão Gama, tributary of Lago Paranoá, tributary of the left bank of rio São Bartolomeu, upper rio Paraná basin, 15°54'55.04"S 47°54'23.87"W, 14 Nov 2016, M. R. S. Melo & M. C. L. B. Ribeiro.

![Image of Characidium onca](https://example.com/image1)

**FIGURE 1** | *Characidium onca*, holotype, MZUSP 125807, 40.1 mm SL, male. **A.** Specimen in lateral view soon after collection; **B–D.** Preserved specimen in lateral dorsal, ventral views.
Paratypes. All from Brazil, Brasilia, Distrito Federal, rio Taquara, tributary of ribeirão do Gama, tributary of Lago Paranoá, tributary of right bank of rio São Bartolomeu. MNRJ 52124, 2, 27.1–28.4 mm SL, córrego Taquara, 15°56′29″S 47°53′52″W, 19 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125795 (ex–IBGE 1175), 4, 28.6–30.6 mm SL, córrego Roncador, 15°56′08″S 47°53′18″W, 26 Mar 1990, M. C. L. B. Ribeiro; MZUSP 125796 (ex–IBGE1180), 3, 28.3–34.6 mm SL, córrego Taquara, 27 Mar 1990, M. C. L. B. Ribeiro; MZUSP 125797, 2, 39.0–44.1 mm SL, córrego Roncador, Reserva Ecológica do IBGE, 15°56′23″S 47°54′13″W, 10 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125799, 1, 30.4 mm SL, córrego da Onça, 15°56′25″S 47°54′05″W, 18 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125800, 4, 23.2–25.7 mm SL, córrego Taquara, 15°55′09″S 47°54′13″W, 19 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125801, 3 (1 cs), 28.8–32.8 mm SL, córrego Taquara, 15°54′36″S 47°54′30″W, 20 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125802, 1, 30.6 mm SL, córrego Taquara, 15°54′32″S 47°54′45″W, 20 Oct 2005, M. C. L. B. Ribeiro; MZUSP 125803, 8 (2 cs), 28.4–41.3 mm SL, córrego Roncador, 24 Oct 2009, M. C. L. B. Ribeiro; MZUSP 125804, 1, 36.7 mm SL, córrego Roncador at Ponte do Corujão, 15°56′07″S 47°53′29″W, 23 Sep 2009, M. C. L. B. Ribeiro; MZUSP 125808, 1, 35.4 mm SL, collected with holotype; ZUEC 17241, 4, 27.0–34.7 mm SL, collected with MZUSP 125803; ZUEC 17242, 2, 38.7–40.1 mm SL, collected with MZUSP 125797; ZUEC 17243, 3, 23.5–26.8 mm SL, collected with MZUSP 125800; ZUEC 17244, 1, 31.2 mm SL, collected with MZUSP 125801.

Non-types. All from Brazil, Brasília, Distrito Federal, upper rio Paraná basin, rio Taquara drainage. IBGE 1022, 2, 31.9–36.6 mm SL, córrego Roncador; IBGE 1023, 1, 20.4 mm SL, collected with IBGE 1022; IBGE 1070, 1, 24.2 mm SL, córrego Taquara; IBGE 1089, 1, 25.4 mm SL, córrego Onça; IBGE 12, 1, 39.8 mm SL, córrego Roncador; IBGE 152, 1, 23.5 mm SL, córrego Taquara; IBGE 170, 1, 31.1 mm SL, córrego Taquara; IBGE 899, 1, 28.3 mm SL, córrego Taquara; IBGE 934, 1, 35.9 mm SL, córrego da Onça; IBGE 988, 1, 22.5 mm SL, córrego Tapera; IBGE 1729, 1, 35.4 mm SL, córrego Taquara.

