

# Two new Critically Endangered species of *Ditassa* (Apocynaceae) from the threatened cangas of the Iron Quadrangle, Minas Gerais, Brazil

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**Background and aims** – Vegetation on ironstone outcrops is highly threatened, particularly due to the impact of mining. In this study, two new species of *Ditassa* (Metastelmatinae, Asclepiadoideae, Apocynaceae) from the cangas of the Iron Quadrangle (Minas Gerais, Brazil) are described and illustrated, and their conservation status is discussed.

**Material and methods** – Species recognition is based on a morphological and molecular study of recent and historical collections, including a survey of the main herbaria of Brazil, Europe and the United States. Conservation status assessments are based on the evaluation of areas of occupancy and the impact of iron mining in the region.

**Key results** – The two new species are morphologically similar to species in the “Hemipogon from the Espinhaço” clade, which includes *Morilloa*. Nevertheless, they exhibit flowers with a double corona and are described in *Ditassa* here, following preliminary phylogenetic analyses with 73 plastid-coding regions. These species are known from only two highly disturbed locations each and are Critically Endangered. A key to identify the 14 species of Metastelmatinae currently recorded in cangas of the Iron Quadrangle is provided.

**Conclusion** – The Critically Endangered *Ditassa cangae* and *D. ferricola* are examples of poorly known, nearly extinct species under strong anthropogenic pressure caused by intense mining activities and the lack of adequate legislation for the protection of canga landscapes.

**Keywords** – Asclepiadoideae; campos rupestres; conservation; Espinhaço Range; *Hemipogon*; iron outcrops; Metastelmatinae; mining; threatened species.

## INTRODUCTION

The Iron Quadrangle (IQ) geosystem (Quadrilátero Ferrífero), in the southern Espinhaço Range (Minas Gerais, Brazil), comprises an area of approximately 7000 km<sup>2</sup> (Dorr 1964) between two biodiversity hotspots, Atlantic Rainforest and Cerrado (Myers et al. 2000; Mittermeier et al. 2005). It com-

prises the largest reserves of high-grade iron ore in the world (Dorr 1964; Jacobi & Carmo 2012; Skirycz et al. 2014) and has been intensively mined since the beginning of the 20<sup>th</sup> century. Additionally, the privatization policy by the Brazilian government at the end of the 20<sup>th</sup> century has boosted the mineral production leading to an increased growth of the iron ore sector (IBRAM 2018). Mineral mining is an impor-

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tant part of the Brazilian economy. It accounted for approximately 8.5% (~50 billion dollars) of the gross domestic product 20 years ago (<https://www.ingeoweb.com.br/mineracao>) and around 1.1% in the last decade (OECD 2017; <https://oec.world/en/profile/country/bra>). In 2017, iron ore represented more than half (62%) of the value of minerals exported by Brazil and was one of the most important export products, second only to soybean (IBRAM 2018).

The IQ is a conglomerate of geological formations and types of vegetation marked by ferruginous soils, heterogeneous topography and water deficit (e.g., Dorr 1964). “Canga” is a typical landscape dispersed over mountaintops along the IQ that is directly associated with ironstone soil. This term was originally applied in geology to the ferruginous hard layer on superimposed banded iron formations, re-formed by weathering events approximately 65 million years ago (Dorr 1964; Shuster et al. 2012; Conceição et al. 2016; Vasconcelos & Carmo 2018; Gagen et al. 2019). It occupies almost 2.5% of the IQ and is distributed in patches along two hydrological basins: the Paraopeba sub-basin (São Francisco basin) to the west and the Doce River sub-basin (Atlantic East basin) to the east (Salles et al. 2018). Characterised by herbs and subshrubs growing on rocky outcrops (Silva 1991; Jacobi & Carmo 2012), the canga vegetation is under strong abiotic stress and most species are adapted to high levels of heavy metals (Baker 1981; Boyd 2012; Skirycz et al. 2014).

In the IQ, an estimated 1109 species of vascular plants, including several rare and endemic species, occur in cangas (Viana & Lombardi 2007; Jacobi & Carmo 2008; Giulietti et al. 2009). Although this region has been floristically studied for centuries, a recent inventory (Jacobi & Carmo 2012) reported nearly 100 undescribed species of plants from cangas and several others have been described since then (e.g., Versieux 2011; Versieux & Machado 2012; Knapp et al. 2015). An inventory of the Amazonian cangas in the Serra dos Carajás, State of Pará, reported 856 species of seed plants; approximately 60% of them were new occurrences for the area (Mota et al. 2018). Although cangas in IQ and Carajás are both highly diverse (amounting to approximately 1700 species combined), only about 5% of this diversity (96 species) is shared between the two regions (Mota et al. 2018; Zappi et al. 2019). Currently, more than half of the area originally covered by cangas in the IQ has been lost (Salles et al. 2018) and large areas are already reserved for ore extraction (Villén-Pérez et al. 2017). In Carajás, the cangas cover an area larger than in the IQ and almost 20% of it has already been affected by mining activities since the 1980s (Souza-Filho et al. 2019). Therefore, mining may represent a negative impact on plant diversity and some have argued that the biodiversity in the cangas is not sufficiently protected by legislation (e.g., Miola et al. 2019).

