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NEW RECORDS IN BRAZIL REVEAL A DISJUNCT DISTRIBUTION FOR *CORDIA WEDDELLII* (CORDIACEAE)

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Abstract. Melo, J. I. M.; G. M. Antar, L. P. Silva & T. S. Silva. 2021. New records in Brazil reveal a disjunct distribution for *Cordia weddellii* (Cordiaceae). *Darwiniana*, nueva serie 9(2): 320-328.

Cordia weddellii, a species of *Cordia* sect. *Cordia* (Cordiaceae, Boraginales) endemic to South America is recorded for the first time in Brazil, growing in Cerrado vegetation in Bahia and Tocantins states. A distribution map, photographs, comments on the habitat and phenology, and a preliminary conservation assessment are provided for the species. Additionally, we provide a lectotype for *C. weddellii*.

Keywords. Boraginales; Cerrado; distribution; diversity; Tocantins.

Resumen. Melo, J. I. M.; G. M. Antar, L. P. Silva & T. S. Silva. 2021. Nuevos registros en Brasil revelan una disyunción de Cordia weddellii (Cordiaceae). *Darwiniana*, nueva serie 9(2): 320-328.

Cordia weddellii, una especie de *Cordia* sect. *Cordia* (Cordiaceae, Boraginales) endémica de Sudamérica fue registrada por primera vez en Brasil, creciendo en la vegetación de Cerrado en los estados de Bahía y Tocantins. Se presentan un mapa de distribución, fotografías, notas sobre ambientes y fenología reproductiva, y una evaluación preliminar del estado de conservación de la especie. Además, se designa lectotipo para C. *weddellii*.

Palabras clave. Boraginales; Cerrado; distribución; diversidad; Tocantins.

INTRODUCTION

Cordia L. is the largest genus of Cordiaceae (Boraginales – following the familial classification proposed in BWG (2016)) comprising around 250 species widely distributed in tropical and subtropical regions, with many species restricted to the Neotropics (Miller & Gottschling, 2007; BWG, 2016). Currently its infrageneric classification comprises six sections: *Cordia* sect. *Cordia* L., *C.* sect. *Gerascanthus* (P. Browne) G. Don, *C.* sect. *Rhabdocalyx* A. DC.,

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C. sect. *Pilicordia* A. DC., *C*. sect. *Superbiflorae* Taroda and *C*. sect. *Myxa* Endl. (Stapf, 2007; Miller, 2013).

In recent decades, many studies have contributed to the knowledge of the sections of *Cordia*, such as taxonomic revisions, new species descriptions and local flora treatments (e.g. Miller, 2001; 2013; Stapf, 2007; Melo, 2012, 2015; Melo & Lyra-Lemos, 2008; Melo et al. 2009, 2018; Vieira et al., 2013, 2015; Guimarães et al., 2016; Melo & Vieira, 2017; Costa & Melo, 2019). However, many specimens of *Cordia* still need revision and/or are misidentified in herbaria and many areas remain poorly collected. Thus, a better understanding of the diversity of the genus, and its respective sections, as well as the distribution of its species and conservation data requires further and more detailed investigations.

This scenario is especially true for Brazil as it presents remarkably poorly collected areas (BFG, 2015; Oliveira et al., 2017) and where 57 species of *Cordia* are currently recognized, of which 29 are endemic (Flora do Brasil, 2020). During a floristic survey of the Jalapão region, a poorly collected area inserted in the Cerrado domain (Antar et al., 2018; Antar & Sano, 2019), a hotspot for conservation (Queiroz et al., 2020), some odd-looking specimens of *Cordia* were collected. These specimens have serrate or serrulate leaves with an entire base, veins with ferruginous trichomes, cladodromous venation, and a calyx with a mucronulate apex, cymose inflorescences, and foliaceous stigmatic branches. After careful examination, these specimens were recognized as part of *Cordia* sect. *Cordia* and a taxon yet unrepresented in the Brazilian territory.

