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Four they are! Broadening the description of *Mimosa flabellifolia* (Leguminosae Mimosoideae), a rare species from the Brazilian Cerrado

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Abstract

During a recent floristic survey in the Jalapão region, located in the state of Tocatins, Brazil, the second collection of *Mimosa flabellifolia*, a species known only from the type material, was made. Since the type collection presents only fruits, we herein broaden the description of the species to include floral features. Knowledge about flower morphology, in particular the number of organs, confirms the placement of *M. flabellifolia* in the tetramerous *M.* ser. *Paucifoliatae*. Illustrations, notes and a discussion on issues related to *Mimosa* taxonomy and conservation in the Jalapão region are presented.

Key words: Fabaceae, floristics, Jalapão, rediscovery

Introduction

Current knowledge about *Mimosa* Linnaeus (1753: 516) (Leguminosae Mimosoideae) taxonomy relies mainly on a monograph for the American species (Barneby 1991), particularly since most of its more than 500 species are restricted to tropical America (Luckow 2005). Barneby's (1991) work presented resolutions for many taxonomic problems, and, most important, described many taxa not previously reported in Bentham (1875), while also reviewing the infraspecific classification of the genus. At the same time, he was aware of some issues in his treatment, which he left to be solved by botanists with easy access to the plants in the field (Barneby 1991: 4). Accordingly, many novelties in *Mimosa* taxonomy, particularly new taxa, have been published by Latin American researchers (Grether 2000, Morales & Fortunato 2010, Simon *et al.* 2010, Morales 2012, Savassi-Coutinho *et al.* 2012, Morales *et al.* 2013, Santos-Silva *et al.* 2013, 2015, Dutra & Garcia 2012, 2013, 2014, Borges *et al.* 2014, Jordão *et al.* 2014).

Many of these new taxa of *Mimosa* were described from Brazil, one of the diversity centers for the genus (Luckow 2005). Within Brazil, many *Mimosa* species are restricted to the Cerrado Domain, where they occur in campestral formations, specifically *campo rupestre* or *campo cerrado* (Barneby 1991). The Cerrado Domain is the richest plant diversity savanna in the world, having a high level of endemism (Klink & Machado 2005, Forzza *et al.* 2012). This is partially explained by its huge extension of about 2 million km^2 in central Brazil, extending to Paraguay and Bolivia (Ratter *et al*. 1997), and by its diversity of physiognomies, which range from gallery or deciduous forest to herbaceous fields with dry or wet soils (Eiten 1972). Despite its biological importance, the Cerrado is badly degraded as a result of human activities, mostly soybean cultivation and cattle raising (Ratter *et al*. 1997). The confluence of high endemism and treat to species positions this domain as a hotspot for conservation (Myers *et al.* 2000).

The Jalapão region is one of the most well-preserved areas of the Cerrado. It is located in the easternmost part of the state of Tocantins, and borders the states of Bahia, Maranhão and Piauí. Jalapão is still preserved mostly because its sandy soils are unsuitable for agriculture and because it is a largely unpopulated area (Schmidt *et al*. 2007). It also comprises the largest continuous extension of protected areas of Cerrado, with two important protected areas, the Parque Estadual do Jalapão and the Estação Ecológica Serra Geral do Tocantins (Silva & Bates 2002).

Despite its degree of conservation, the Jalapão flora, much like Cerrado flora as a whole, is relatively unknown (Proença *et al.* 2007), and many areas are botanically under-sampled, particularly the herbaceous stratum (Ratter *et al*. 1997). During a floristic survey recently undertaken in this region (Antar & Sano 2015), a poorly known species of *Mimosa* was collected.

The specimen (*Antar et al. 701*) was a paucifoliate subshrub with thin, diverging stems and small leaves. It was

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blooming, but it had no fruits (Fig. 1). The specimen's morphological features allowed us to place it within *Mimosa* ser. *Paucifoliatae* Bentham (1842: 412). The series is one of the many infraspecific groups recognized within the genus, and it includes plants that are herbaceous or suffrutescent; lack filiform setae (with rare exceptions); may bear glandular setae; may or may not have recurved prickles; and share the presence of tetramerous flowers and craspedial fruits (Barneby 1991). The group comprises 17 species plus 10 varieties, most of them occurring in mountainous areas of Central Brazil, including Jalapão, and Paraguay, but with a few occurring in subtropical Argentina and Brazil, plus one reaching up to tropical Mexico (Barneby 1991).