The Apocynaceae are one of the ten largest families of angiosperms in the IQ cangas with 29 species (Rapini 2012). Only two species, *Blepharodon pictum* (Vahl) W.D.Stevens and *Mandevilla tenuifolia* (J.C.Mikan) Woodson, are shared with the Amazonian cangas in Carajás (Fernandes et al. 2018). Most species of Apocynaceae in the IQ cangas are Asclepiadoideae (21 vs. only 6 of the 22 species of Apocynaceae in the Carajás cangas), including two rare undescribed species, listed as “*Hemipogon* aff. *carassensis* (Malme) Ra-

pini” and “*Hemipogon* aff. *hemipogonoides* (Malme) Rapini” in Rapini (2012). Rarity is common in Asclepiadoideae: some species of asclepiads are known only from the type material and others have not been collected for decades (e.g., Rapini et al. 2002; Rapini 2010, 2012; Biodiversitas 2011). Nonetheless, only three species of Asclepiadoideae from these cangas, *Ditassa laevis* Mart., *D. longisepala* (Hua) Fontella & E.A.Schwarz and *Minaria monocoronata* (Rapini) T.U.P.Konno & Rapini, are listed as threatened in the official Brazilian Red List (Brazilian Ministry of the Environment 2014).

Here, we describe and illustrate the undescribed “*Hemipogon* aff. *carassensis*” and “*Hemipogon* aff. *hemipogonoides*” (Rapini 2012) as two new microendemic species (*sensu* Silva et al. 2019) of *Ditassa* R.Br. (*D. cangae* Bitencourt & Rapini and *D. ferricola* Bitencourt & Rapini, respectively), and discuss their conservation status within the context of the mining impact in the region. This seems to be a remarkable example of convergence. Morphologically, the two new species resemble species from the “*Hemipogon* from the Espinhaço” clade, a cohesive lineage, well supported by molecular data from both nuclear and plastid regions (Silva et al. 2012), though partially (i.e., the four twining species) segregated to *Morilloa* Fontella, Goes & S.Cáceres (Fontella-Pereira et al. 2014). However, phylogenetic analyses using 73 plastid-coding regions (Bitencourt et al. 2019) strongly supported them as sister species, nested in a clade consisting predominantly of species endemic to the Espinhaço Range, but classified primarily in *Ditassa* R.Br. (fig. 1). The unexpected position of these two species puts into question the taxonomic classification of other species endemic to the IQ cangas classified due to their morphology but that have not yet been phylogenetically analysed with molecular data, such as *Minaria monocoronata* (Konno et al. 2006; Ribeiro et al. 2014). The current circumscription of *Ditassa* is not monophyletic (e.g., Silva et al. 2012; Liede-Schumann et al. 2014), but the placement of the two novelties in this genus seems most appropriate at this time. To facilitate the recognition of the new species, a key to identify the 14 species of Metastelmatinae (for subtribe circumscription, see Endress et al. 2018) recorded in the cangas of the Iron Quadrangle (Rapini 2012) is provided.

## MATERIAL AND METHODS

This study is part of a forthcoming systematic work on Metastelmatinae (Bitencourt 2019, Bitencourt et al. unpubl. res.). We analysed approximately 1200 specimens deposited at the main herbaria in Brazil (e.g., BHCB, CEN, DIAM, HRB, HUEFS, IBGE, MBM, R, RB, SP, SPF, UB) and outside Brazil (e.g., B, BR, C, F, K, LPB, M, MO, NY, P, S, USZ, W) (acronyms according to Thiers continuously updated). Morphological terms follow Beentje (2016) and locations were retrieved from herbarium labels. Since the two species are known from only two locations each and lack population data, their conservation status is inferred based mainly on the IUCN’s (2017) criteria for area of occupancy (AOO), calculated using  $2 \times 2$  km cells in the GeoCAT Tool (Bachman et al. 2011).

## TAXONOMIC TREATMENT

*Ditassa cangae* Bitencourt & Rapini, sp. nov.

Figs 2, 3

**Diagnosis** – *Ditassa cangae* differs from the morphologically similar *Morilloa carassensis* (Malme) Fontella, Goes & S. Cáceres and *M. piranii* (Fontella) Fontella, Goes & S. Cáceres by the subcampanulate, adaxially puberulent corolla (vs. urceolate, adaxially bearded corolla in *M. carassensis* and *M. piranii*), gynostegial double corona (vs. absent), anthers with triangular wings (vs. laterally falcate in *M. carassensis* and recurved in *M. piranii*) and caudicles obreniform (vs. linear).

**Type** – Brazil: Minas Gerais, Mun. Catas Altas, Chapada de Canga, 20°08'14.5"S, 43°24'19"W, 910 m a.s.l., 6 Dec. 2008, fl., *Carmo 3773* (holotype: BHCB).

