

Novelties in Brazilian *Tradescantia* L. (Commelinaceae)

Marco O. O. Pellegrini^{1,2,4}, Rafaela C. Forzza², Cassia M. Sakuragui³

1 Universidade de São Paulo, Departamento de Botânica, Rua do Matão 277, CEP 05508-900, São Paulo, SP, Brazil **2** Jardim Botânico do Rio de Janeiro, Rua Pacheco Leão 915, CEP 22460-030, Rio de Janeiro, RJ, Brazil **3** Universidade Federal do Rio de Janeiro, CCS, Instituto de Biologia, Departamento de Botânica, Av. Carlos Chagas Filho 373, Bloco A, Sala A1-088, Ilha do Fundão, CEP 21941-902, Rio de Janeiro, RJ, Brazil **4** Current address: Smithsonian Institution, NMNH, Department of Botany, MRC 166, P.O. Box 37012, Washington D.C. 20013-7012, USA

Corresponding author: Marco O. O. Pellegrini (marcooctavio.pellegrini@gmail.com; pellegrinim@si.edu)

Academic editor: Peter Boyce | Received 11 February 2017 | Accepted 12 April 2017 | Published 25 April 2017

Citation: Pellegrini MOO, Forzza RC, Sakuragui CM (2017) Novelties in Brazilian *Tradescantia* L. (Commelinaceae). *PhytoKeys* 80: 1–31. <https://doi.org/10.3897/phytokeys.80.12232>

Abstract

We present a new record to the Brazilian territory (i.e. *Tradescantia boliviana*), the rediscovery of a species exclusively known from the cultivated type collection (i.e. *T. valida*), the description of a new taxon (i.e. *T. chrysophylla*), synonyms for *T. crassula* and *T. boliviana*, correct the typification of *T. crassula*, and designation of a lectotype for *T. ambigua* and *T. ambigua* var. *pilosula*. Furthermore, we present illustrations, comments, distribution maps, and identification keys for the studied taxa.

Keywords

Austrotradescantia, Commelinales, *Mandonia*, Tradescantiinae, spiderworts

Introduction

Tradescantia L., as currently circumscribed, is the second largest genus of Commelinaceae, with ca. 80 species (Faden 1998; eMonocot 2010; The Plant List 2013). The genus is closely related to *Callisia* Loebl., *Elasis* D.R.Hunt, *Gibasis* Raf., and *Tripogandra* Raf. (Evans et al. 2003; Wade et al. 2006; Burns et al. 2011; Hertweck and Pires 2014), with the genera being differentiated based on inflorescence, floral, and seed morphology, and some additional anatomical characters (Faden and Hunt 1991; Faden 1998; Pellegrini 2015). *Tradescantia* is characterized by its main florescences composed of a double-

cincinni fused back to back, with each cincinni being contracted and subtended by an expanded bract, actinomorphic flowers with six equal or subequal stamens, and seeds with a linear hilum (Faden 1998; Panigo et al. 2011; Pellegrini 2015). The genus is currently circumscribed into 12 taxonomic sections and four series, and native to the Neotropics, but with a center of diversity in Mexico and Southern USA. This can be explained by the occurrence of two species-rich sections (*T. sect. Tradescantia* and *T. sect. Setcreasea*) in drier environments (Hunt 1975, 1980, 1986a).

In Brazil, *Tradescantia* is represented by four of the 12 taxonomic sections (i.e., *T. sect. Austrotradescantia*, *T. sect. Campelia*, *T. sect. Mandonia*, and *T. sect. Zebrina*) and 12 species (Pellegrini et al. 2015; Pellegrini 2016, 2017). Currently, nine out of 12 species known to Brazil are circumscribed in *T. sect. Austrotradescantia* (Pellegrini 2015, 2017), but three species belong to different sections; *T. ambigua* Mart. ex Schult. & Schult.f. (*T. sect. Mandonia*), which is restricted to the Caatinga and Cerrado domains, *T. zanonía* (L.) Sw. (*T. sect. Campelia*), which is geographically disjunct between the Amazon and the Atlantic Forest domains, and *T. zebrina* Heynh. ex Bosse (*T. sect. Zebrina*), an aggressive invasive species widely distributed in Brazil (Pellegrini 2017). The systematics, taxonomy, and species delimitation in this genus are complex, and have been the subject of many recent studies (Hertweck and Pires 2014; Pellegrini 2015, 2016; Pellegrini et al. 2015, 2016), shedding new light on this challenging group. As part of our ongoing studies in *Tradescantia* (Pellegrini 2015, 2016, 2017; Pellegrini et al. 2015, 2016), we describe a new species for Southern and Southeastern Brazil, present the rediscovery of a poorly understood species, document a new record for the Brazilian territory, and contribute with two new synonyms, as well as comments, illustrations, maps, conservation assessments, and the necessary typifications.