The absence of prickles and the presence of unijugate leaves with petioles at most 1 mm long, appearing to be sessile, unequivocally matched *Antar et al. 701* to *Mimosa flabellifolia* Barneby (1991: 226), a species previously known only by its fruiting type material, also collected near the Jalapão region (Barneby 1991). The collection of *Antar et al. 701* finally allowed us to know that *M. flabellifolia* indeed has tetramerous flowers (see more below).

In order to expand the taxonomic knowledge about *Mimosa flabellifolia*, we present here an amplification of the description of the species to include floral features. We also discuss some issues concerning the species affinities and conservation.

Material & Methods

Morphological characterization

Morphological features of *Mimosa flabellifolia* were acquired from the recently collected specimen stored at SPF, from the RB holotype images available at JSTOR Global Plants (plants.jstor.org) and from the isotype at NY (acronyms according to Thiers, continuously updated). Measurements were taken with an optical ruler attached to a 10–60 × magnification microscope or with the JSTOR Global Plants digital ruler. Terminology follows Barneby (1991), Harris & Harris (2001) and Radford *et al*. (1976).

Conservation status assessment and mapping

Conservation status was assessed using the GeoCAT Tool (Bachman *et al.* 2011). Area of Occupancy (AOO) analysis was run with the IUCN default cell width of 2 km^2. Values of AOO and Extent of Occurrence (EOO) are given. On the absence of at least three points of occurrence, mandatory for GeoCAT, existing points were replicated and slightly dislocated on the map. The distribution map was produced with QGIS version 2.8.1 (Quantum GIS Development Team 2015).

Taxonomic update

Mimosa flabellifolia Barneby (1991: 226) Figs. 1–3

Type:—BRAZIL. Goiás: [Pindorama de Tocantins], campo cerrado em solo concrecionario, próximo a Pindorama de Goiás, 11º14' S, 47º28' W, 21 April 1978, fr., *R.P. Orlandi 77* (holotype: RB photo! (2 sheets), isotypes: NY! [fragmentary], HRB [?]).

FIGURE 1. *Mimosa flabellifolia*. A. Sparsely clustered individuals. B. Shoot apex with inflorescences. All from *Antar et al. 701*. Photographs by G.M. Antar.