Diagnosis. Characidium onca can be distinguished from its congeners except C. chancoense Agudelo-Zamora, Ortega-Lara & Taphorn, 2020, C. japuhybense Travassos, 1949, C. lauroi Travassos, 1949, C. oiticicai Travassos, 1967, C. pellucidum Eigenmann, 1909, C. phoxocephalum Eigenmann, 1912, C. pteroides Eigenmann, 1909, C. schubarti Travassos, 1955, C. stigmosum, and C. travassosi Melo, Buckup & Oyakawa, 2016 by small dots on the side of body present (vs. spots absent), and from these exceptions by the dots arranged in two or three well-marked, longitudinal lines (vs. dots irregularly distributed); and by the pectoral fin short, not reaching the vertical that passes through the origin of the dorsal fin (vs. tip of pectoral fin reaching or extending posterior to the vertical that passes through the origin of dorsal fin). It further differs from C. chancoense, C. japuhybense, C. lauroi, C. helmeri, C. pellucidum, C. phoxocephalum, C. pteroides, and C. schubarti by the adipose fin absent (vs. adipose fin present); from C. stigmosum, C. japuhybense, C. longum, and C. pteroides by the bars absent (vs. bars present); from C.
japuhybense, C. lauroi, C. helmeri, C. oiticicai, C. schubarti, and C. travassosi by the isthmus scaled (vs. isthmus scaleless); and from C. pellucidum and C. pteroides by the blotches on dorsum absent (vs. sickle-shaped, reddish-brown blotches present, formed by the fragmentation of vertical bars on sides of body present), and longitudinal stripe present (vs. absent).

Description. Morphometric data summarized in Tab. 1. Largest examined specimen 40.1 mm SL. Body elongate. Dorsal profile moderately convex between snout tip and dorsal-fin base, gently convex between dorsal and caudal-fin. Ventral profile gently convex between dentary tip and anal-fin origin, slightly convex at anal-fin base; almost straight between anal and caudal-fin bases. Belly strongly accentuated arched in females with well-developed ovarium. Greatest depth of body at dorsal-fin origin.

Snout in lateral view triangular and short, its tip at level of center of eye. Mouth

| Characters                        | Holotype | N  | Range       | Mean | SD  |
|-----------------------------------|----------|----|-------------|------|-----|
| Total length (mm)                 | 49.0     | 24 | 28.3–52.2   | 39.5 | –   |
| Standard length (mm)              | 40.1     | 18 | 23.3–44.1   | 31.5 | –   |
| **Percentage of standard length** |          |    |             |      |     |
| Head length                       | 22.7     | 24 | 21.3–25.8   | 23.7 | 1.2 |
| Prepectoral distance              | 21.5     | 24 | 20.5–26.3   | 23.5 | 1.7 |
| Pectoral-fin height               | 17.4     | 24 | 14.8–20.1   | 18.3 | 1.3 |
| Predorsal distance                | 52.0     | 24 | 48.7–53.6   | 50.6 | 1.4 |
| Dorsal-fin height                 | 14.6     | 23 | 14.6–20.7   | 16.6 | 1.5 |
| Dorsal-fin base                   | 14.5     | 24 | 13.7–16.0   | 14.8 | 0.5 |
| Prepelvic distance                | 55.2     | 24 | 50.1–58.8   | 53.3 | 2.3 |
| Pelvic-fin height                 | 10.9     | 24 | 10.9–16.5   | 12.8 | 1.1 |
| Preanal distance                  | 77.7     | 24 | 71.2–78.9   | 74.9 | 2.0 |
| Anal-apex distance                | 94.8     | 24 | 89.8–96.8   | 92.8 | 1.4 |
| Anus to anal-fin distance         | 5.3      | 24 | 3.0–6.8     | 5.2  | 1.0 |
| Anal-fin height                   | 13.1     | 24 | 13.1–17.0   | 14.7 | 0.9 |
| Anal-fin base                     | 9.1      | 24 | 5.7–9.6     | 7.9  | 1.0 |
| Peduncle length                   | 19.5     | 24 | 15.6–21.3   | 18.9 | 1.4 |
| Body width                        | 11.6     | 24 | 8.9–13.4    | 10.7 | 1.2 |
| Body depth at dorsal-fin origin   | 28.9     | 24 | 21.8–29.6   | 25.0 | 2.0 |
| Body depth at anal-fin origin     | 19.1     | 24 | 14.2–19.1   | 16.7 | 1.2 |
| Body depth at caudal peduncle     | 13.2     | 24 | 10.6–14.0   | 12.5 | 0.8 |
| **Percentage of head length**     |          |    |             |      |     |
| Snout length                      | 20.0     | 24 | 17.3–22.2   | 19.3 | 1.1 |
| Snout-maxillary tip               | 27.4     | 24 | 25.0–31.1   | 28.0 | 1.5 |
| Anterior naris-orbit              | 8.3      | 24 | 5.7–9.4     | 8.0  | 0.8 |
| Posterior naris-orbit             | 4.1      | 24 | 3.0–5.3     | 4.0  | 0.6 |
| Cheek                             | 8.8      | 24 | 6.7–9.7     | 8.6  | 0.8 |
| Orbital diameter                  | 25.2     | 24 | 25.2–31.4   | 28.0 | 1.8 |
| Interorbital diameter             | 18.8     | 24 | 12.0–19.8   | 14.8 | 2.2 |
small, terminal. Snout-maxillary tip about equal to diameter of orbit; tip of maxilla reaching level of anterior margin of orbit. Orbit nearly rounded, margin of orbit free. Cheek narrow, its depth less than one third of eye diameter. Nares distinctly separated, distance between nares shorter than distance between posterior naris and eye. Dermal flap along posterior border of anterior naris, and to anterior margin of posterior naris.

