



Two new and endangered species of *Syngonanthus* (Eriocaulaceae) from Chapada dos Veadeiros, Goiás, Brazil

MAURICIO T. C. WATANABE¹; LÍVIA ECHTERNACHT²; NANCY HENSOLD³ & PAULO TAKEO SANO¹

¹ Laboratório de Sistemática Vegetal, Departamento de Botânica, Instituto de Biociências, Universidade de São Paulo, CEP 05508-900, São Paulo, Brasil. E-mail: mtcwatanabe@gmail.com, ptsano@usp.br

² Instituto de Biologia, Universidade Federal de Uberlândia, Rua Ceará s/n Bloco 2D, Umuarama, CEP 38400-902, Uberlândia, MG, Brasil. E-mail: livia.echter@inbio.ufu.br

³ Botany Department, Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, Illinois 60605-2496, U.S.A. E-mail: nhensold@fieldmuseum.org

Abstract

We describe and illustrate two new species of *Syngonanthus* from Chapada dos Veadeiros (Central highlands of Brazil), an area known for its high number of endemic and threatened species, such as those described here. These species have a restricted distribution and inhabit critical areas. *Syngonanthus incurvifolius* has not been collected since 1994 and is critically endangered; *Syngonanthus vittatus* is known only from a small somewhat disturbed area, on private property, and is endangered. Evaluation of threatened status was provided by CNCFlora, the IUCN Red List Authority in Brazil.

Key words: Brazil, Cerrado, Conservation, Everlasting plants, Monocotyledons, new species, Taxonomy

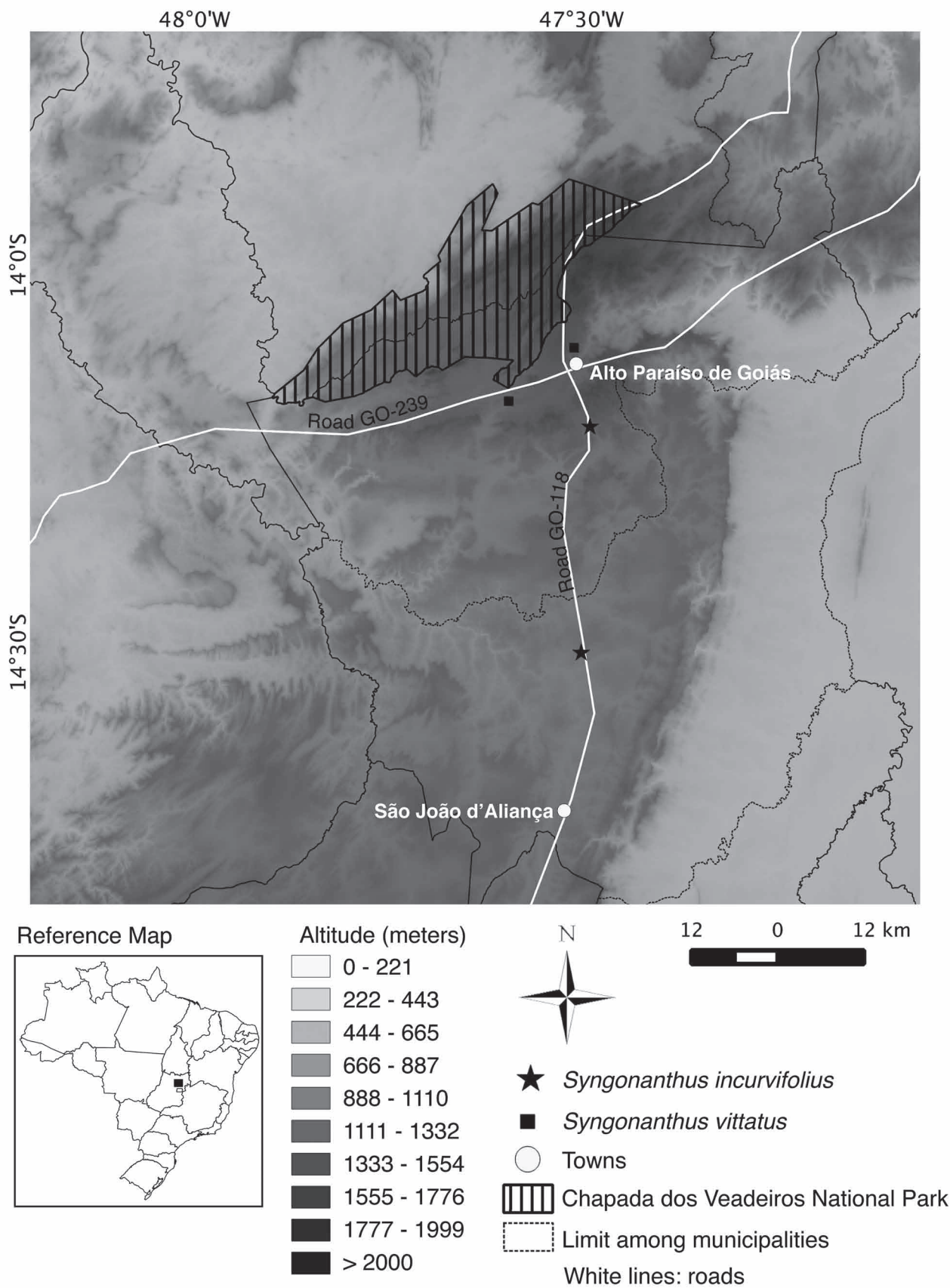
Resumo

Duas novas espécies de *Syngonanthus* são descritas para a Chapada dos Veadeiros, na região do Brasil Central. Conhecida pela grande quantidade de endemismos, esta área abriga muitas espécies ameaçadas como as descritas aqui. Não há registro de coleta para *Syngonanthus incurvifolius* desde 1994, que é criticamente ameaçada de extinção; *Syngonanthus vittatus* é uma espécie conhecida apenas para pequenas áreas em propriedades particulares e está ameaçada. A avaliação do estado de ameaça foi provida pelo CNCFlora, a autoridade da Lista Vermelha da IUCN no Brasil.

Palavras chave: Brasil, Cerrado, Conservação, Monocotiledôneas, espécies novas, Sempre-vivas, Taxonomia

Introduction

Syngonanthus Ruhland (1900: 487) is characterized by pistillate flowers with petals fused in the middle and free at the base and apex, a character also attributed to *Mesanthemum* Körn. (1856:572) and *Comanthera* L.B.Sm. (1937:38) *emend.* Parra *et al.* (2010:1136), a genus recently reestablished and recircumscribed based on molecular and morphological data (Giulietti *et al.* 2000; Andrade *et al.* 2010; Echternacht *et al.* 2014; Echternacht *et al.* 2015). The features that distinguish *Syngonanthus* from *Comanthera* are petals shorter than sepals in pistillate flowers (*vs.* pistillate flowers with sepals shorter than petals), petals fused in the distal part with short lobes (*vs.* fused in a narrow region leaving long free apices), seed surface reticulate (*vs.* rough) (Giulietti *et al.* 2012, Echternacht *et al.* 2014) and predominance of flavonoids as 6-hydroxyluteoline derivatives (*vs.* C-glucosides) (Ricci *et al.* 1996). *Syngonanthus* contains approximately 110 species, distributed in Africa and the Neotropics. Species diversity is concentrated in the mountains of the Espinhaço Range, in Minas Gerais and Bahia States; in Chapada dos Veadeiros, in Goiás State; and in the Amazonian savannas (Echternacht 2012), where micro-endemic species are common, some of them restricted to a few mountaintops. However, some species are widespread, accounting in large part for the distribution of the genus from southern South America to northern Central America. In Brazil, the genus is well represented in open areas, especially on sandy streambanks, grasslands and rock outcrops.