In this work, we present the description of this new record for Brazil, *Cordia weddellii* I.M. Johnst., a species previously known only from Bolivia and Paraguay, with a morphological description, illustrations, photographs of the species in the field, a preliminary global conservation status assessment, a distribution map and comments on the ecology and its affinities based on morphological features. Additionally, we provide a lectotype for the species.

MATERIAL AND METHODS

The morphological analyses and species description were based on specimens from the following herbaria: CEN, ESA, HACAM, HUEFS, NY, PY, SPF, UB, and UFG, acronyms according to Thiers (2021). Additionally, the online databases Reflora Virtual Herbarium (Reflora, 2020), GBIF (GBIF.org, 2021), and SpeciesLink (2021) were consulted. Observations and photographic records of the species were carried out in the field in 2013. Morphological terminology for the descriptions follows Radford et al. (1974).

The distribution maps were produced in QGIS (QGIS Development Team, 2020). For distribution purposes, coordinates were gathered from the labels and in the case of their absence, specimens were georeferenced using the locality description. When it was not possible to georeference specimens, the centroid coordinate for the municipality was adopted. The specimens used for the distribution of *Cordia weddellii* in Bolivia and Paraguay are listed in Appendix 1.

A preliminary conservation status assessment for *Cordia weddellii* was established only for criterion B, restricted distribution, based on International Union for Conservation Nature criteria (IUCN, 2012) and guidelines (IUCN, 2019). The extent of occurrence (EOO) and area of occupancy (AOO) were evaluated through GeoCAT software (Bachman et al., 2011) using default values.

RESULTS AND DISCUSSION

Taxonomic Treatment

Cordia weddellii I.M. Johnst., J. Arnold Arb. 16: 173. 1935. TYPE: Bolivia, Santa Cruz, Chiquitos, 16°46'15" S, 061°27'15" W, September 1845 - October 1845, *H. A. Weddell 3454* (Lectotype, designated here: P [barcode P00634096]; isotypes: GH [barcode 00095907, fragment], P [barcode P00634095]). Figs. 1A-E, 2A-J.

= *Corda bordasii* Schinini, Bonplandia 5: 101. 1981**.** TYPE: Paraguay, Nueva Asunción, Ruta Trans-Chaco, Cauce seco, 21°30'S, 061°12'W, 12-III-1979, *A. Schinini & E. Bordas 16533* (holotype: CTES, isotypes: G, MO, NY, SI).