**Description** – **Herb** twining; stems cylindrical, puberulous (non-glandular trichomes), sometimes only along a pair of longitudinal lines. **Leaves** opposite, ascendant; petiole 2–7 mm long; blade linear to narrowly elliptic, 1.1–3.5 × 0.1–0.2 cm, base and apex attenuate, margins entire, revolute, membranous, glabrescent; colleters intrapetiolar. **Cymes**, 4- or 5-flowered, subaxillary; bracts lanceolate, c. 1 × 0.5

mm, glabrous; peduncle c. 1 mm long. **Flowers** with pedicel 1–3 mm long; sepals ovate, c. 1.3 × 1 mm, apex acute, involute, glabrescent, axillary colleters alternisepalous; corolla subcampanulate, probably creamy, abaxially glabrescent, adaxially puberulent, tube 0.3–0.5 × 1.1–1.2 mm, lobes triangular, 2–2.5 × 1.3–1.5 mm, apex attenuate, involute; corona gynostegial, double, 5-lobed, lobes shorter than the gynostegium, outer lobes ovate, 1–1.2 × 0.6–0.8 mm, apex caudate, inner lobes lanceolate, c. 1 × 0.4 mm, apex acute; anthers 0.8–1 × 0.3–0.4 mm, quadrangular, M-shaped, wings triangular, c. 0.5 × 0.25 mm, apical membranous appendix quadrangular, c. 0.2 mm long; corpusculum ovate, 0.2–0.23 × 0.15–0.17 mm; caudicles obreniform, horizontal, c. 0.06 mm long; pollinia ovate-elliptic, 0.3–0.35 × c. 0.2 mm; style head apically mamillated, exerted from the corolla tube. **Follicles** obclavate, 1.9–3.7 × 0.3–0.4 cm, glabrous, striate, apex sometimes curved.

**Distribution** – *Ditassa cangae* is restricted to the Chapada de Canga, in Catas Altas, and Serra de Gandarela, in Santa Bárbara, both in the Doce River basin, east sector of the Iron Quadrangle, southern Espinhaço Range, state of Minas Gerais, Brazil (fig. 3).

**Habitat and ecology** – The species occurs in canga, growing on ironstone soils, between 910–1637 m a.s.l.

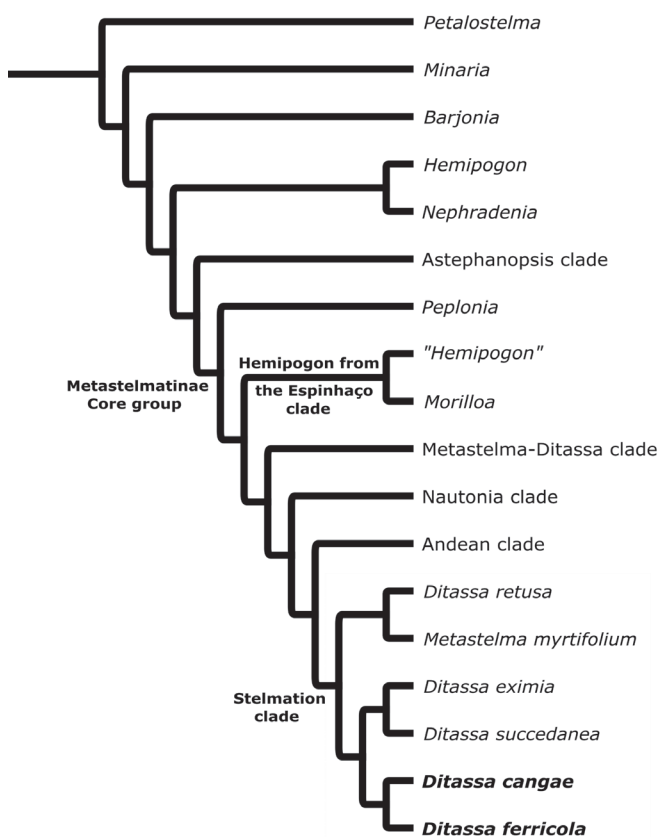
**Phenology** – Collected with flowers in December and May, and fruits in May.

**Etymology** – The epithet refers to canga, a landscape associated with ferruginous substrates where the species is found.