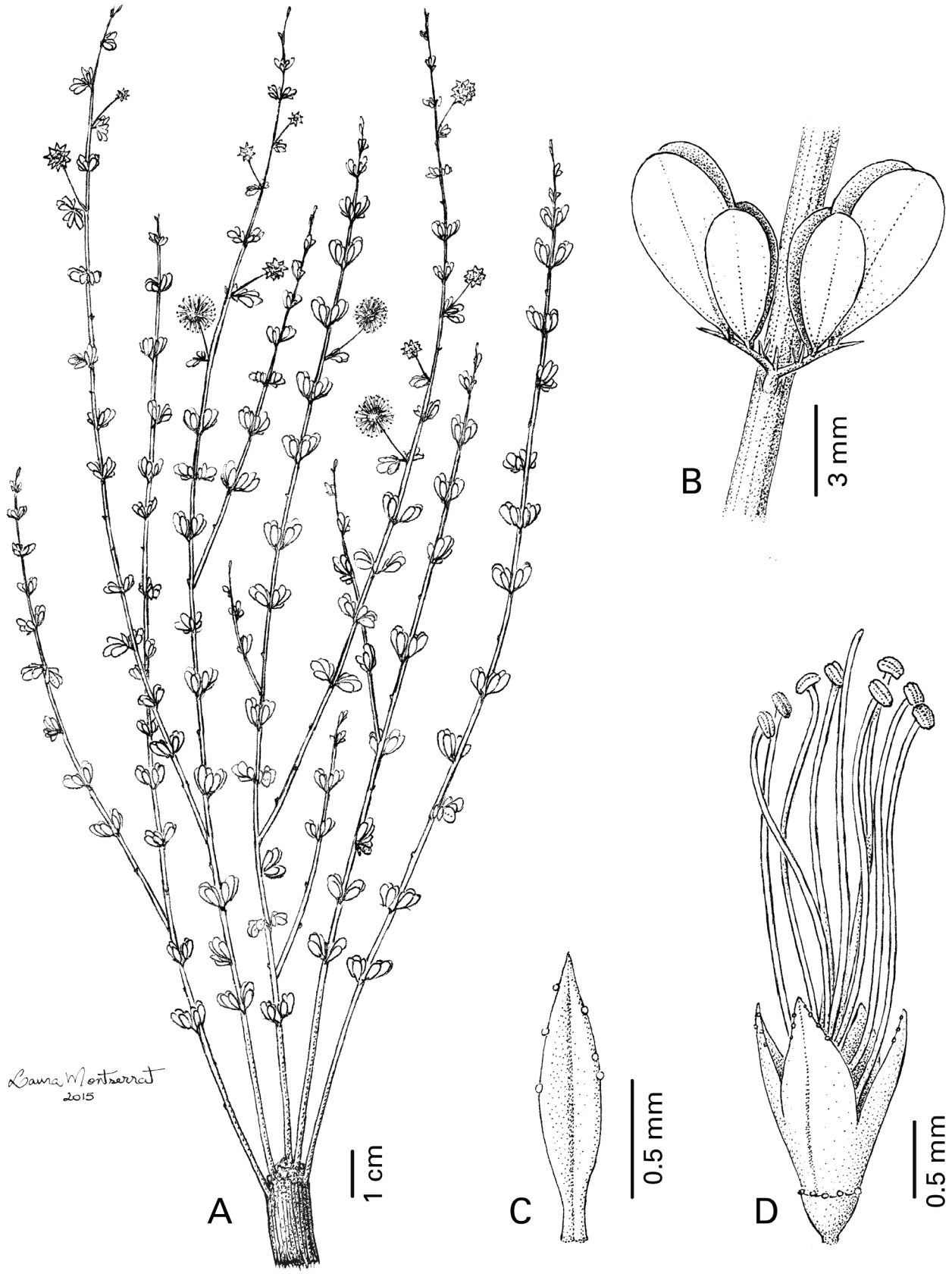

FIGURE 2. *Mimosa flabellifolia*. A. Branch bearing leaves and inflorescences. B. Leaf. C. Floral bract. D. Flower. All based on *Antar et al. 701*. Drawing by Laura Montserrat.