Scale 1: 550 000

Source: altitudinal data from TOPODATA project

<http://www.dsr.inpe.br/topodata/>, accessed November 2013

FIGURE 1. Map of Chapada dos Veadeiros region showing collection localities of *Syngonanthus incurvifolius* and *S. vittatus*.

The new species described here occur in Alto Paraíso de Goiás municipality (Goiás State, Central Brazil) on the Veadeiros Plateau (“Chapada dos Veadeiros”) (Fig. 1). This region has a species-rich flora and high levels of endemism, especially in Eriocaulaceae, Cyperaceae, Poaceae and Xyridaceae (Munhoz & Felfili 2006) at elevations ranging from 800 to 1650 m. This plateau encompasses open grass savannas, *campo rupestre* vegetation and *Cerrado* woodlands located among rock outcrops and over shallow, acid soils derived from sandstone and quartzite rocks (Munhoz & Felfili 2006; Simon *et al.* 2010; Trovó & Sano 2011). This region corresponds to a small portion of the Brazilian Cerrado hotspot under constant threat. An aggravating factor is that these new species occur outside protected areas of Chapada dos Veadeiros National Park (PNCV), near to tourist areas and cattle grazing. Even now, new species are still being described and discovered in this region, including recent examples in Eriocaulaceae (Trovó & Sano 2011; Echternacht *et al.* 2015). This fact shows that Chapada dos Veadeiros is still in need of basic taxonomic studies and its biodiversity is still poorly known (Simon *et al.* 2010).

Syngonanthus is divided into two sections, *S.* sect. *Syngonanthus* and *S.* sect. *Carphocephalus*; the former includes most of the morphological and species diversity and the latter includes species with spongy petals, usually free filaments, and elongated vegetative stems. *Syngonanthus* sect. *Syngonanthus* appears paraphyletic, encompassing a polyphyletic *S.* sect. *Carphocephalus* (Echternacht *et al.* 2014), but further phylogenetic studies are necessary to provide stable phylogenies and a corresponding taxonomy (Watanabe *et al.* in prep.). The species described herein are included in the morphological concept of *S.* sect. *Syngonanthus* and, more precisely, are similar to the species of *Syngonanthus* previously placed within *Paepalanthus* Martius (1834:28) subg. *Andraspidopsis* Koern. Ruhland (1903) did the last worldwide revision for the family and transferred these species from *Paepalanthus* to *Syngonanthus*.

To avoid any confusion, we would like to explain that several of the “varieties” that will be mentioned here in the text are to be treated as different species. A taxonomic treatment is being done to change the status of these taxa by Echternacht *et al.* (in prep.).

Taxonomic treatment

Syngonanthus incurvifolius M.T.C.Watan. & Echternacht, *sp. nov.* Type:—BRAZIL. Goiás: Alto Paraíso de Goiás, ca. 15 km south of Veadeiros, road to São João da Aliança, cerrado on outcrops, in wet sand, adjacent campo, 1000 m alt., 19 March 1969, H. S. Irwin, R. Reis dos Santos, R. Souza & S. F. da Fonseca 24648 (Holotype UB!, Isotypes F!, MO!, NY! RB!). Figures 2 A–G & 3.

Syngonanthus incurvifolius differs from all other New World species of *Syngonanthus* by the rosette leaves incurved from the middle to the apex. It differs from *Syngonanthus arenarius*, the most similar species, by pistillate flowers with cream sepals and adpressed trichomes on the leaves. *Syngonanthus incurvifolius* is also similar to *Syngonanthus densifolius* var. *majus* but differs by pistillate flowers with pilose petals, sepals cream with a light castaneous longitudinal band, and individuals smaller.

Perennial herbs, 7.5–18.0 cm tall. *Roots* 0.75–1.4 mm in diameter, cream-colored, spongy. *Rosettes* 1.7–3.4 cm in diameter. *Rhizome* 1.0–2.5(–5) cm × 2.5–7.5 mm, horizontal to oblique, often branched, tomentose to villous, with white, dense and interwoven trichomes ca. 1 cm long; each branch giving rise to a rosette of leaves, each rosette bearing 1–5 synflorescences. *Leaves* 0.5–2.0 cm × 0.75–1.20 mm, linear, flat to semi-terete, apex acute to round, base truncate, sinuous, recurved at base, becoming incurved from the middle to the apex, firm to rigid, striate adaxially with 3-veins prominent, or only the midvein perceptible in young leaves; densely pilose adaxially, glabrescent to pilose abaxially, with adpressed trichomes, and patent, simple trichomes ca. 0.5 mm long; basal sheath not enlarged. *Synflorescences* with a primary axis bearing a lax umbel of 1–18 inflorescences at the apex. *Synflorescence axes* 2–8 cm long, 0.2–1.0 mm in diameter, emerging from the center of the rosette, erect to curved, brown, sometimes with a dark-reddish tinge, glabrescent to pilose with simple filamentous trichomes ca. 0.3 mm long. *Bracts of synflorescence axis* restricted to the apex, 0.2–3.0 cm × 0.5 mm, whorled and numerous, patent, progressively elongating from the outer toward the inner series, linear to narrowly lanceolate, apex acute, erect to uncinata, pubescent on both surfaces with adpressed trichomes, and patent, capitate and simple, filamentous trichomes, capitate trichomes mostly on abaxial surface, simple trichomes concentrated at margins. *Inflorescences* composed of a closed spathe subtending a scape with a capitulum at the apex. *Spathes* 1–4 cm long, chartaceous, cylindrical, lax at apex, obliquely opened, apex acute to obtuse, erect to recurved, tip erect to uncinata, margin entire, not involute, glabrous adaxially, pubescent abaxially with capitate and simple, filamentous trichomes. *Scapes* erect, 3–12 cm long, green to straw-colored with age, 3-costate, pilose, pubescent near the apex with erect to patent, simple and capitate trichomes. *Capitula* 4–8 mm in diameter,