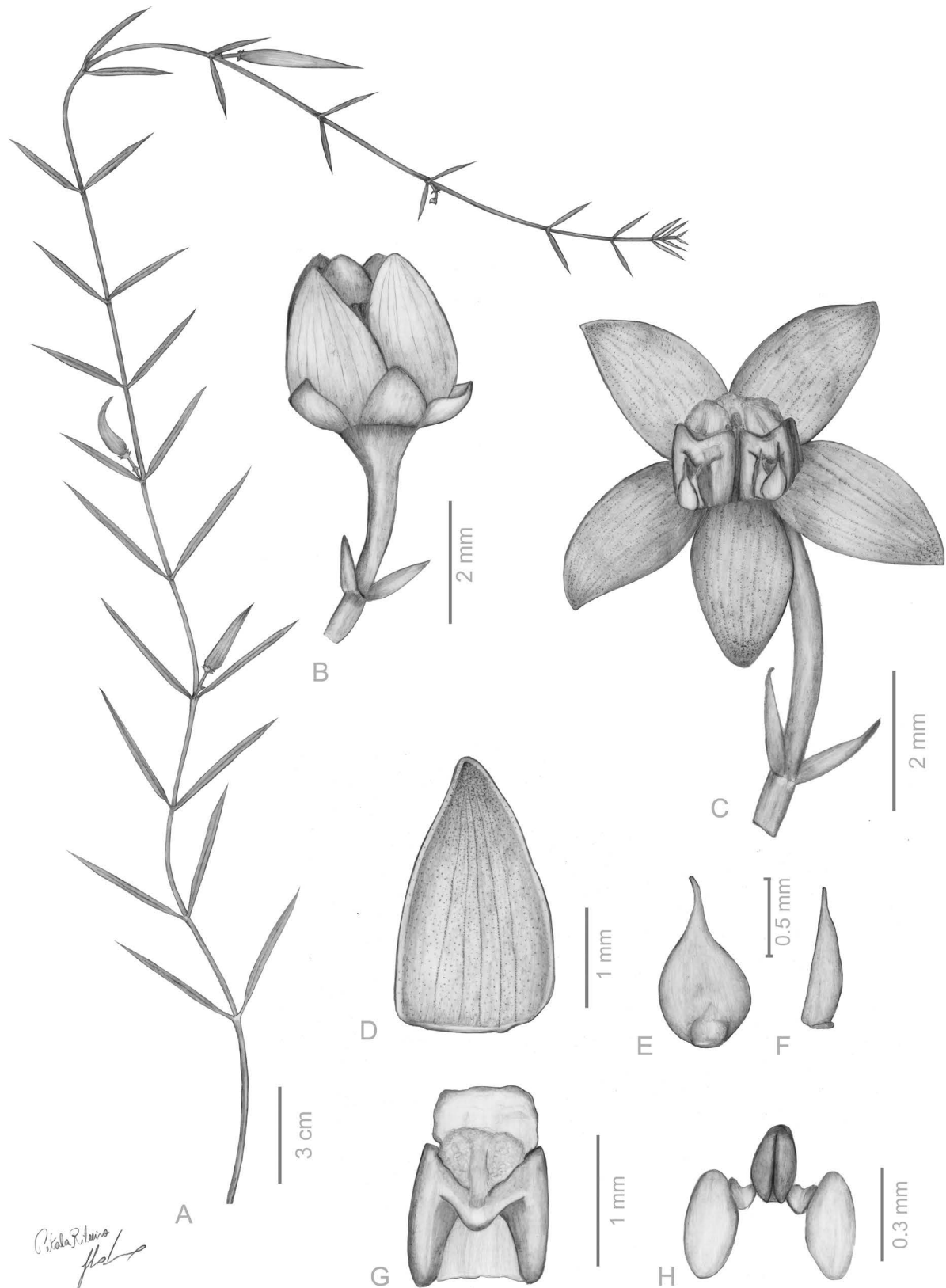
**IUCN conservation assessment** – *Ditassa cangae* is known from only two locations, both close to the Caraça Sanctuary, in the most preserved sector of the Iron Quadrangle (Salles et al. 2018). The two collections lack population and environmental data, and the species is rare. Its area of occupancy is less than 8 km<sup>2</sup> and, despite frequent fieldwork in the Iron Quadrangle, the species has not been recollected in the last decade; we also tried to find it without success three times. The Doce River basin has become unpopular because of the dam collapse in Mariana (2015) and Brumadinho (2019) and the locations of *D. cangae* are seriously threatened and declining, one of them is highly mined (fig. 3E) and the other is close to the pit of the Gongo Soco mine (Barão de Cocais municipality, fig. 3G), which is under threat of imminent collapse. A National Park covers part of the Serra de Gandarela, but most patches of canga were not included in the park due to their high value for mining (Salles et al. 2018). From our *in situ* observation and the satellite image (fig. 3E), we conclude that one of the two locations of this species (the Chapada de Canga, Catas Altas) is destroyed. The small area of occupancy, the lack of collections after 2008, the high disturbance caused by mining activities in the region and the reduction of the number of locations to only one suggest that *D. cangae* is Critically Endangered [CR B2ab(i, ii, iii, iv, v)].

**Additional material examined (paratype)** – Brazil: Minas Gerais: Mun. Santa Bárbara, Serra de Gandarela, em borda de capão, 20°03'24"S, 43°41'28.6"W, 1637 m a.s.l., 25 May 2008, fl., fr., *Carmo 3224* (BHCB).