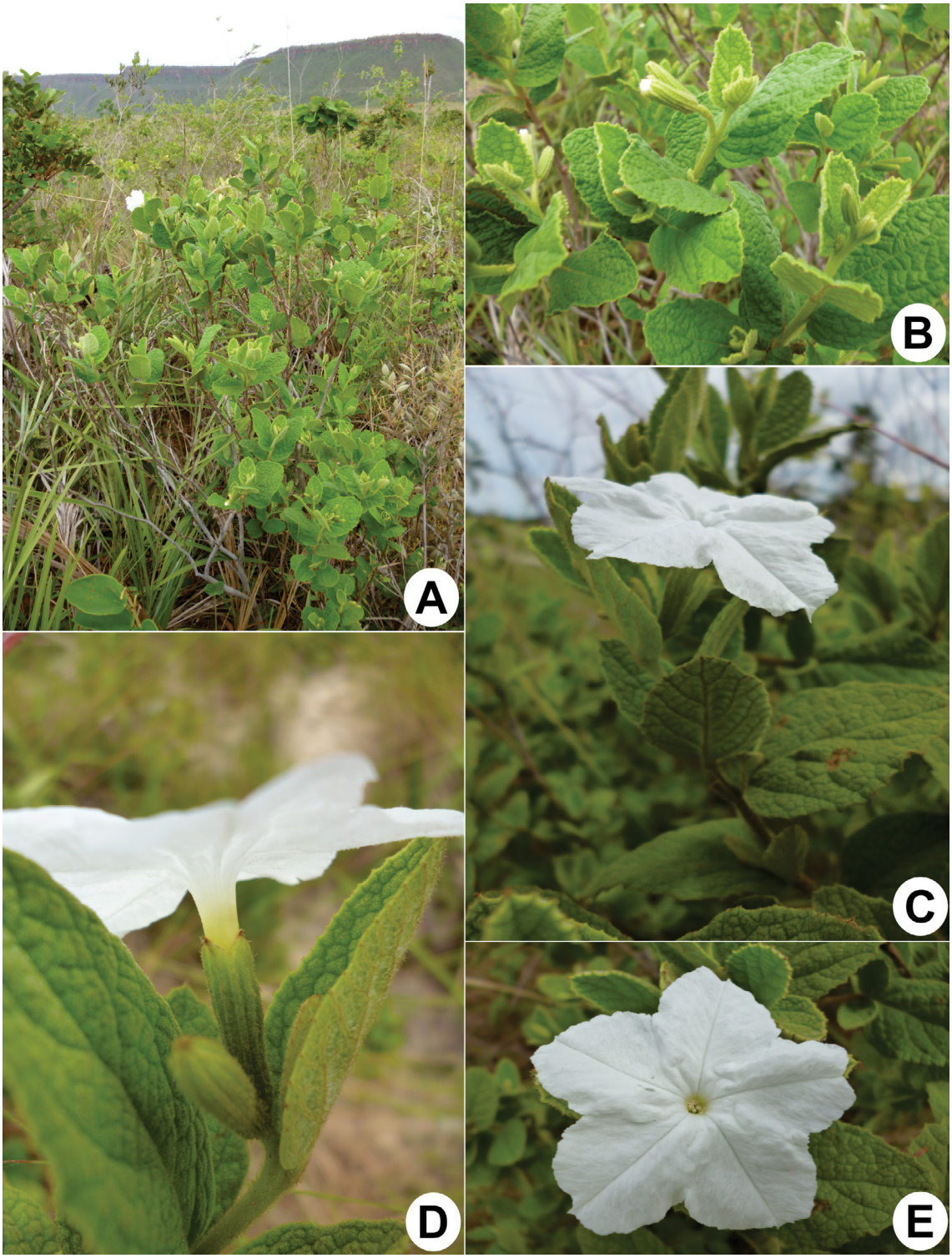

Fig. 1. *Cordia weddellii*. **A,** habit. **B,** flower bud. **C,** flower in lateral view. **D,** detail of flower in lateral view. **E,** flower in frontal view. Photographs by G. M. Antar. Color version at http://www.ojs.darwin.edu.ar/index.php/darwiniana/article/view/964/1232