radiate. *Involucral bracts* in 5–7 series, castaneous, reddish-brown to brown, sometimes with a lighter stramineous longitudinal band in the middle and on the margins, glabrous on adaxial surface, pilose to glabrescent abaxially, ciliate, with simple filamentous trichomes, rarely also capitate trichomes, these concentrated at the apex, ca. 0.3 mm long; external series 1.0–1.8 × 0.5–0.8 mm, triangular to ovate, apex acute, progressively longer toward the internal series, middle series 2.5–3.0 × 0.9–1.2 mm, obovate, apex acute to obtuse, internal series 2.5–3.0 × 0.3–0.7 mm, equaling the flower height, elliptic to slightly oblanceolate, apex acute to obtuse, sometimes membranous, lighter-colored than the external series; receptacle obconic, pilose. *Floral bracts absent*. *Flowers* 3-merous, 40–100 per capitulum, the staminate and pistillate generally equal in number, with contrasting colors, staminate flowers darker and concentrated at the border of the capitulum or mixed. *Staminate flowers* with pedicels 0.5–1.0 mm long, pilose in the bottom part of pedicel with simple trichomes ca. 1 mm long; sepals 1.5–2.0 mm long, coppery brown, shortly fused at base, concave, membranous, the sepals slightly different from each other, or two sepals similar to each other and a third different, falcate-asymmetrical, oblanceolate, elliptic or irregular-subspathulate, apex mucronate, cuspidate, rounded or obtuse to acute, glabrous adaxially, pubescent abaxially, especially at apex and margin, with simple filamentous trichomes ca. 0.4 mm long; petals 1–2 mm long, hyaline, membranous, fused, tubulose, lobes obtuse to rounded, involute after anthesis, glabrous; stamens adnate to the petals at base, anthers ca. 0.3 mm long, cream to yellowish; anthophore ca. 0.3 mm long; pistillodes 3, ca. 0.3 mm long, clavate, papillose at apex. *Pistillate flowers* 2–3 mm long, including pedicels; pedicels 0.4–1.0 mm long, with filamentous trichomes at insertion with receptacle, actinomorphic; sepals equaling the petal height, 1.2–2.0 mm long, oblong to widely ovate, concave, apex acute, base thickened, free, white with a light castaneous longitudinal band, adaxially glabrous, abaxially pubescent near the apex, ciliate, with simple filamentous trichomes up to 0.5 mm long; petals about equaling the sepals, 1–2 mm long, linear to oblong, fused at the upper half, free at base and at the very top, lobe triangular, apex acute, membranous, white to hyaline when hydrated, pilose with simple filamentous trichomes up to 0.5 mm; gynoecium ca. 2 mm long; ovary 0.4–0.6 mm long; style column ca. 0.2 mm long, cream-colored to castaneous; appendages ca. 0.4 mm long, the glandular apex capitate; stigmatic branches simple, ca. 1.5 mm long. *Seed* 0.4–0.6 × 0.2–0.3 mm, ellipsoid, brown-colored.

Etymology:—The specific epithet refers to the orientation of the rosette leaves, which are curved inward and upward at the distal middle, a unique feature within Brazilian *Syngonanthus*. Only *Syngonanthus wahlbergii* Ruhland (1903:247) in Africa has leaves like this.

Notes and taxonomic affinities:—Several species share a similar architecture with *Syngonanthus incurvifolius*, including: a rhizome with apical rosettes of leaves, bearing synflorescences with verticillate bracts at the apex and scapes arranged in lax umbels. The following taxa also share dark and pilose involucral bracts (Fig. 3H), usually with a lighter longitudinal band abaxially: *Syngonanthus arenarius* (Gardner) Ruhland (1903:260), *S. densifolius* var. *brachyphyllus* Moldenke (1984: 372), *S. densifolius* var. *majus* Moldenke (1972:499), and *S. vittatus*, the new species described here below. *Syngonanthus densifolius* var. *majus* and *S. densifolius* var. *brachyphyllus*, actually do not belong to *S. densifolius*, which possess golden to cream, glabrous involucral bracts, and shall be elevated to species status (Echternacht *et al.* in prep.). We consider these five taxa to form a cohesive morphological group due to the characters mentioned above. All of them, except *S. arenarius*, occur in Chapada dos Veadeiros and they are possibly sympatric.

Syngonanthus incurvifolius also shares with these four taxa an unusual floral trait: sepals of staminate flowers are always clearly asymmetrical (FIG. 3D; 3F). The three sepals might differ in form and curvature or two might be similar and the third different.

Syngonanthus incurvifolius differs from the congeneric species that have synflorescences by the remarkable form of the rosette leaves, which are recurved at base and incurved at the upper half. This feature persists even after diaphanization. *Syngonanthus densifolius* var. *brachyphyllus* can be easily distinguished from *S. incurvifolius* by its broader leaves (ca. 2–5 vs. 0.5–2 mm), with arachnoid trichomes on the adaxial surface (vs. not arachnoid), which is reticulate (vs. striate), and leaf bases achlorophyllous and pale (vs. chlorophyllous and green) (FIG. 3C). *Syngonanthus densifolius* var. *majus* differs by pistillate flowers with glabrous petals (vs. pilose), and darker sepals, light-brown at the upper half (FIG. 3G; 3J) (vs. cream with a longitudinal light castaneous band); moreover, individuals are bigger than *S. incurvifolius* and the rosette leaves are erect and flexuous. *Syngonanthus arenarius* var. *arenarius* shares with *S. incurvifolius* the small size and pilose petals of pistillate flowers (FIG. 3E; 3I); it differs by the cup-shaped bracts of the synflorescence (equal size), which are fewer (vs. progressively elongating from the outer toward the inner series and more numerous), and pistillate flowers with sepals cream at base and dark reddish-brown on the upper half (vs. cream with a longitudinal light castaneous band). *Syngonanthus incurvifolius* also differs from *S. vittatus* by the synflorescence axis bearing bracts only at the apex (vs. tiny bracts scattered along axis), the petals of the pistillate flowers pilose (vs. glabrous), and the involucral bracts of the middle series obovate (vs. narrow-elliptic).