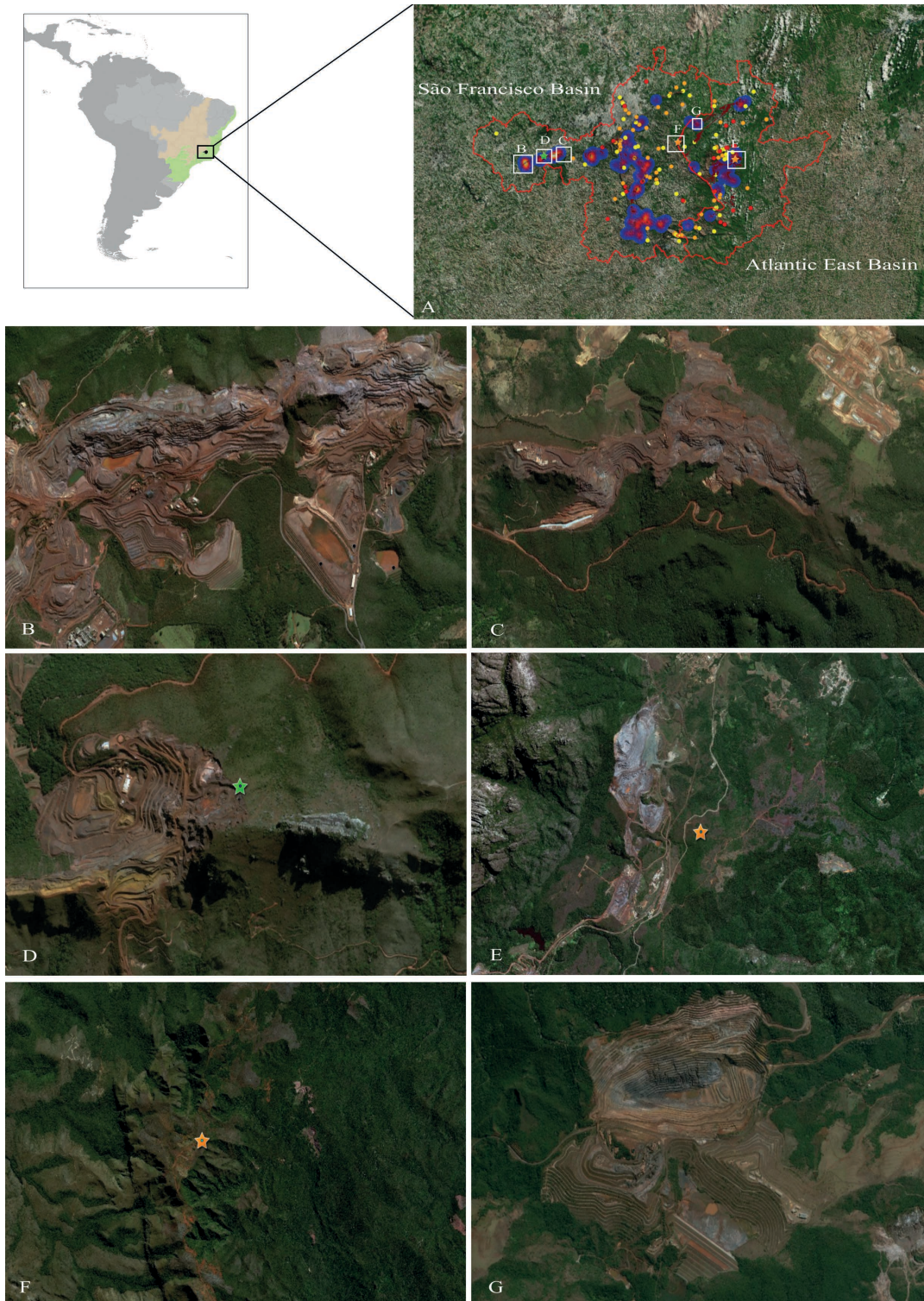
**Taxonomic notes** – *Ditassa cangae* is morphologically similar to *Morilloa carassensis* and *M. piranii*, two twining species of the “Hemipogon from the Espinhaço” clade



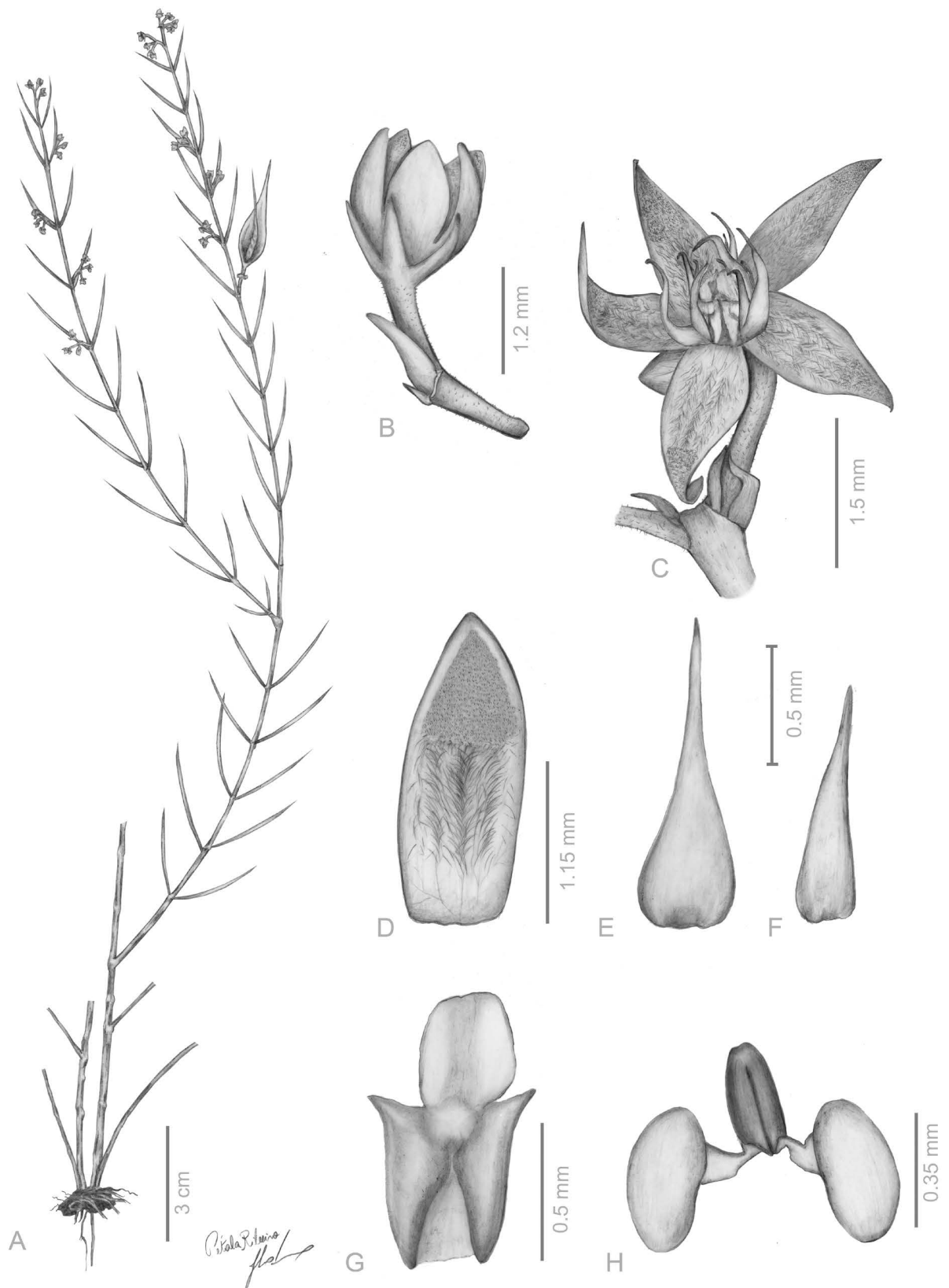
**Figure 1** – Summary cladogram of Metastematinae (Apocynaceae) based on the phylogenetic analysis of 73 plastid-coding regions (Bitencourt 2019) to show the position of the new species *Ditassa cangae* and *D. ferricola* (in bold). All clades are highly supported (posterior probability  $\geq 0.95$ ). Clade names after Silva et al. (2012) and Liede-Schumann et al. (2014).