Subshrubs 20–30(–50) cm tall; the thin, ribbed, green to reddish branches spreading from the xylopodium; individuals sparsely clustered. Plants completely glabrous except by some sessile glandular trichomes ca. 0.03–0.05 mm diam. on branches apexes, floral bract's margins and calice's rim. Leaves 1-jugate; stipules 0.5–0.8 mm × 0.1–0.2 mm, lanceolate, persistent; petioles 0.8–1 mm long, ca. 0.4 mm diam., grooved on adaxial surface, the pulvinus 0.4–0.5 mm long, terminal projection 0.5–0.7 × 0.1 mm, lanceolate; rachillas 10–16 mm long, ca. 0.2 mm diam., slightly recurved; leaflets in (1–) 2 pairs per pinna, the basal ones 2.8–3.8 × 1.3–2 mm and the larger distal ones 4.5–5.9 × 2.1–3 mm, all narrowly-obovate to obovate, 0.3–0.5 mm apart, veins 3-palmate, but usually only the midrib is perceived as prominent on the abaxial surface, apex rounded and mucronate to obtuse, base slightly inequilateral, rounded; the prominent paraphyllidia 0.3–0.4 × ca. 0.1 mm, subulate. Racemes 3.3–3.5 × 3.5–3.8 mm, globose, 1-axillary to a young leaf that may fully develop only after the anthesis of its associated raceme; peduncles 8.2–9.5 mm long; floral bracts 0.7–1 × ca. 0.3 mm, ellipsoid-acuminate, slightly cymbiform, 1-nerved, glabrous except by the margins with a few glandular trichomes; flowers 4-merous, diplostemonous, basal ones staminate only; pedicel 0.1–0.2 mm long; calyx 0.3–0.5 mm long, cupulate, tube 0.2–0.4 mm long, lobes 0.1–0.2 mm long, rim ciliate with a few glandular sessile trichomes less than 0.5 mm long; corolla 1.7–2.2 mm long, campanulate, glabrous, lobes 0.9–1.1 × 0.6–0.7 mm, narrowly ovate, 1-nerved, vein branching at the acute apex; filaments 3.8–5 mm long, glabrous, fused ca. 0.1 mm at base, apparently white; anthers ca. 0.4 × 0.4 mm, glabrous; ovary 0.5–0.6 × ca. 0.3 mm, compressed, elliptic, glabrous, stipe ca. 0.2 mm long, glabrous; style 5.2–6 mm long, glabrous; stigma porate, glabrous. Fruit a craspedium 24–35.7 × 6.2–8.75 mm, elliptic to narrowly oblong, constricted between articles, papery, dark brown, apex obtuse to rounded, obliquely aristate, base cuneate, sometimes rounded; pedicel 3–6.5 × 0.5–0.6 mm; replum ca. 0.5 mm wide; valves breaking into 1–3(–5?, Barneby 1991) articles, 6.6–12 × 5.4–7.95 mm, monospermic, oblong to elliptic, truncate at the breaking region, colliculate over each seed; sparsely puberulous with sessile glandular setae ca. 0.05 mm diam.; seeds not seen.