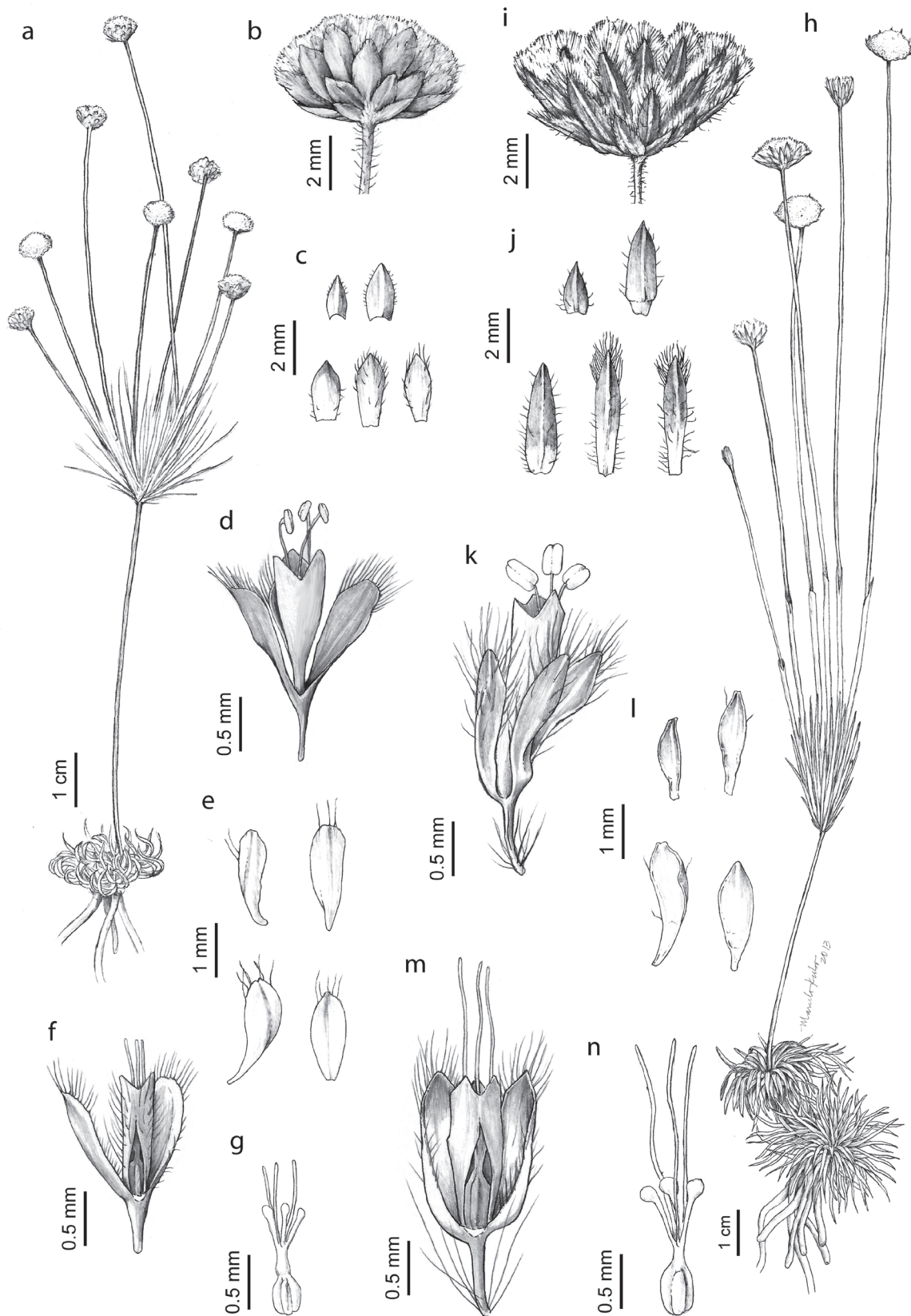


FIGURE 2 A–G. *Syngonanthus incurvifolius* (based on Irwin *et al.* 24648). **A.** Habit; **B.** Capitulum detail; **C.** From outermost to innermost series of involucral bracts; **D.** Staminate flower; **E.** Various forms of sepals of staminate flower; **F.** Pistillate flower with one sepal removed; **G.** Gynoecium. **H–N.** *S. vittatus* (based on Watanabe & Watanabe 377). **H.** Habit; **I.** Capitulum detail; **J.** From outermost to innermost series of involucral bracts; **K.** Staminate flower; **L.** Various forms of sepals of staminate flower; **M.** Pistillate flower with one sepal removed; **N.** Gynoecium. Illustrated by Marcelo Kubo.

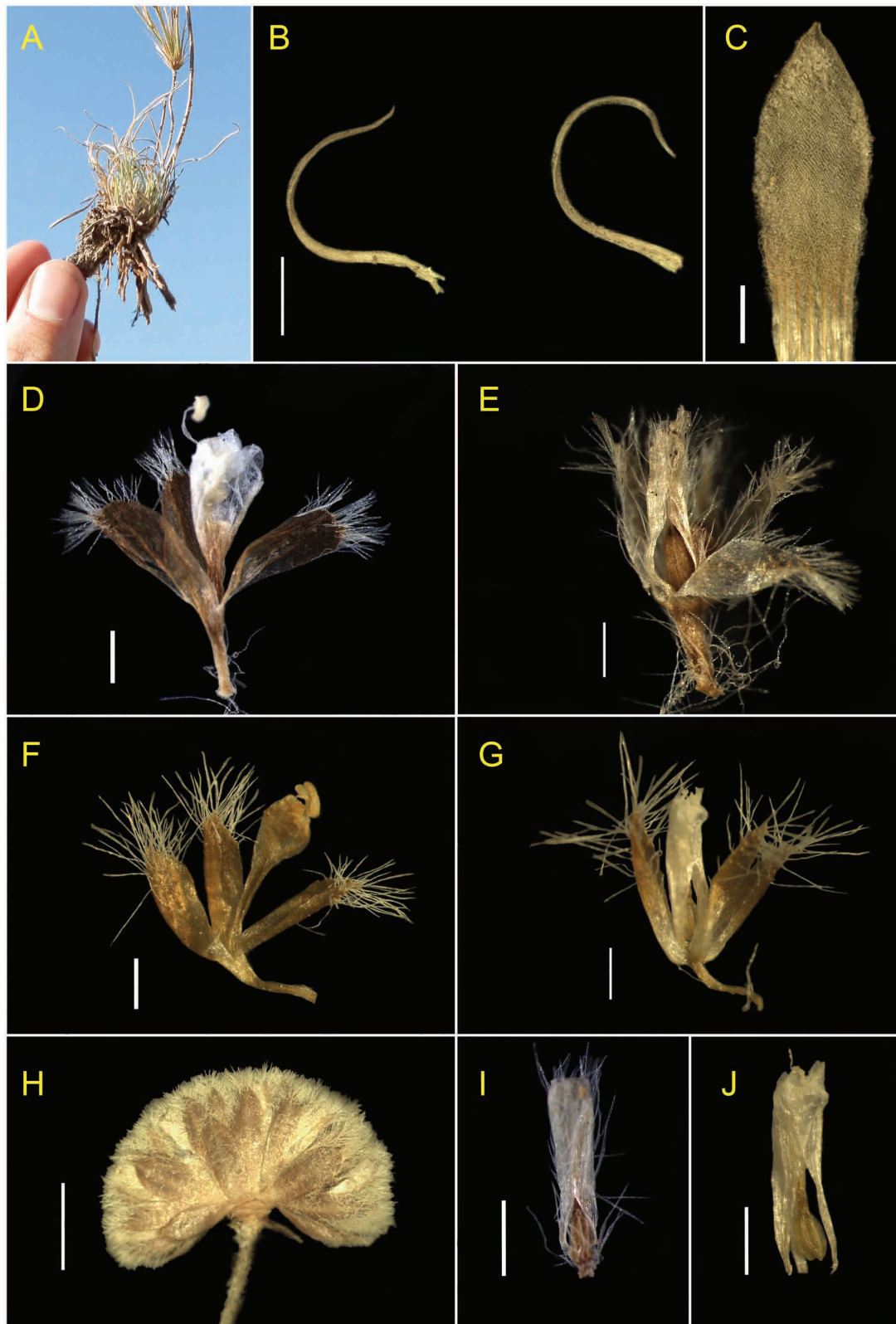


FIGURE 3. *Syngonanthus incurvifolius* and other morphologically similar *Syngonanthus* species. **A–C.** Comparison among leaves: **A.** *Syngonanthus densifolius* var. *majus* showing erect, flexuous leaves in a rosette; **B.** Incurved leaves of *S. incurvifolius*; **C.** Leaf of *S. densifolius* var. *brachyphyllus*, showing achlorophyllous base. **D–G.** Comparison among sexual traits of *S. incurvifolius* and *S. densifolius* var. *majus*: **D.** Staminate flower of *S. incurvifolius* (trichomes removed from pedicel); **E.** Pistillate flower of *S. incurvifolius* with filamentous trichomes; **F.** Staminate flower of *S. densifolius* var. *majus*; **G.** Pistillate flower of *S. densifolius* var. *majus* exhibiting trichomes only at upper portion of the sepals; **H.** Capitulum detail of *S. incurvifolius*; **I–J.** Comparative vestiture of the petals in pistillate flowers: **I.** *S. incurvifolius* showing pilose petals; **J.** Petals glabrous in *S. densifolius* var. *majus*. Scale bars: B= 3 mm, C,H= 2mm, D–G, I–J: 500 μ m. (Photos by Mauricio T. C. Watanabe).