**Figure 2** – *Ditassa cangae*. **A.** Habit. **B.** Flower (lateral view). **C.** Flower, outer lobes of the corona removed to show the gynostegium. **D.** Corolla lobe (adaxial view). **E.** Outer lobe of the corona (adaxial view). **F.** Inner lobe of the corona (adaxial view). **G.** Anther (abaxial view). **H.** Pollinarium. Illustration by Pétala Gomes Ribeiro from *Carmo* 3773.



**Figure 3** – Distribution of plants threatened by mining companies showing areas affected by iron ore exploitation in the Iron Quadrangle, Minas Gerais, Brazil. **A.** Distribution of vulnerable (yellow circles), endangered (orange), and critically endangered (red) species of vascular plants and density of mining companies (low to high: purple – red – white) (database from Instituto Pristino: <https://www.institutopristino.org.br/atlas/geossistemas-ferruginosos-do-brasil/quadrilatero-ferrifero/baixе-os-arquivos-shp-e-kml/>, accessed 28 Aug. 2019); red lines show river basin borders; phytogeographic domains in the map, light brown = Cerrado and green = Atlantic Forest. **B–G.** Details of areas affected by mining, with the type locality of *Ditassa ferricola* (green star in D); and *Ditassa cangae* (orange stars) in Chapada de Canga, Catas Altas (E) and Serra de Gandarela, Santa Bárbara (F) just south of Gongo Soco mine, Barão de Cocais (G). Satellite images and distribution maps were built and exported using ArcGIS online (<https://www.arcgis.com>). © Esri and its licensors, all rights reserved. This image is not distributed under the terms of the Creative Commons license of this publication. For permission to reuse, please contact the rights holder.



**Figure 4** – *Ditassa ferricola*. A. Habit. B. Flower (lateral view). C. Flower, showing the gynostegium. D. Corolla lobe (adaxial view). E. Outer lobe of the corona (adaxial view). F. Inner lobe of the corona (adaxial view). G. Anther (abaxial view). H. Pollinarium. Illustration by Pétala Gomes Ribeiro from *Carmo* 4296.

(*sensu* Silva et al. 2012) because of the shared habit, lanceolate leaves, and 4–7-flowered cymes. Nevertheless, it can be easily distinguished from both species by the flowers with subcampanulate, adaxially puberulent corolla (vs. urceolate, bearded corolla) and double corona, with caudate outer lobes (vs. without corona). Although morphologically similar to species of *Morilloa*, it is described in *Ditassa* because phylogenetic analyses with plastid-coding regions (Bitencourt 2019) show that it is closer to *Ditassa banksii* R.Br. ex Schult. than to *Morilloa lutea* (E.Fourn.) Fontella, Goes & S.Cáceres, the type species of the respective genera (fig. 1). *Ditassa cangae* is nested in a clade that consists of species classified primarily in *Ditassa* and also having a double corona, a feature traditionally used to define this genus. Thus, the similarities between *Ditassa cangae* and species of *Morilloa*, in particular concerning their vegetative morphology, are possibly convergences due to their occurrence in rupes-trian grasslands.

***Ditassa ferricola* Bitencourt & Rapini, sp. nov.**

Figs 3, 4

**Diagnosis** – *Ditassa ferricola* is morphologically similar to the erect species of the “Hemipogon from the Espinhaço” clade, in particular to *Hemipogon hemipogonoides* (Malme) Rapini, and also to the two sister species *Ditassa auriflora* Rapini and *D. cordeiroana* Fontella. However, they all differ in habit: *D. ferricola* is a subshrub whereas *H. hemipogonoides* is an erect herb, *D. cordeiroana* is a twining herb, and *D. auriflora* is a shrub. The corolla is adaxially densely pilose on the middle third and puberulent on the upper third (vs. barbate at the base of lobes and sericeo-tomentulose upwards in *H. hemipogonoides* and barbellate at the base of lobes and papillo-puberulent upwards in *D. auriflora* and *D. cordeiroana*). The new species exhibits a gynostegial double corona, similar to the two species of *Ditassa*, whereas *H. hemipogonoides* exhibits a gynostegial corona with a single whorl of lobes. The corpusculum is subelliptic in *D. ferricola* (vs. obovate in *H. hemipogonoides* and oblong to elliptic in *D. auriflora* and *D. cordeiroana*).