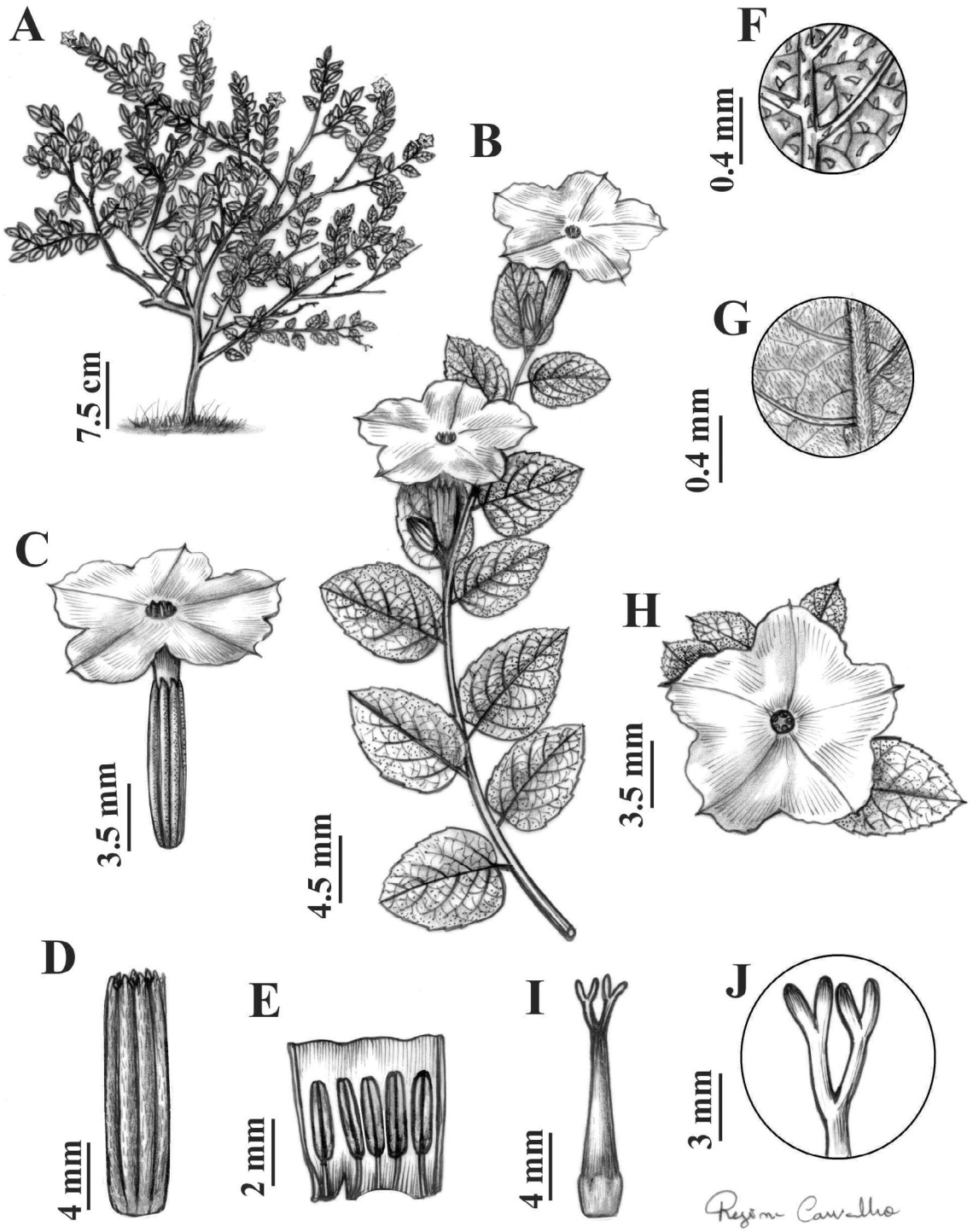

Fig. 2. *Cordia weddellii.* **A,** habit. **B,** flowering branch. **C,** flower. **D,** calyx. **E,** open corolla showing stamens. **F,** detail showing adaxial surface of leaf blade. **G,** detail showing abaxial surface of leaf blade. **H,** flower in frontal view. **I,** gynoecium. **J,** stigmatic branches. Line drawings by R. Carvalho, from *G.M. Antar & M. Escaramai 289*.

Shrubs or subshrubs, 0.3-1.2 m tall; branches cylindrical, costate, lenticellate. Leaves alternate, discolorous, petiolate, petiole 0.5-1.5 cm long, sericeous or hispid; leaf blade 1.7-3.6 × 1.2-2.6 cm, chartaceous, bullate, ovate; adaxial surface scabrous, abaxial surface tomentose, base cordate or truncate, margins serrate or serrulate with base entire, apex obtuse; venation cladodromous, veins ferruginous. Inflorescences cymose, terminal or internodal. Flowers 1.3-1.5 cm long, monoclinous, dichlamydeous, actinomorphic; subsessile or evidently pedicellate, pedicel ca. 5 mm long; calyx 1.4 × 0.4 cm, gamosepalous, tubular-cylindrical, externally sericeous, internally glabrous, apex mucronulate; corolla 1.3-3.0 cm long, hypocrateriform, 5-lobed, rounded, apex acuminate to erose, acuminate in the middle portion, glabrous, resiniferous glands present; stamens 5, epipetalous, homodynamous, filaments ca. 1.2 mm long, glabrous, anthers rimose, ca. 3 mm long; ovary ca. 1.8 mm long, globose, 4-locular, with 1 ovule per locule, presence of white glands in cross section, nectariferous disk present, placentation axillary; style ca. 3 mm long; stigmatic branches foliaceous, each ca. 0.6 mm long, erect. Fruits not seen.