Syngonanthus incurvifolius has been determined as *S. densifolius* var. *pilosior* Silveira (1928:320) in some herbaria. Actually, *S. densifolius* var. *pilosior* is probably a synonym of *S. anthemiflorus* var. *similis* (Ruhland) L.R.Parra & Giulietti (1997:228) (Echternacht 2012), which can be easily distinguished from *S. incurvifolius* by the involucre bracts surpassing the capitulum disc (*vs.* not surpassing), the outer series golden to straw-colored and the internal series cream (*vs.* all series castaneous to reddish-brown). Furthermore, the distributions of these taxa do not overlap, as *S. anthemiflorus* is restricted to the Espinhaço Range in Minas Gerais State.

Phenology:—The flowering season of *Syngonanthus incurvifolius* is somewhat different from congeneric sympatric species. Most species of *Syngonanthus* bloom during the dry season but the blooming period of *S. incurvifolius* recorded in herbaria is between February and May (the rainy season). Exceptions are *S. densifolius* var. *majus* and *S. densifolius* var. *brachyphyllus*, whose records also attest for a blooming in the first semester of the year. Flowers of *S. incurvifolius* are in anthesis from February to April, corresponding to the latter half of the rainy season in the region. Fruits were observed only in herbarium specimens collected in May, suggesting that seeds are dispersed during the dry season.

Habitat and distribution:—Records for this species have only been reported from the municipality of Alto Paraíso de Goiás, along a small stretch of GO-118 highway, that connects Alto Paraíso de Goiás and São João da Aliança, between 5–15 km south of Alto Paraíso de Goiás. According to herbarium labels, *S. incurvifolius* occurs on *campos rupestres* within the Cerrado biome, over quartzitic sandy soils and in wet meadows, typical habitats at the border of the highway at the described locality. Field observations (King & Bishop 8900, MO) reported the species to be locally abundant. However, we have done fieldwork in Chapada dos Veadeiros over a large area and we did not find the reported population neither did we see any other subpopulation. This fact indicates that the populations probably occupy narrow areas. The roadside along GO-118 northwest of Alto Paraíso de Goiás belongs to the Parque Nacional da Chapada dos Veadeiros (PNCV); roads to the south and northeast are privately owned, used for cattle grazing and farming, fragmenting the original *campo rupestre* habitat. *Syngonanthus incurvifolius* is registered southward, outside the PNCV and therefore might be threatened by human activities.

Conservation status:—*Syngonanthus incurvifolius* is known from a stretch no longer than 10 km along GO-118 highway, where the natural habitat is severely fragmented. The species is not recorded from a protected area and the region is affected by fire, pasturage and farming, with great impact on natural habitats. As it has not been collected since 1994 and there was no success to find it in recent fieldwork, the species could be classified as extinct in the nature. However, the region is still poorly collected and a careful search might discover new populations. Because there is reasonable doubt that the last individual has died, a more thorough check of expected habitat of this species is needed to confirm it. CNCFlora (Brazilian National Center for Plant Conservation, cncflora.jbrj.gov.br) evaluated the species threatened status, following the criteria of the IUCN Red List (IUCN 2001, 2015). *Syngonanthus incurvifolius* has an area of occupancy of 8 km², which tend to contract and deteriorate in quality. According to criteria A2ac and B2ab(i,ii,iii) this species is currently considered critically endangered (Negrão 2014a).

Additional specimens examined:—BRAZIL. Goiás: Alto Paraíso de Goiás, Region of the Chapada dos Veadeiros at 14°30' S 47°30' W, 7 km south of Veadeiros, wet meadowland below sandstone outcrop 7, 24 May 1956, Y. Dawson 14639 (LL); Rod. GO-12, km 5–10 ao Sul de Alto Paraíso, campo arenoso, 26 May 1975, G. Hatschbach 36814 (C, LL, MBM); 5–12 km S of Alto Paraíso de Goiás, mostly E of road to São João da Aliança, 3300–3800 feet, 8 February 1981, L. R. M. King & L. E. Bishop 8900 (MO, UB); 10 km S of Alto Paraíso de Goiás (GO-118) heading for Brasília, adjacent to Chapada dos Veadeiros, 14°30'S, 47°30'W, 23 February 1990, J. Saunders, L. Breyer & G. Eiten 3020 (LL); Rod. GO-118, 10 km S de Alto Paraíso, campo rupestre, solo arenoso úmido, 1150 m, 10 February 1994, G. Hatschbach, M. Hatschbach & J. M. Silva 60290 (F, MBM).

Syngonanthus vittatus M.T.C.Watan. & Echternacht, *sp. nov.* Type:—BRAZIL. Goiás: Alto Paraíso de Goiás, Chapada dos Veadeiros, estrada Alto Paraíso de Goiás - Teresina de Goiás, Fazenda Água Fria, em campo limpo após a piscina, próximo a vereda e mata de galeria, 14°06'21.7''S, 47°30'33.6''W. 19 July 2012 (fl), M. Watanabe & W. Watanabe 377 (holotype SPF!, isotype F!). Figures 2H–N & 4.

The new species is similar to *Syngonanthus arenarius* var. *heterophyllus* but differs by involucre bracts narrowly lanceolate with apex markedly acute and petals glabrous in pistillate flowers. *Syngonanthus vittatus* is also similar to *Syngonanthus densifolius* var. *majus* differing by all characteristics mentioned above as well the rosette leaves recurved.

Perennial herbs, 20–40 cm tall. *Roots* 0.2–1.5 mm in diameter, white to cream-colored, spongy. *Rhizome* 0.7–3.3 cm × 2.5–3.5 mm, horizontal to oblique, often branched, tomentose to villous, with white, dense and woolly curled