Premaxillary teeth arranged in single row, with 5(2), 6*(14), 7(7), or 8(1) unicuspid teeth, increasing in size from lateral to medial (Fig. 3A). Maxillary teeth absent (Fig. 3A). Dentary teeth arranged in two rows; outer row with 7(1), 6(3), 9*(16), 10(3), or 11(1) teeth, increasing in size from lateral to medial, medial teeth tricuspid with lateral cusps reduced, lateral teeth unicuspid, medial teeth larger and tricuspid; inner row with 9(1 cs), or 14(2 cs) teeth, minute and conical (Fig. 3B). Ectopterygoid teeth arranged in single row, with 6(1 cs), or 7(2 cs) teeth, minute and conical. Mesopterygoid teeth absent. Branchiostegal rays 5(3 cs); four attached to anterior ceratohyal (3 cs), one
attached to posterior ceratohyal (3 cs). Total gill rakers on first arch 12(2); gill rakers attached to epibranchial 4(1), or 5(2); gill rakers attached to ceratobranchial 6(1), or 7(2); gill rakers attached to basibranchial 2(3).

Scales cycloid; parallel radii present on posterior field of scale, circuli on exposed field absent. Lateral line complete, with 33(4), 34*(10), 35(8), 36(1) perforated scales. Scales above lateral line 4.5*(24). Scales below lateral line 4*(24). Circumpeduncular scales 14*(24). Pre-dorsal scales series regularly arranged; scales on pre-dorsal series 11(4), 12(14), or 13*(8). Scales between anus and anal fin 2(9) or 3(15). Isthmus scaled.

Pectoral fin short, not reaching vertical that pass through dorsal-fin origin; origin of dorsal fin at level slightly anterior to pelvic-fin origin; pectoral-fin rays iii,4,iii(1), iii,5,ii*(7), iii,6,i(7), iii,6,ii(8), or iii,6,iii(1). Pelvic fin short, not reaching anus; pelvic-fin rays ii,4,i(1), i,6,ii*(21), ii,6,ii(1), or i,7,i(1). Dorsal-fin rays iii,8(3), ii,9*(18), iii,9(1), or i,10(2); supranumerary element on first pterygiophore of dorsal fin 1(3 cs); last dorsal-fin ray not adnate (3 cs). Anal fin not reaching ventralmost caudal-fin ray; anal-fin rays ii,6*(24); supranumerary element on first pterygiophore of anal fin 1(3 cs); last anal-fin ray not adnate (3 cs). Principal caudal-fin rays i,8,9,*i(24); lower procurrent rays 7(2 cs), or 9(1 cs); upper procurrent rays 7(1 cs) or 8(2 cs). Adipose fin absent (24).