Distribution and habitat. *Cordia weddellii* was previously known only from southwestern South America, in Bolivia and Paraguay. However, in this work it is recorded for the first time in Brazil, presenting a disjunct distribution where it was found in eight localities from Bahia and Tocantins states (Fig. 3), which are part of the Northeast and North regions respectively. The species was found growing in savannah physiognomies (*campo sujo* and *campo cerrado*) with dry, sandy soils or rocky savannah with rocky outcrops (*cerrado rupestre*) at altitudes of 460 to 815 meters, exclusively in areas of the Cerrado phytogeographic domain.

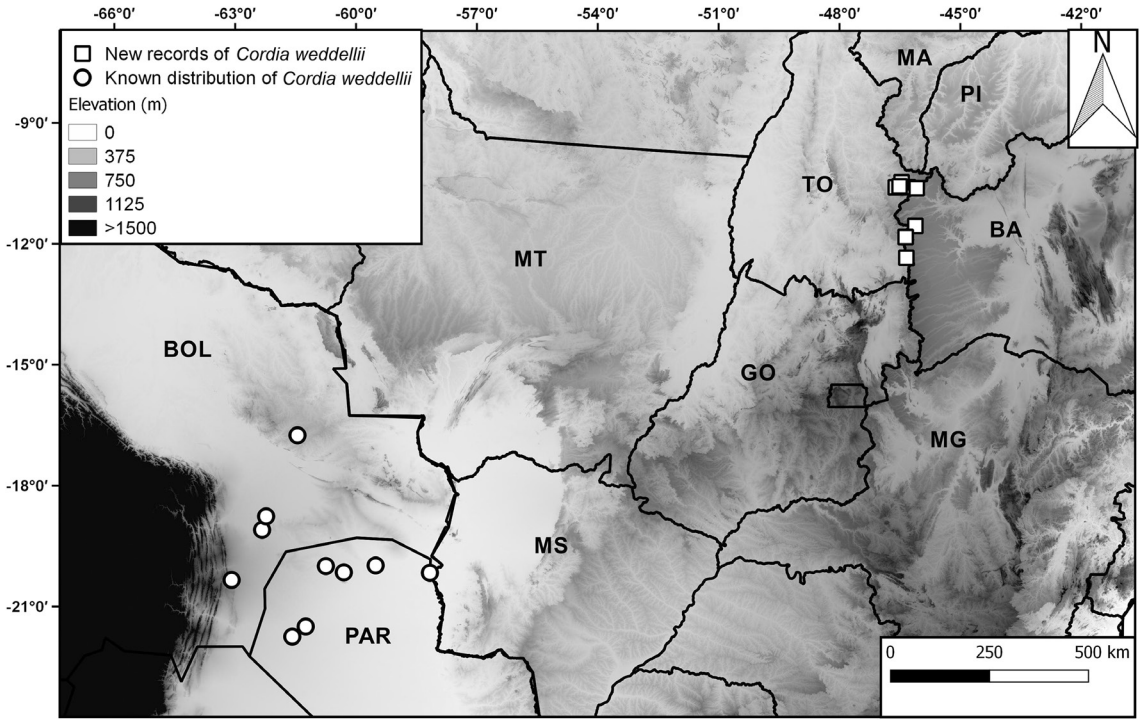

Fig. 3. Distribution map of *Cordia weddellii* showing the disjunction between previously known collections from Bolivia and Paraguay and new records from Brazil. Abbreviations: Countries and Territories: BOL: Bolivia; PAR: Paraguay. Brazilian States: BA: Bahia; GO: Goiás; MA: Maranhão; MS: Mato Grosso do Sul; MT: Mato Grosso; PI: Piauí; RO: Rondônia; TO: Tocantins.