trichomes; each branch giving rise to a rosette of leaves, each rosette bearing 1–3 synflorescences. *Rosettes* 19–41 mm in diameter. *Leaves* 9.0–22.5 × 0.3–1.0 mm, linear to narrowly lanceolate, flat to semi-terete, apex acute, base truncate, recurved, coriaceous, striate abaxially with 3–5 conspicuous veins, only the midvein visible on upper surface in young leaves; pilose on both surfaces, with arachnoid trichomes and adpressed trichomes adaxially, filamentous hairs and adpressed trichomes abaxially, mainly concentrated on midvein, ca. 0.3 mm long; basal sheath slightly enlarged, 0.5–1.0 mm wide, pale and achlorophyllous at base. *Synflorescences* with a primary axis bearing a lax umbel of 1–5 inflorescences at the apex. *Synflorescence axis* 5.0–8.5 cm long, emerging from the center of the rosette, erect to flexuous, yellow-reddish when young, dark reddish brown in maturity, pilose at base with filamentous trichomes, glabrescent, becoming tomentose near the apex with simple filamentous and capitate trichomes. *Bracts of synflorescence axis* usually restricted to the apex, rarely a few tiny scattered bracts along the axis ca. 3 mm long; apical bracts 1–30 × 0.3–1.0 mm, whorled, patent, the external series lanceolate, progressively elongating from the outer toward the inner series, the internal series linear, apex acute to rounded, erect, pubescent on both surfaces with capitate filamentous trichomes. *Inflorescences* composed of a closed spathe subtending a scape with a capitulum at the apex. *Spathes* 3.5–5.5 cm long, chartaceous, cylindrical, obliquely opened, apex acute, erect, recurved or rarely involute, tip erect to uncinat, margin minutely involute, ciliate, adaxial surface glabrous to glabrescent, abaxial surface pubescent with capitate trichomes. *Scapes* erect, 9–30 cm long, greenish to straw-colored with age, 4(–5)-costate, sparsely hairy to densely pilose with erect to patent glandular hairs and adpressed, and simple trichomes, pubescent near the apex with a collar of patent, simple filamentous and capitate [gland-tipped] trichomes. *Capitula* 5–12 mm in diameter, obconic, later becoming depressed-hemispherical. *Involucral bracts* in 4–6 series, all similar in color, light to dark brown, often with a reddish tinge, with a lighter longitudinal band in center and a darker pigmentation on the margins, adaxial surface glabrous, abaxial surface strigose, ciliate, with patent, simple trichomes, rarely also capitate trichomes ca. 0.5 mm long; external series 1.5–2.0 × 0.5–0.8 mm, triangular to ovate, apex acute, bracts progressively elongating toward the internal series, middle series 4–5 × 1 mm, narrow elliptic, apex acute, internal series 3.0–5.5 × 0.7–1.0 mm, inner series surpassing the flowers by 0.1–0.3 mm, narrow-lanceolate, elliptic, rarely narrow-oblongate, apex acute; receptacle hemispheric, pilose. *Floral bracts* absent. *Flowers* 3-merous, 60–110 per capitulum, staminate and pistillate generally equal in number, with contrasting colors, staminate flowers darker and concentrated at the border of the capitulum. *Staminate flowers* 2.5–3.5 mm long, including pedicels; pedicels 0.5–1.0 mm long; sepals 2.0–2.5 mm long, coppery brown, shortly fused at base, concave, membranous, usually two sepals similar in form, elliptic to lanceolate (-oblanceolate) with acute apex, slightly curved, asymmetrical, and the third different, slightly irregular-subspathulate with round to truncate apex, but occasionally occurs a reversal of forms, or occasionally the three sepals slightly different, margins ciliate, adaxially glabrous, abaxially setose with simple filamentous trichomes ca. 0.5 mm long; petals ca. 2 mm long, hyaline, membranous, fused, tubulose, lobes triangular, obtuse, involute after anthesis, glabrous; filaments free, anthers ca. 0.6 mm long, white; anthophore ca. 0.3 mm long; pistillodes 3, ca. 0.2 mm long, clavate, papillose at apex. *Pistillate flowers* 2.4–3.5 mm long, including pedicels of 0.4–1.5 mm long; sepals ca. 2 mm long, elliptic, concave, apex acute to obtuse, base thickened, free, cream to light castaneous, hyaline and membranous toward the apex, dark reddish brown-colored at apex, ciliate, hairy on the inside, with simple filamentous trichomes up to 1 mm long, glabrous outside; petals about equaling the sepals, 1.8–2.7 mm long, oblanceolate, fused at the distal third, membranous, white to hyaline, glabrous, the lobes triangular-rounded to obtuse, involute after anthesis; ovary ca. 0.6 mm long; style column 0.2–0.4 mm long, cream-colored; appendages ca. 0.5 mm long, the glandular apex capitate-curved; stigmatic branches simple, ca. 1.5 mm long. *Seed* ca. 0.40 × 0.25 mm, ellipsoid, reddish-brown colored.

Etymology:—The specific epithet refers to the well-marked longitudinal stripe evident in the center of the involucral bracts.

Notes and taxonomic affinities:—In the field, the species looks superficially similar to *Paepalanthus* (FIG. 4A), because of its pilose capitula and dark involucral bracts. However, a closer examination reveals the compound inflorescences (synflorescences), with a differentiated, usually leafless primary axis, a feature that does not occur in *Paepalanthus*. In addition, the species has petals of pistillate flowers fused in the distal part and free at the base, and staminate flowers isomerous an exclusive set of characters of *Syngonanthus* (Giulietti *et al.* 2012).

Syngonanthus vittatus belongs to the same morphological group as *S. incurvifolius*, which also includes *Syngonanthus arenarius*, *S. densifolius* var. *brachyphyllus* and *S. densifolius* var. *majus*. All these species share a similar architecture and dark and pilose involucral bracts with a contrasting pale longitudinal band. *Syngonanthus vittatus* differs from all of them by the involucral bracts narrowly lanceolate to linear, with a narrower and more conspicuous pale stripe, composing a laxer involucre (FIG. 4G); the other species have large elliptical to obovate bracts, forming a denser involucre (Fig. 4F, 4H–I).