**Type** – Brazil: Minas Gerais, Mun. Igarapé, Pico do Itatiaiaçu, 20°07'17"S, 44°21'43.7"W, 1340 m a.s.l., 10 Feb. 2009, fl., fr., *Carmo 4296* (holotype: BHCB).

**Description** – Subshrub, 30–40 cm tall; stems cylindrical, pubescent (non-glandular trichomes), sometimes only along a pair of longitudinal lines. Leaves opposite, ascendant to erect; petiole 1–2 mm long; blade aciculate, 1–3.5 × 0.1–0.15 cm, coriaceous, base and apex attenuate, margins entire, revolute, sparsely ciliate; colleters intrapetiolar. Cymes 2–4-flowered, subaxillary; bracts lanceolate, 0.8–1.4 × 0.25–0.3 mm, glabrous; peduncle 1.5–2 mm long, puberulous. Flowers with pedicel 0.8–1.2 mm long, puberulous; sepals ovate, c. 1.2 × 0.5 mm, apex attenuate, margins entire, involute, pubescent, axillary colleters alternisepalous; corolla subcampanulate, probably brownish creamy, abaxially glabrous, adaxially glabrous on the basal third, densely pilose on the medium third and puberulent on the upper third, tube 0.5–0.6 × 0.7–0.8 mm, lobes lanceolate, 0.8–1.0 × 0.7–0.8 mm, apex attenuate, involute; corona gynostegial, double, 5-lobed, outer lobes lanceolate, c. 1.2 × 0.4 mm, acuminate,

protruding above the gynostegium, inner lobes lanceolate, c. 0.8 × 0.2 mm, acuminate, as high as the gynostegium; anthers subcuneiform, c. 0.5 × 0.4 mm, wings cuneiform, c. 0.5 × 0.2 mm, apical membranous appendix subcuneiform, c. 0.3 mm long; corpusculum subelliptic, c. 0.1 × 0.05 mm; caudicles c. 0.03 mm long, subtriangular, horizontal; pollinia oblong, c. 0.15 × 0.08 mm; style head apically globose. Follicles turbinate, 3–3.5 × 0.5–0.8 cm, striate, puberulous, apex attenuate.

**Distribution** – *Ditassa ferricola* is known from two locations, the Pico do Itatiaiaçu and Serra Azul, along the Serra do Curral, in the northern portion of the Iron Quadrangle, southern Espinhaço Range and south of Belo Horizonte, state of Minas Gerais, Brazil (fig. 3).

**Habitat and ecology** – The species occurs on ironstone soil of a canga outcrop, ca. 1340 m a.s.l.

**Phenology** – Collected with flowers and fruits in January and February.

**Etymology** – The epithet is a reference to the ferruginous habitat in which the species is found.

**IUCN conservation assessment** – *Ditassa ferricola* has been collected only twice, both times in mining areas. Although we do not have the precise locality of the collection in Serra Azul, we know that it is located in the main mining area of IQ (fig. 3B). We did not have permission to access these areas and the two attempts to find the species nearby were not successful. However, from our *in situ* observation and the satellite image (fig. 3D), the type location (but probably both locations) is completely destroyed by mining. Specimen labels provide no information about population density and environmental conditions, but since the species is known from only two, highly mined locations (AOO < 8 km<sup>2</sup>), one or both of them completely destroyed, surrounded by urban landscapes near the capital of Minas Gerais, it should be classified as Critically Endangered [CR B2ab(i, ii, iii, iv, v)].

**Additional material examined (paratype)** – **Brazil: Minas Gerais:** Mun. Brumadinho, Serra Azul, Serra das Farofas, Campo Ferruginoso, 1329 m a.s.l., 7 Jan. 2016, fl., *Gontijo 1116* (BHCB).

**Taxonomic notes** – Morphologically, *Ditassa ferricola* is very similar to (1) *Hemipogon hemipogonoides*, an erect perennial plant of the “Hemipogon from the Espinhaço” clade (*sensu* Silva et al. 2012), and (2) *D. auriflora*, because of the erect habit and the opposite linear leaves. The species can be distinguished from both by the characters provided in the diagnosis. *Ditassa ferricola* is a subshrub with aciculate leaves and flowers with corolla lobes internally densely pilose on the middle portion and double corona, with ovate outer lobes and lanceolate inner lobes. It is phylogenetically sister to *D. cangae* (fig. 1; Bitencourt 2019) and is therefore described in *Ditassa* for the same reasons mentioned for *D. cangae*.