Precordial vertebrae 20(1 cs), or 21(2 cs); total vertebrae 35(1 cs), or 36(2 cs). Supraneurals 5(1 cs), or 7(2 cs). Postcleithrum 1 rudimentary (1) or absent (2); postcleithrum 2 and 3 present and well developed (3) (Fig. 3C). Epurals 3(3 cs); hypurals 4(1 cs) or 6(2 cs). Parietal branch of supraorbital laterosensory canal present (3 cs), elongate, reaching the parietal bone. Epiphysial branch of the supraorbital laterosensory canal present. Fontanel limited antero-laterally by parietals and posteriorly by supraoccipital (2 cs) (Fig. 3D), or extending anteriorly and contacting frontals (1 cs) (Fig. 3E). Posterior chamber of swim bladder larger than anterior chamber, 21.9–35.3% in SL (3 cs).

Pseudotympanum immediately posterior to supracleithrum, underneath anterior part of longitudinal stripe, antero-dorsally elongate, limited dorsally by lateralis superficialis, anteriorly and posteriorly, by obliquus inferioris, and ventrally by obliquus superioris; lined dorsally by lateral-line nerve. Humeral hiatus divided into anterior and posterior chambers by pleural rib of fifth. Fatty tissue filling humeral hiatus absent (Fig. 4).

**Coloration in alcohol.** Ground color of head and trunk light yellow, darker on dorsum, lighter on belly (Figs. 1–2). Cheek, distal portion of upper jaw, ventral part of head and opercle pale with widely spaced melanophores. Dorsal portion of snout and head light brown. Oblique preorbital stripe extending from snout tip to anterior portion of eye present and conspicuous. Postorbital stripe present, conspicuous. Bars on body absent. Three thin stripes present on dorsal part of body; dorsal stripe extending from head to dorsal-fin base; middle bar extending from head to caudal peduncle; and ventral bar extending from head to base do dorsa-caudal fin ray. Midlateral stripe, stout, extending from supracleithrum to caudal peduncle, not reaching base of middle caudal-fin rays. Humeral blotch absent. Basicaudal spot inconspicuous, vertically elongated. Dots arranged in two or three longitudinal rows; dorsal row of dots extending from level of cleithrum to caudal peduncle, slightly dorsal to, or overlapped by, midlateral stripe; middle and ventral rows of dots extending from posterior angle of opercle to caudal peduncle, ventrally to lateral line. Pectoral, pelvic, dorsal, anal and caudal fins mostly hyaline, or caudal and pectoral fins dusky; melanophores present only on lepidotrichia.
Coloration in life. Overall color pattern same as preserved. Ground color yellow to brownish with dorsum darker and belly whitish, with gold tint on opercle, eye and parts of head. A longitudinal, gold stripe present, extending along body immediately dorsal to longitudinal stripe.

**FIGURE 3** Osteological characteristics in *Characidium onca*, paratypes: **A.** Right upper jaw in medial view (MZUSP 125803); **B.** Right dentary in medial view (MZUSP 125803); **C.** Left pectoral gridle in lateral view (MZUSP 125801); **D.** Skull in dorsal view (MZUSP 125803); **E.** Posterior portion of skull in dorsal view (MZUSP 125803). Abbreviations: ANT, antorbital; CLE, cleithrum; COR, coracoid; DEN, dentary; dentl, lateral row of dentary teeth; dentm, middle row of dentary teeth; dentr, replacement lateral row of dentary teeth; DPSO, dorsal process of the supraoccipital; ESC, extrascapular; FR, frontal; fbsc, frontal branch of the supraorbital canal; fo, fontanel; IO 1–6, infraorbitals 1 to 6; MCO, mesocoracoid; MEC, Meckel's cartilage; METH, mesethmoid; MX, maxilla; NA, nasal; PAR, parietal; pbsc, parietal branch of the supraorbital canal; PCP, posterior cleithral process; PCL 1–3, postcleithrum 1 to 3; PMX, premaxilla; pmxt, premaxillary teeth; pmxtr, replacement premaxillary teeth; POST, posttemporal; PTE, pterotic; SC, scapula; SCL, supracleithrum; SUO, supraorbital. Scale bar = 1 mm.
Sexual dimorphism. A total of 22 specimens had the sex and gonadal development stage evaluated, including eight immature females (23.3–27.2 mm SL), seven mature females (31.1–44.1 mm SL), and seven males (26.7–40.1 mm SL). The body depth at origin of dorsal fin has a statistically significant, positive growth in both females and males, varying from 22.2 to 27.0% in SL (mean 24.3%) in immature females; from 26.5 to 29.6% in SL (mean 27.3%) in mature females; and from 21.8 to 25.5% in SL (mean 23.4%) in mature males (Fig. 5). The mature females with fully developed eggs have a largely expanded belly, resulting in a considerable deeper body and high standard deviation for the body depth at origin of dorsal (Tab. 1). Further secondary sexual dimorphic characters, such as differences in the color pattern or the lepidotrichia bony process, are absent.