Preliminary conservation status. *Cordia weddellii* is known in Brazil from eight collections, of which five were recorded outside any protected area along the boundaries of Bahia (Northeast region) and Tocantins (North region) states and the other three are restricted to the protected area Parque Estadual do Jalapão, Tocantins state. In Bolivia, it is known until now from three localities, none of them inside Protected Areas; and in Paraguay in five localities, one of them inside the Parque Nacional Defensores del Chaco, a protected area located between the Departments of Alto Paraguay and Boquerón. Although the Extent of Occurrence is high, at 712,600 km², due to the species disjunct distribution, the Area of Occupancy is reduced, encompassing only 76 km². Therefore, we categorize the species as endangered EN B2b(ii,iii)c(iv) (IUCN 2012, 2019). Although the species is included in some protected areas, the Cerrado and Chaco domains, in which the species occurs, have been suffering from continuous habitat loss, due to the rapid advance of the agricultural frontier (Morales et al., 2019; Colli et al., 2020). In Brazil, for instance, the region along the borders of Bahia, Tocantins, Piauí and Maranhão is known as MATOPIBA (area comprising parts of Maranhão (MA), Tocantins (TO), Piauí (PI), and Bahia (BA) states), which the Brazilian government regards as a promising region for agricultural development (Antar et al., 2018; Barbosa-Silva & Antar, 2020). Such development pressures jeopardize the long-term conservation of these northern populations of the species.

Phenology. Recorded flowering in February, May, October, November, and December.

Notes on the species.

The presence of a distinctly 10-ribbed, tubular-cylindrical calyx, large flowers (1-4 cm long), and stamens basally adnate to the corolla tube (Taroda, 1984; Miller, 2013) supports the positioning of this species in *Cordia* section *Cordia*. Although *Cordia bordasii* Schinini is treated as an accepted species in some databases such as the Plants of the World Online (POWO, 2019) and Flora del Cono Sur (Zuloaga & Anton, 2021), it was recently synonymized under *Cordia weddellii* in the Catalogue of the Vascular Plants of Bolivia (Jørgensen et al., 2014), which despite not providing a complete justification for this taxonomic decision, is valid according to ICNAFP (Turland et al., 2017). After a careful examination of protologs and specimens, including original material, mostly as part of the preparation of the treatment of Boraginaceae s.l. for the Flora of Paraguay (Melo, pers. comm.), we agree with the synonymization as both species' circumscriptions completely overlap.

Johnston (1935) in the protologue of *Cordia weddellii*, cites the type as a specimen collected by *H. A. Weddell* numbered 3454 at P herbarium. However, on checking the material housed at P, two specimens of *H. A. Weddell 3454* were found. The specimen with barcode P00634096 is the most complete, with handwriting in the label stating that it is the type. For this reason, the material P00634096 is designated here as the lectotype.

During a survey in various Brazilian herbaria, some specimens of *Cordia weddellii* were identified as belonging to the genus *Varronia* P. Browne, probably due to its shrubby habit, leaves with serrate or serrulate margins and cymose inflorescences. However, the presence of pedicellate or subsessile flowers (always sessile in *Varronia*) and the long tubular and conspicuously ribbed calyx (shortly tubular and never ribbed in *Varronia*) supports its placement in *Cordia*.

The highly disjunct pattern, separated by ca. 1700 km, called our attention, and our first hypothesis was that the specimens from Brazil corresponded to a new species. However, after a more detailed analysis, we verified that these specimens fit entirely in the concept of *Cordia weddellii*, without even any noticeable morphological differences from the type populations. Nevertheless, it is intriguing why a species that apparently has no significant ecological preferences presents such a disjunct distribution. The species inhabits savanna formations in Chaco (Paraguay) and Cerrado (Bolivia) domains, and, located between the confirmed occurrences for the species, there is a lot of similar vegetation, mostly in Mato Grosso and Mato Grosso do Sul states.

Although we could not detect any other species with a similar Bolivia/Paraguay - Tocantins/Bahia states disjunct distribution, other long-distance disjunctions in South America are known.

Examples are between the Andes and the mountains of southeastern Brazil (e.g., *Asplenium castaneum* Schltdl. & Cham., Sylvestre & Windisch, 2003); between semi-arid vegetation along the lower Orinoco River, in the Brazilian semiarid region (Caatinga) and Venezuela (e.g., *Eriopidion strictum* (Benth.) Harley, Harley & Pastore, 2012); between the Guyana Highlands and southeastern Brazil (e.g., *Asplenium pedicularifolium* A. St.-Hil., Sylvestre & Windisch, 2003); and between Amazonia and the Atlantic Rainforest (e.g., *Couratari macrosperma* A.C. Sm., Ribeiro et al., 2020).