DISCUSSION

The Espinhaço Range harbours one of the highest levels of plant diversity and endemism in Brazil (e.g., Rapini et al. 2008; Silveira et al. 2016). While its biodiversity is possibly less threatened by climate change in the southern part (Biten-

Key to the Metastelmatinae from the cangas of the Iron Quadrangle

1. Plants erect ..... 2
- 1'. Plants twinning or prostrate..... 5
2. Leaves with blade aciculate (ratio > 10 long : 1 wide).....*Ditassa ferricola*
- 2'. Leaves with blade cordiform, oblong or ovate to lanceolate (ratio < 10 long : 1 wide ..... 3 (*Minaria*)
3. Plants < 10 cm tall; leaves with blade membranous, glabrous to sparsely ciliate, not revolute; corona simple, lobes with one segment .....*Minaria monocoronata*
- 3'. Plants > 10 cm tall; leaves with blade chartaceous or coriaceous, hirsute, setulose or pilose, strongly revolute; corona double, lobes with two segments ..... 4
4. Leaves with blade cordiform or triangular, > 2 mm wide; corona with linear lobes.....*M. decussata*
- 4'. Leaves with blade oblong, < 1.5 mm wide; corona with triangular to ovate lobes ..... *M. acerosa*
5. Leaves > 1.5 cm wide ..... 6
- 5'. Leaves < 1.5 cm wide .....10 (*Ditassa*)
6. Leaves with blade lanceolate, venation inconspicuous; corolla urceolate.....*Peplonia organensis*
- 6'. Leaves with blade ovate to obovate, venation conspicuous; corolla campanulate to globose..... 7
7. Branches tomentose; leaves with blade pilose on venation; corona simple, lobes with one segment...  
..... *Ditassa longispala*
- 7'. Branches glabrous to glabrescent; leaves with blade glabrous or glabrescent; corona double, lobes cymbiform or with a pair of segments ..... 8
8. Corolla lobes not ciliate; corona with outer and inner lobes free from each other ....*Ditassa lagoensis*
- 8'. Corolla lobes ciliate; corona lobes cymbiform, with outer and inner lobes clearly fused to each other  
..... 9 (*Blepharodon*)
9. Pollinia subdeltoid to subglobose .....*Blepharodon pictum*
- 9'. Pollinia ovoid to reniform.....*B. bicuspidatum*
10. Leaves hirsute ..... *Ditassa mucronata*
- 10'. Leaves glabrous or with sparse trichomes along the margins or on the central vein.....11
11. Leaves linear to narrowly elliptic (ratio c. 10 long : 1 wide), < 2 mm wide, apically attenuate; corona with outer lobes shorter than the gynostegium .....*D. cangae*
- 11'. Leaves linear to oblong or ovate to obovate (ratio < 10 long : 1 wide), usually > 2 mm wide, apically mucronate; corona with outer lobes higher than (rarely as high as) the gynostegium..... 12
12. Corolla lobes ≤ 1.95 cm long; corona with outer lobes < 1 mm long..... *D. laevis*
- 12'. Corolla lobes > 1.95 cm long; corona with outer lobes > 1.5 mm long..... 13
13. Corona with inner lobes higher than the gynostegium .....*D. linearis*
- 13'. Corona with inner lobes shorter than the gynostegium..... *D. retusa*

court et al. 2016), the species endemic to this region are most threatened by anthropogenic pressure caused by the long history of mining (Ribeiro et al. 2012). This is particularly worrisome because disturbances in old landscapes, such as the cangas (on ironstone) and the associated campos rupes- tres s. str. (on quartzite), are irreversible: once environmental conditions have changed, the original state is not recovered and their communities move to other, less complex states (Miola et al. 2019).

The IQ produces more than 75% of the Brazilian iron ore (Jacobi & Carmo 2008; ANM 2018). The region is almost completely (96%) under prospecting licenses for private initiative (Jacobi & Carmo 2012; ANM 2019) and more than 22 500 mining projects are planned within protected areas (Villén-Pérez et al. 2017). The situation is alarming but might become worse as the Brazilian government is treating environmental laws as obstacles for national economic development (e.g., Abessa et al. 2019; Ferrante & Fearnside



2019). Regardless of the huge socioeconomic and ecological impact caused by the rupture of two dams in the IQ in less than four years (e.g., Fernandes et al. 2016), the government openly supports a set of bills that will reduce the need for environmental licenses and may allow mining activities in protected areas (e.g., Carmo et al. 2017; Villén-Pérez et al. 2017; Abessa et al. 2019; Câmara et al. 2019; Campos-Silva & Peres 2019). If passed, these changes in legislation will greatly increase the area affected by mining in a short time, enhancing the threat to canga biodiversity even more (Villén-Pérez et al. 2017).

*Ditassa cangae* and *D. ferricola* are only two of the 116 species endemics to the Iron Quadrangle, 25% of which are also restricted to the threatened cangas (Jacobi & Carmo 2012; fig. 3A). Exhaustive fieldwork in the region did not locate these species, suggesting that both are examples of poorly known, nearly extinct species in areas under high anthropogenic pressure. The number of still undescribed species in a similar situation is however higher (Jacobi & Carmo 2012). While the number of extinct species will probably increase rapidly in the IQ, the discussion about economic development and biodiversity conservation does not seem to advance in a compatible rhythm. Rather than relaxing the environmental legislation, strategies to monitor mining activities and their impact on biodiversity and landscape should be implemented urgently. The use of remote sensing (e.g., Buchanan et al. 2008; Tracewski et al. 2016; Santini et al. 2019), with particular attention to areas with threatened species, may signal the initial stages of landscape transformation to inspection authorities, contributing to reducing the decline of biodiversity in the IQ cangas caused by mining and associate activities.

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