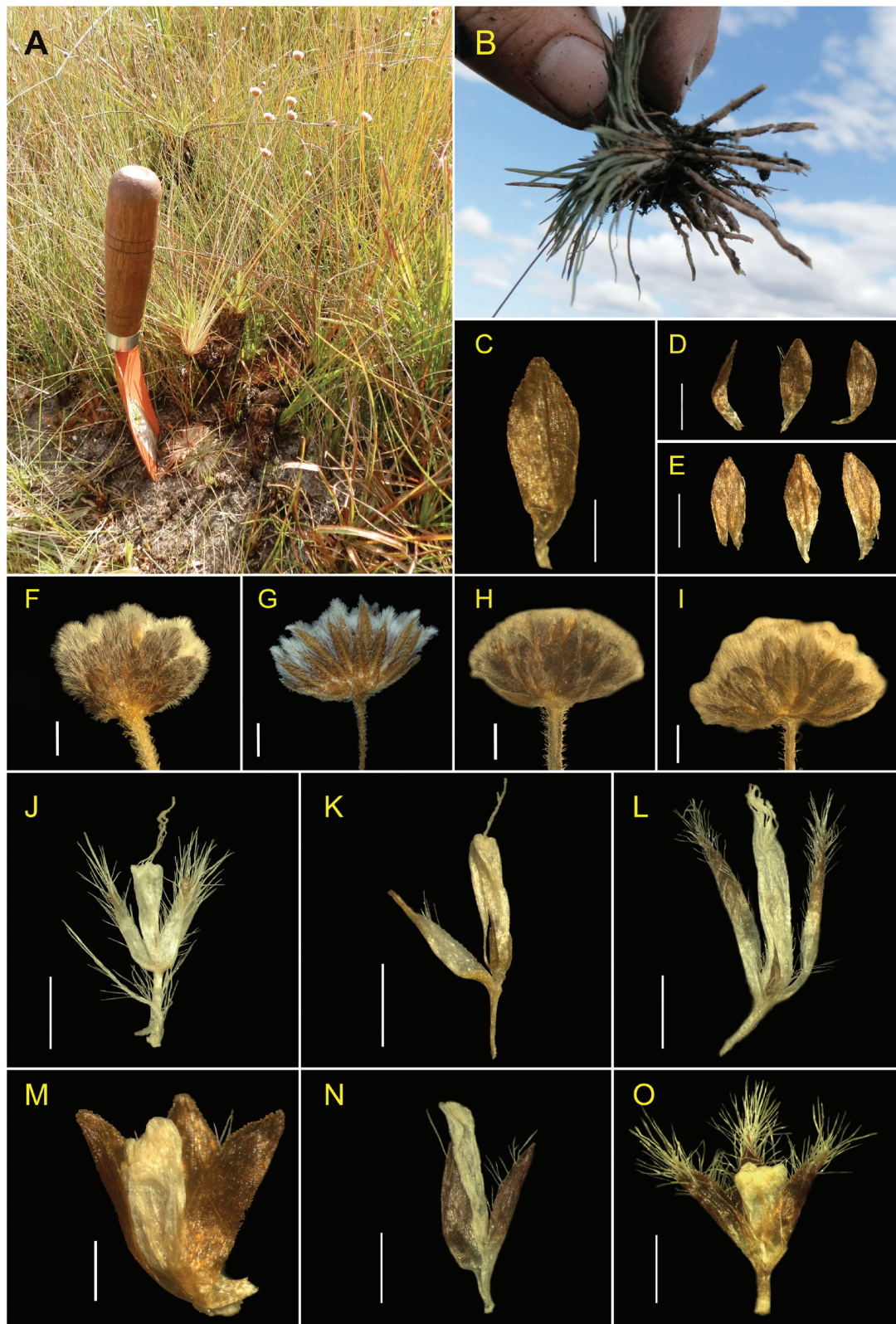


FIGURE 4. *Syngonanthus vittatus* and other morphologically similar *Syngonanthus* species. **A–E.** *S. vittatus*: **A.** Habit detail showing specimen at flowering; **B.** Rosette and roots; **C.** Elliptic sepal of staminate flower; **D.** Other forms of sepals revealing concave shapes in staminate flowers; **E.** Three different shapes of sepals in the same staminate flower revealing asymmetry among the sepals. **F–I.** Comparison among capitula in *Syngonanthus* species: **F.** *S. arenarius* var. *heterophyllus*; **G.** *S. vittatus*; **H.** *S. densifolius* var. *brachyphyllus*; **I.** *S. densifolius* var. *majus*; **J–K.** Pistillate flower of *S. vittatus*: **J.** Flower exhibiting trichomes on sepals; **K.** Flower with two sepals removed, the remaining sepal with hairs deciduous, showing the glabrous petals; **L.** Pistillate flower of *S. arenarius* var. *heterophyllus*; **M–N.** Staminate flowers of *S. vittatus*: **M.** Young flower; **N.** Mature flower; **O.** Staminate flower of *S. arenarius* var. *heterophyllus*. Scale bars: C, M= 500 μ m. D–E, J–L, N–O= 1 mm. F–I= 2 mm. (Photos by Mauricio T. C. Watanabe).

The flowers of *Syngonanthus vittatus* are very similar to those of *S. arenarius* var. *heterophyllus* (1903:260), except that the former has petals of pistillate flowers glabrous (FIG. 4J–K; vs. petals pilose, FIG. 4L) and smaller flowers (up to 3.5 vs. 4.5 mm). In addition, *S. vittatus* has pistillate and staminate flowers strongly contrasting in colour, the staminate with brown sepals and the pistillate with cream sepals (FIG. 4M–N and 4K–J, respectively), whereas both types of flowers in *S. arenarius* var. *heterophyllus* have a similar pigmentation (FIG. 4L; 4O), cream at base and reddish-brown at apex.

Other features differentiating *Syngonanthus vittatus* from *S. incurvifolius* and *S. densifolius* var. *majus* are the rosette leaves recurved (FIG. 4B) (vs. incurved in the distal half or flexuous, respectively, FIG 3A–B), the synflorescence axis often bearing tiny scattered bracts along its length (vs. bracts restricted to the apex), and the petals of pistillate flowers glabrous (vs. pilose). *Syngonanthus vittatus* also differs from *Syngonanthus densifolius* var. *brachyphyllus* by the narrower leaves (0.3–1.0 mm vs. 2.0–5.0 mm), with simple and adpressed trichomes (vs. only simple) and striate adaxial surface (vs. reticulate).

Additionally, the evident asymmetrical sepals of staminate flowers are an important characteristic shared with *S. incurvifolius* and the other species previously cited (FIG. 4C–E).

Phenology:— Flowering of *Syngonanthus vittatus* occurs during the dry season (winter), from July to September. This period coincides with all collections reported for this species. Most *Syngonanthus* from Chapada dos Veadeiros bloom at the same time, for example, *S. decorus* Moldenke (1976:485) and *S. densifolius* var. *majus*. Seeds mature at the end of the dry season, implying a dispersal period concomitant with the rains and possible hydrochory.

Habitat and distribution:—All collections are known from the same population as the type, at the farm called “Água Fria”, except by a single record from waterfall “São Bento”. These localities are about 10 km apart and close to recreational and agricultural areas. The expansion and intensification of human activities in the area threatens the natural surroundings. The limited distribution of the known populations contrasts with a local abundance of individuals, and further fieldwork may reveal other populations. *Syngonanthus vittatus* occurs outside conservation units, although very close to the boundaries of the PNCV. The species occurs over hydromorphic soils, in moist grasslands or wet campo, a common physiognomy on floodplains between Cerrado *sensu stricto* and gallery forest (Ratter *et al.* 1997). These wet campos occur on well-drained sandy soils, which become waterlogged during summer and quite dry in winter, a variation that constrains tree growth and prevents forest formations (Ratter *et al.* 1997), favoring the occurrence of herbs such as *S. vittatus*.

Conservation status:—This species is classified as critically endangered, according to criteria B1ab and B2ab of IUCN (2001, 2015). The taxon is known only from two populations, both on privately owned land hosting human activities that may threaten the species with extinction. *Syngonanthus vittatus* has an area of occupancy of 12 km². Conservation status is endangered, as evaluated by CNCFlora according to the IUCN (2001, 2015), matching criteria B2ab(i,ii,iii) (Negrão 2014b).

Additional specimens examined:—BRAZIL. Goiás: Alto Paraíso de Goiás. Est. 11-Chapada dos Veadeiros, mata, 06 August 1972, *Rizzo* 8236 (SPF); 9 km de Alto Paraíso / São Jorge, cachoeira São Bento, campo úmido próximo a floresta de galeria, 09 September 1994, *Silva et al.* 2315 (IBGE, SPF); Fazenda Água Fria, próximo a sede da fazenda, borda de mata de galeria, 14°09'07" S, 47°37'08" W, 06 June 1997, *Munhoz et al.* 462 (UB); Fazenda Água Fria, cerca de 10 km em direção a Teresina de Goiás, campo limpo úmido, borda de cerrado rupestre e mata de galeria, 14°04'21.7" S, 47°30'33.6" W, altitude 1488 m, 17 June 2000, *Munhoz et al.* 1651 (IBGE, SPF); idem, 01 July 2000, *Munhoz et al.* 1721 (IBGE, SPF); idem, 01 July 2000, *Munhoz et al.* 1729 (IBGE, SPF); idem, 19 July 2000, *Munhoz et al.* 1764 (IBGE, SPF); idem, 19 July 2000, *Munhoz et al.* 1797 (F, IBGE, SPF); idem, 16 August 2000, *Munhoz et al.* 1831 (F, IBGE, SPF).