Geographical distribution. Characidium onca is only known from córrego Taquara and its tributaries, itself being a tributary of the ribeirão do Gama which nowadays drains into the lago Paranoá, a tributary of the right margin of the rio São Bartolomeu, tributary of the left margin of rio the Corumbá, rio Paranaíba drainage, in the upper rio Paraná basin, Distrito Federal, Brazil (Fig. 6).

Etymology. The specific name onca refers to the Portuguese name onça, used for the jaguar Panthera onca (Linnaeus) (Mammalia: Felidae), in an allusion to the black spots in a bright gold-yellow body. It is derived from the Latin lynx, meaning lynx (Italian “lonza”, old French “l’once”), and should be pronounced as 'ō.se. A noun in apposition.

FIGURE 4 | Pseudotympanum in Characidium onca (MZUSP 125801, paratype). Abbreviations: 5th pl, pleural rib of fifth vertebra; a, anterior window of pseudotympanum; lln, lateral line nerve; ls, lateralis superficialis; oi, obliquus inferioris; os, obliquus superioris; p, posterior window of pseudotympanum. Scale bar = 1 mm.
Conservation status. *Characidium onca* is known only from córrego Taquara and its tributaries, which have about 6.5 km of extension. Since the 1980’s, the second author (MCLBR) has been sampling the drainages in the Distrito Federal and surroundings building a collection of over 1,000 lots of *Characidium* hosted mainly at the IBGE–RECOR, MZUSP and ZUEC fish collections, but *C. onca* was never found in any other drainages. Additional ichthyofaunistic inventories conducted in the Distrito Federal also did not report the presence of *C. onca* elsewhere, supporting the evidence that it truly has a narrow distribution (Ribeiro et al., 2001, 2008; Aquino et al., 2009; Ribeiro, 2012). The extent of occurrence of *C. onca* is calculated in 15 km² and considered a single location. Additionally, the species is naturally rare and have extremely low abundance in nature (MRSM and MCLBR, pers. obs.).
Since the construction of Brasilia in 1960’s, the impacts on the ribeirão do Gama drainage are gradually increasing (Figs. 7A–D). The lago Paranoá is an artificial lake formed by damming the rio Paranoá in 1959, to provide water supply, electric power and to increase the air humidity in Brasilia. The Lago Paranoá extends to the lower part of the ribeirão do Gama, slightly downstream (>8 km) from the collection sites of C. onca, resulting on habitat loss by changing the original characteristics of a lotic into a lentic system, and by the destruction of the original riparian vegetation. The formation of the lake was followed by the introduction of several exotic species, such as the Congo tilapia Coptodon rendalli (Boulenger, 1897), the largemouth bass (known in Brazil as black bass) Micropterus salmoides (Lacepède, 1802), the bluegill Lepomis macrochirus Rafinesque, 1819 and the carp Cyprinus carpio Linnaeus, 1758 (Ribeiro et al., 2001).