The drupaceous fruits of *Cordia weddellii*, which are probably consumed by birds, could explain its wide dispersal. However, this pattern could also be explained by the lack of collections (BFG, 2015), and future expeditions may uncover new populations in Mato Grosso and Mato Grosso do Sul states (Brazilian Central-west region). Furthermore, future phylogeographic studies are desirable to better understand the differences between the disjunct populations and allow for the proposition of well-grounded hypotheses to explain this peculiar distribution pattern.

Specimens examined

BRAZIL. **Bahia.** Formosa do Rio Preto, 10°37'12" S, 46°04'48" W, 11-XII-2017, *O. Neto 881* (UB); ibid, 20 Km da guarita da Faz. Estrondo, 11°33'28" S, 46°6'51" W, 450 m, 02-II-2000, *M. L. Guedes et al. 6792* (HUEFS). Divisa entre Bahia e Tocantins, 11°49'58" S, 46°21'20" W, 14-I-2007, *J. F. B. Pastore et al. 2406* (HUEFS, NYBG, UB). **Tocantins.** Mateiros, Estrada Rio Nova, 10°36'0" S, 46°36'0" W, 469 m, 09-V-2001, *L. H. Soares e Silva et al. 984* (CEN, UFG); ibid, Parque Estadual do Jalapão, 10°34'31" S, 46°30'29" W, 521 m, 30-X-2013, *G. M. Antar & M. Escaramai 289* (HACAM, SPF); ibid, APA Jalapão, estrada para São Felix do Tocantins, 10°28'26" S, 46°27'22" W, 518 m, 02-XII-2012, *M. L. Fonseca et al. 6738* (HUEFS); ibid, ca 23 Km, 10°35'48" S, 46°17'46" W, 603 m, 11-XI-2009, *E. Melo 7212* (HUEFS); ibid, Fazenda Alvorada, 01-VI-2008, *J. Cordeiro et al. 2845* (MBM). Taguatinga, Serra Geral de Goiás, em direção ao distrito de Luís Eduardo Magalhães, 12°20'50" S, 46°20'17" W, 815 m, 26-I- 2005, *J. Paula-Souza et al. 4753* (ESA).

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Appendix 1. List of additional material examined of *Cordia weddellii* from Bolivia and Paraguay.

BOLIVIA. **Santa Cruz.** Cordillera, Santa Cruz, ca. 200 kms. hacia el Sud, Proyecto Abapó Izozog, cerca al rio Grande, 12-III-1981, *G. Beck 6423* (E); ibid, bañados del Izozog, trayecto entre Laguna Negra y Estancia Toborochi, 19°06' S, 62°20' W, 5-I-1993, *I. G. Vargas et al. 1910* (F). Curuyuqui, 50 km SE of Santa Cruz on Rio Parapeti, 18°45'56" S, 62°13'59" W, *A. Gentry et al. 75145* (MO). PARAGUAY. **Alto Paraguay.** Agua Dulce, Parque Nacional Defensores del Chaco, 28-X-1980, *M. Vavrek & E. Enciso 8* (PY); ibid, X.1980, *M. Vavrek & E. Enciso 17* (PY); ibid, X.1980, *M. Vavrek & E. Enciso 25* (PY); ibid, XII.1981, D. Darr 610 (PY); ibid, línea 1, 12 km E. de Agua Dulce, trayecto a Lagerenza, 19°59' S, 59°30'50" W, 12-IV-1997, *F. Mereles 6*536 (MA). Puerto Diana, 5 km de Bahía Negra, 20°10' S, 58°10' W, I-1976, *P. Arenas 1384* (BACP). **Boquerón**: Misión Santa Rosa, 21°45' S, 61°35' W, II-1981, *P. Arenas 1684* (CTES). **Chaco.** Mayor Pedro Lagerenza, 20° S, 60°45' W, 4-IV-1978, *A. Schinini & Bordas 14990* (CTES).