Conclusion

Probably, the new *Syngonanthus* species described here are closely related. The similarity in several aspects including floral attributes, vegetative characters and geographical proximity of taxa suggest close relationship, except for the different flowering times. Ongoing phylogenetic studies investigate this hypothesis (Watanabe *et al.* in prep.). The pilose and castaneous to reddish-brown involucre bracts are common features, shared with a small group of plants in Minas Gerais and Goiás states. These phylogenetic studies in preparation confirm that *S. vittatus* and *S. densifolius* var. *majus* are sister species, although the relationship is not clear among similar species such as *S. incurvifolius*, *S. arenarius* and *S. densifolius* var. *brachyphyllus* (Watanabe *et al.* in prep.).

Acknowledgments

We would like to thank the support from the Brazilian agencies: Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Coordenação de Aperfeiçoamento de Pessoal de Nível superior (CAPES); the curators at C, F, IBGE, K, LL, MBM, MO, NY, SPF and UB; Dr. Peris Kamau for initial language editing and suggestions; and Marcelo Kubo for providing the botanical illustration that was funded by PROTAX/CNPq (Programa de Capacitação em Taxonomia).

References

- Andrade, M.J.G., Giulietti, A.M., Rapini, A., Queiroz, L.P., Conceição, A.S., Almeida, P.R.M. & van den Berg, C. (2010) A comprehensive phylogenetic analysis of Eriocaulaceae: Evidence from nuclear (ITS) and plastid (*psbA-trnH* and *trnL-trnF*) DNA sequences. *Taxon* 59: 379–388.
- Echternacht, L. (2012) Sistemática de *Comanthera* e de *Syngonanthus* (Eriocaulaceae). *Ph.D. Thesis, Universidade de São Paulo*, São Paulo, 294 pp.
- Echternacht, L., Sano, P.T. & Dubuisson, J.-Y. (2015) Taxonomic study of *Comanthera* subg. *Thysanocephalus* (Eriocaulaceae). *Systematic Botany* 40 (1): 136–150.
<http://dx.doi.org/10.1600/036364415X686431>
- Echternacht, L., Sano, P.T., Bonillo, C., Cruaud, C., Couloux, A. & Dubuisson, J.-Y. (2014) Phylogeny and taxonomy of *Syngonanthus* and *Comanthera* (Eriocaulaceae): evidence from expanded sampling. *Taxon* 63 (1): 47–63.
- Giulietti, A.M., Scatena, V.L., Sano, P.T., Parra, L.R., Queiroz, L.P., Harley, R.M., Menezes, N.L., Benko-Yseppon, A.M., Salatino, A., Salatino, M.L., Vilegas, W., Santos, L.C., Ricci, C.V., Bonfim, M.C.P. & Miranda, E.B. (2000) Multidisciplinary studies on Neotropical Eriocaulaceae. In: Wilson, K.L. & Morrison, D.A. (Eds.) *Monocots II: Systematics and evolution*. CSIRO, Melbourne, pp. 580–589.
- Giulietti, A.M., Andrade, M.J.G. de, Scatena, V.L., Trovó, M., Coan, A.I., Sano, P.T., Santos, F. de A.R. dos, Borges, R.L.B. de & van den Berg, C. (2012) Molecular phylogeny, morphology and their implications for the taxonomy of Eriocaulaceae. *Rodriguésia* 63: 1–19.
- Koernicke, F. (1854–1856) Eriocaulacearum monographiae supplementum. *Linnaea* 27: 561–692.
- IUCN (2001) *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland & Cambridge, UK, 70 pp.
- IUCN (2015) *The IUCN red list of threatened species*. Available from: www.iucnredlist.org/ (accessed 1 January 2015)
- Martius, C.F.P. von (1834) Die Eriocaulaceae als selbständige Pflanzenfamilie aufgestellt und erläutert. *Annales des Sciences Naturelles, Botanique Ser. 2* (2): 25–43.
- Moldenke, H.N. (1972) Four novelties from Brazil. *Phytologia* 24: 498–499.
- Moldenke, H.N. (1976) Notes on new and noteworthy plants LXXXV. *Phytologia* 32 (6): 483–487.
- Moldenke, H.N. (1984) Notes on new and noteworthy plants CLXXVI. *Phytologia* 55: 372.
- Munhoz, C.B.R. & Felfili, J.M. (2006) Floristics of the herbaceous and subshrub layer of a moist grassland in the Cerrado biosphere reserve (Alto Paraíso de Goiás), Brazil. *Edinburgh Journal of Botany* 63: 343–354.
<http://dx.doi.org/10.1017/S0960428606000539>
- Negrão, R. (2015a) *Syngonanthus incurvifolius*. Lista Vermelha CNCFlora. Available from: <http://cncflora.jbrj.gov.br> (accessed 15 April 2015)
- Negrão, R. (2015b) *Syngonanthus vittatus*. Lista Vermelha CNCFlora. Available from <http://cncflora.jbrj.gov.br> (accessed 15 April 2015)
- Parra, L.R. & Giulietti, A.M. (1997) Nomenclatural and taxonomic changes in Brazilian *Syngonanthus* (Eriocaulaceae). *Willdenowia* 27: 227–233.
<http://dx.doi.org/10.3372/wi.27.2723>
- Parra, L.R., Giulietti, A.M., Andrade, M.J.G. & van den Berg, C. (2010) Reestablishment and new circumscription of *Comanthera* (Eriocaulaceae). *Taxon* 59: 1135–1146.
- Ratter, J.A., Ribeiro, J.F. & Bridgewater, S. (1997) The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany* 80 (3): 223–230.
- Ricci, C.V., Patrício, M.C.B., Salatino, M.L.F., Antônio, A. & Giulietti, A.M. (1996) Flavonoids of *Syngonanthus* Ruhland (Eriocaulaceae): taxonomic implications. *Biochemical Systematics and Ecology* 24: 577–583.

[http://dx.doi.org/10.1016/0305-1978\(96\)00056-7](http://dx.doi.org/10.1016/0305-1978(96)00056-7)

- Ruhland, W. (1900) Eriocaulaceae. In: Urban, I. (Ed.) *Symbolae Antillanae seu fundamenta florum Indiae Occidentalis* 1. Borntraeger, Berlin, Klincksieck, Paris and Williams & Norgate, London, pp. 482–494.
- Ruhland, W. (1903) Eriocaulaceae. In: Engler, A. (Ed.) *Das Pflanzenreich* IV, 30 (Heft 13). W. Engelmann, Leipzig, pp. 1–294.
- Silveira, A. (1928) *Floralia Montium*. Imprensa Official, Belo Horizonte. 399 pp.
- Simon, M.F., Hughes, C.E. & Harris, S.A. (2010) Four new species of *Mimosa* (Leguminosae) from the Central Highlands of Brazil. *Systematic Botany* 35 (2): 277–288.
<http://dx.doi.org/10.1600/036364410791638333>
- Smith, L.B. (1937) A new genus of Eriocaulaceae. *Contributions from the Gray Herbarium* 117: 38–39.
- Trovó, M. & Sano, P.T. (2011) Five new and narrowly distributed species of *Paepalanthus* section *Diphyomene* (Eriocaulaceae) from Central Brazil. *Systematic Botany* 36 (3): 610–620.
<http://dx.doi.org/10.1600/036364411X583600>