The construction of Brasilia also resulted in dynamic land use and vegetation coverage changes, with the replacement of natural areas of open fields (campo nativo) and Cerrado vegetation for agriculture and urban uses (Figs. 7A–D). Over the last two decades, the population in the Distrito Federal increased in more than 70%, from 1,737,813 in 1995 to 2,977,216, in 2016 (UNESCO, 2002). The rapid urbanization has replaced large areas of the natural Cerrado ecosystem with urban areas and agriculture land for cultivating soybean, corn, and bean. The intense use of surface and underground hydrological resources for such purposes caused water depletion and local climate changes of longer dry seasons and a predicted increase of temperature by up to 5° C (Campos, 2004; Cadamuro, Campos, 2005; Lorz et al., 2012; IBGE, 2017). The most severe consequences of those impacts are loss of ecological integrity of both terrestrial and aquatic ecosystems, such as the reduction of water level in lakes, rivers and floodplains, the deterioration of water quality, changes in the fire regimes, loss of gallery forests, and the increase of river channel sedimentation that reduces habitats conditions for the species of Characidium (Alley et al., 1999; Ribeiro et al., 2018).

The distribution of C. onca is within the Area de Proteção Ambiental (APA) das Bacias do Gama e Cabeça de Veado, created by the Decreto Distrital Nº 9.471, of April 21st, 1986 and protected by both district (Reserva da Biosfera do Cerrado, Lei Distrital Nº 742, of July 28th, 1994) and federal laws (ARIE dos córregos Capetinha e Taquara, Decreto Federal Nº 91.303, of June 3rd, 1985; APA do Planalto Central, Decreto s/nº da Presidência da República, of January 10th, 2002). The APA das Bacias do Gama e Cabeça de Veado is composed by a relatively large mosaic with more than 10,000 hectares of protected areas, including the Reserva Ecológica do IBGE (RECOR), Estação Experimental Fazenda Águas Limpas (FAL–UNB) of the University of Brasilia and Estação Ecológica do Jardim Botânico (EEJBB) de Brasilia, among others. The ARIE dos córregos Capetinha e Taquara was initially classified as a “Zona de Conservação Ambiental” and had a relatively low protection stability (UNESCO, 2003) (Fig. 7).

Because of its proximity to downtown Brasilia, a considerable extension of the APA das Bacias do Gama e Cabeça de Veado is already occupied by urban areas, especially in the ribeirão do Gama left margin. The mosaic composed of the FAL–UNB, RECOR and EEJBB is also under strong agricultural and real state speculations and the plans to expand the city limits includes the construction of the Juscelino Kubitschek bridge in 2002 and several changes in delimitation and management categories of the protected areas occasioned by the revision of the Distrito Federal Master Plan (Plano Diretor de Ordenamento Territorial – PDOT, Lei Complementar Nº 17/1997, of January 23rd,
In summary, *C. onca* has a very narrow distribution in a single location that has observed impacts of human occupation and introduction of exotic species in the basin and nearby areas, and predicted impacts of reduction of the river flow and loss of water quality caused by the longer periods of the dry season and higher temperatures due to local climate changes allied to the intense use of surface and underground hydrological resources. Following the IUCN Red List Categories and Criteria (IUCN Standards and
New Characidium from Distrito Federal

PETITIONS Subcommission, 2019), *C. onca* should be categorized as Critically Endangered (CR) because of its restricted geographic distribution (B1: Extent of occurrence <100 km²) and the following two conditions: number of location equals one (a); and continuing decline observed, estimated, inferred or projected of area extent and/or quality of habitat (biii).

**Comparative material examined.** Same as listed in Melo et al. (2016); Melo, Espíndola (2016); Teixeira, Melo (2021).

**DISCUSSION**

Only a few species of *Characidium* have dots on sides of body: *C. chancoense*, *C. japuhybense*, *C. lauroi*, *C. longum*, *C. oiticicai*, *C. pellucidum*, *C. phoxocephalum*, *C. pterooides*, *C. schubarti*, *C. stigmosum*, and *C. travassosi* (Eigenmann, 1909, 1912; Travassos, 1949a,b, 1955, 1967; Melo, Buckup, 2002; Melo et al., 2016; Agudelo-Zamora et al., 2020a). Buckup (1993a) produced the most inclusive phylogenetic hypothesis for the species of *Characidium*, obtaining three major clades, namely Clades C1, C4 and C4, and a polytomy at the base among those clades and the species that did not fit in any of them, such as *C. zebra* Eigenmann, 1909 and *C. hasemani* Steindachner, 1915. In accordance to such hypothesis, the species of *Characidium* having spots do not consist in a monophyletic group, as discussed below, and therefore, despite being very distinctive from its congeners, *C. onca* cannot be promptly included in any of the clades proposed by Buckup (1993a).