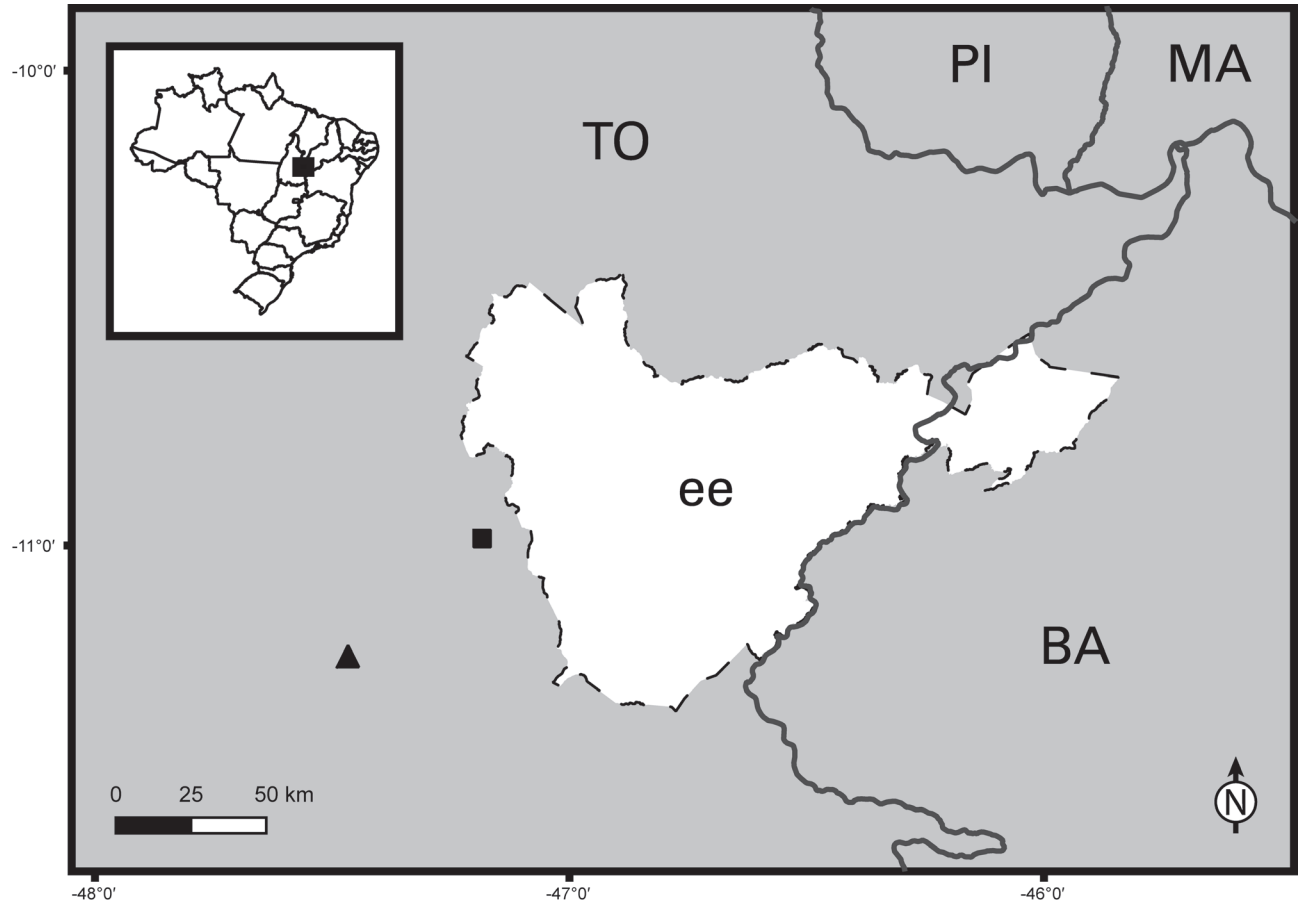

FIGURE 3. Known points of occurrence of *Mimosa flabellifolia*, both outside of the Estação Ecológica Serra Geral do Tocantins (ee; white area). ■ *Antar et al. 701*. ▲ Approximate type collection site. States: BA—Bahia; MA—Maranhão; PI—Piauí; TO—Tocantins.

Additional specimens examined:—BRAZIL. Tocantins: Ponte Alta do Tocantins, estrada Ponte Alta do Tocantins–Rio da Conceição, próximo à fazenda do Sr. Luis Piriquito, 10°59'08,9'' S, 47°11'02,4'' W, 29 January 2015, fl., *G.M. Antar et al. 701* (SPF! NY! [To be distributed]).

Distribution:—*Mimosa flabellifolia* is endemic to Jalapão and nearby areas in the state of Tocantins, Brazil. It occurs in sandy soils of open cerrado vegetation, at elevations from 450 to 600 m. Populations are small, apparently rare and formed by sparsely clustered individuals.

Conservation status:—CR. GeoCAT analysis indicates EOO as 0.344 km^2 and AOO as 8000 km^2. Both values place *Mimosa flabellifolia* in the critically endangered category (IUCN 2012). It is important to note, however, that the species was collected only twice in a botanically underexplored area. Therefore, it is possible for its areas of occurrence and extension to be larger. Nonetheless, the fact that only two populations with few sparsely distributed individuals are known rises the threaten concern of *M. flabellifolia*.

Notes:—The type specimens of *Mimosa flabellifolia* were collected as part of the RADAM Brasil project, which had as one of its goals to survey the Brazilian Vegetation. Specimens collected during the project were stored at the HRB herbarium and duplicates were sent to other herbaria, including RB. We were not able to check the HRB collection, but it is very likely that it houses an isotype of *M. flabellifolia*.

Barneby (1991) indicates that the proximal anterior leaflet is commonly lacking in the species. However, all leaves of *Antar et al 701* bear four leaflets organized in two pairs. The photograph of the isotype at RB also appears to have both basal leaflets, although study of the specimen itself is necessary. Nonetheless, we believe that Barneby's impressions are artificial, based on the scant collection he studied and the ease with which leaflets fall.

According to Barneby (1991: 226), the racemes of *Mimosa flabellifolia* may form "a lax terminal pseudoraceme, the lowest ones subtended by a leaf, the upper bracteate". Nonetheless, the specimens and images we studied, particularly the recently collected specimens, exhibit all racemes subtended by leaves, which may not be fully expanded during anthesis. In some cases, similar to what is seen in the type material, those leaves may have fallen. At present, it is not possible to evaluate if the development of leaves continues parallel to fruit maturation, since leaves subtending fruits are not present in the type material, and *Antar et al. 701* has only flowers.