The Clade C1, including Clades C2 and C3, is composed of species having unscaled isthmus, the postcleithrum 1 reduced or absent, and the fontanel reduced, limited antero-laterally by the parietals, such as *C. amaila* Lujan, Agudelo-Zamora, Taphorn, Booth & López-Fernández, 2013, *C. fasciatum* Reinhardt, 1867, and *C. gomesi* Travassos, 1956 (Buckup, 1993a; Lujan et al., 2013). According to Buckup (1993a), the size of the fontanel is variable among the members of Clade C1, but interspecific variation was never reported so far. *Characidium japuhybense*, *C. lauroi*, *C. oiticicai*, *C. schubarti*, and *C. travassosi* also are considered as members Clade C1 and compose the *C. lauroi* group, having as main diagnostic feature the presence of small dots on body (Travassos, 1949a,b, 1955, 1967; Melo et al., 2016). Within the *C. lauroi* group, the postcleithrum 1 is well developed in *C. japuhybense* and *C. travassosi* and reduced in the remaining species. In *C. onca*, the postcleithrum 1 is either reduced or absent (Fig. 3C); the fontanel can either be reduced and limited antero-laterally by the parietals or elongated, reaching the frontals anteriorly (Figs. 3D–E); but the isthmus is completely scaled.

The Clade C4 is composed of the species with a single row of dentary teeth, the absence of the parietal branch of the laterosensory canal of head, and 12 or more vertical bars on body, such as *C. cacah*, *C. bahiense* Almeida, 1971, *C. interruptum* Pellegrin, 1909, and *C. stigmosum* (Buckup, 1993a; Netto-Ferreira et al., 2013; Mendonça, Netto-Ferreira, 2015; Melo, Espíndola, 2016; Zanata et al., 2020a). In addition, the pigmentation pattern of *C. stigmosum* is very distinctive and unique among its congeners, as the spots are enlarged and vertically elongate (Melo, Buckup, 2002). *Characidium onca* does not share any synapomorphies with the species of Clade C4 and, therefore, we refute a hypothesis
of closer relationships between \textit{C. onca} and \textit{C. stigmosum}. Likewise, \textit{C. onca} lacks the synapomorphies defining the Clade C5, which includes the species with narrow and fragmented bars, the reddish-brown blotches on dorsum, and a slender body, such as \textit{C. longum}, \textit{C. pellucidum} and \textit{C. pteroides} (Buckup, 1993a; Taphorn et al., 2006).

\textit{Characidium chancoense} and \textit{C. phoxocephalum} are trans-Andean species with scaled isthmus and dots on the sides not assigned to any clade of \textit{Characidium} (Agudelo-Zamora et al., 2020a). \textit{Characidium chancoense} has considerable fewer dots, restricted to an irregular line below the longitudinal stripe, apparently associated to the transversal bars, being remarkably similar to \textit{C. japuhyense}. \textit{Characidium phoxocephalum} is the species that most closely resembles \textit{C. onca} because of the numerous dots on body and the short pectoral and pelvic fins, and but can be externally distinguished by having an adipose fin. Nevertheless, osteological features suggest such external similarity would be the result of evolutionary convergence, with \textit{C. phoxocephalum} having a well-developed postcleithrum 1 and an elongated and a finger-like posterior cleithral process (Agudelo-Zamora et al., 2020a) while, in \textit{C. onca}, the postcleithrum 1 is reduced or absent, and the posterior cleithral process being short and triangular (Fig. 4).

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Marcelo Roberto Souto de Melo: Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing—original draft, Writing—review and editing.

Mauro César Lambert de Brito Ribeiro: Data curation, Investigation, Resources, Writing—review and editing.

Flávio César Thadeo de Lima: Conceptualization, Data curation, Investigation, Methodology, Writing—original draft, Writing—review and editing.

**ETHICAL STATEMENT**

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**COMPETING INTERESTS**

The authors declare no competing interests.

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