Discussion

The collection of a flowering specimen of *Mimosa flabellifolia* proved that Barneby (1991: 226) was right in predicting that the species would have tetramerous flowers, even if based only on the overall morphology of the type collection. The discovery of the flower was also important to ascertain the affinities of *M. flabellifolia*, since *M.* ser. *Paucifoliatae*, as already noted by Barneby (1991), shares morphological similarities with *M.* ser. *Filipedes* Barneby (1991: 283). The distinction between those series is mainly based on the number of floral parts (Barneby 1991: 198; 284). Also, seven (out of 27) taxa with just one pair of pinnae are present in *M.* ser. *Paucifoliate*, but all six species of *M.* ser. *Filipedes* have unijugate leaves. Thus, it was possible that *M. flabellifolia* belonged to the latter.

Although the discovery of *Mimosa flabellifolia* flowers has confirmed its placement in the *Mimosa* infrageneric classification, it does not shed additional light on the relationship between *M.* ser. *Paucifoliatae* and *M.* ser. *Filipedes*. A molecular phylogenetic study (Simon *et al.* 2011) indicates that the latter series is monophyletic and is placed in a grade with elements of the first series plus the monotypic *M.* ser. *Echinocaulae* Barneby (1991: 195). Apparently, regardless of the resolution of this particular clade in the *Mimosa* phylogeny, the trimerous condition is a derived feature and a synapomorphy of *M.* ser. *Filipedes*. In turn, the number of pinnae pairs in *Mimosa* is variable, even within the same species. However, it seems that once it is reduced to just one pair, it tends to be fixed at this number. This condition is striking in *Mimosa* sect. *Mimosa*, a large section with all its members having just one pair of pinnae. Nonetheless, interpretation of this character's evolution is uncertain, since the phylogenetic relationships of *Mimosa* sect. *Mimosa* are still not clear (Simon *et al.* 2011). Hence, it would be interesting to determine if *M.* ser. *Filipedes* is sister to *M. paucifoliatae*, or, if nested within *M. paucifoliatae*, if it is related to the few unijugate species belonging to it, all of which were not sampled in the phylogeny of Simon *et al.* (2011).

The Jalapão region has the largest continuous extension of protected areas in the Cerrado, but *Mimosa flabellifolia* does not occur in any of them. However, the most recent collection of the species was made near the Estação Ecológica Serra Geral do Tocantins. Therefore, even if it was not found within the Estação Ecológica Serra Geral during recent surveys, it most likely does occur inside this protected area. On the other hand, the area where *M. flabellifolia* was rediscovered has an apparent different soil composition, since visually similar soils were not found elsewhere during intensive fieldwork conducted in the Jalapão region. If that is the case, it is likely that this particular soil type houses other species with the same edaphic preferences of *M. flabellifolia*. Following this reasoning, conservation management plans should consider merging this area with existing protected sites, such as the Estação Ecológica Serra Geral. This would increase the conservation of a larger diversity of species and sites in a region that is already threatened by the

expansion of soybean cultivation. Nearby areas have already been replaced by crop cultures that use chemicals to make the cerrado soil suitable for agriculture.

Final remarks

The rediscovery of *Mimosa flabellifolia* after more than 35 years of the type collection shows that well planned, well executed and thoroughly conducted botanical surveys (Antar & Sano 2015) are important for the development of taxonomy. Moreover, they support the establishment of detailed knowledge about organism's diversity and distribution that provides a basis for changing conservation strategies and policies.

Currently we face a critical time for biodiversity maintenance (Barnosky *et al.* 2011, Butchart *et al.* 2010), lack or undermining of natural history collections (Deng 2015, Paknia *et al.* 2015) and taxonomic impediment (Wheeler 2004, 2014). Thus, it is important to reinforce the execution of biological surveys, which, in turn, may set in motion a process which includes valorization of biological collections and production of comprehensive monographs with multifaceted approaches (Funk 2006, Marhold *et al.* 2013), culminating in increased knowledge about the biological world.

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