Methods

The descriptions and phenology of the species were based on herbaria, spirit, fresh material, field data, and literature. All species were studied in the field and thus their descriptions are complemented with field notes, photographs, and cultivated specimens, gathered during field trips throughout Brazil between the years of 2008–2016. Specimens collected by the authors were kept in cultivation at the greenhouse of the Jardim Botânico do Rio de Janeiro, in order to better observe, photograph, and analyze fresh flowers, fruits and seeds, as well as other phenological data. Specimens from the following herbaria were also analyzed: ALCB, B, BHCB, BHZB, BM, BOTU, BRIT, C, CAL, CEPEC, CESJ, CGE, CGMS, CNMT, COR, CVRD, EAC, ESA, F, FCAB, FLOR, FURB, GUA, HAMAB, HAS, HB, HBR, HDCE, HRB, HSTM, HUEFS, HURB, IAC, ICN, INPA, JOI, K, L, M, MBM, MBML, MG, MO, MY, NY, P, PMSP, R, RB, RFA, RFFP, SP, SPF, U, UEC, UFRN, UPCB, US, W, WAG, and WU (herbaria acronyms according to Thiers 2017). The distribution of *Tradescantia boliviana* (Hassk.) J.R.Grant was modified from Grant (2004) with the new Brazilian records. The classification of the vegetation patterns follows IBGE (2012).

The indumenta and shapes terminology follows Radford et al. (1974); the inflorescence terminology and morphology follows Weberling (1965, 1989) and Panigo et al. (2011); the fruit terminology follows Spjut (1994); seeds terminology follows Faden (1991); and general terminology for *Tradescantia* follows Pellegrini (2015, 2016) and Pellegrini et al. (2016). Conservation assessments were carried out following IUCN Red List Categories and Criteria, Version 3.1 (IUCN 2001). GeoCAT (Bachman et al. 2011) was used for calculating the Extent of Occurrence (EOO) and the Area of Occurrence (AOO).

Results

We update the number of species of *Tradescantia* known from Brazil to 14 (from 12), with the description of a new species, a new record, two new synonyms, and the rediscovery of *T. valida* G.Brückn in the wild. We present complete descriptions of the new species and the rediscovered taxon, and detailed diagnoses for the other three studied species. The results are organized in the treated sections (i.e. *T. sect. Austrotradescantia*, *T. sect. Campelia*, *T. sect. Mandonia*, and *T. sect. Zebrina*). Furthermore, as a result of our improved knowledge of *Tradescantia*, we present an updated, illustrated, and more functional identification key for the sections occurring in Brazil.

Updated key to the Brazilian sections of *Tradescantia* (modified from Pellegrini et al. 2015)

- 1 Filaments basally densely bearded with long moniliform hairs, connectives rhomboid, anther sacs elliptic, style cylindrical with conical apex, stigma punctate (Figs 1A, 2H, I); embryotega inconspicuous.....***Tradescantia* sect. *Austrotradescantia* D.R.Hunt**
- Filaments medially sparsely bearded with short moniliform hairs, connectives quadrangular to rectangular (Fig. 6D) or sagittate to linearly-tapered (Figs 4C, 7F), anther sacs C-shaped (Fig. 6D) or round (Figs 4C, 7F), style cylindrical throughout, stigma truncate to capitate (Fig. 6D) or capitate to trilobate (Fig. 4C, D); embryotega conspicuous.....**2**
- 2 Inflorescences sessile, cincinni bracts reduced (Fig. 5D, E); flowers flat, straight at anthesis and pre-anthesis, sepals equal, free (Fig. 6D), stamens equal, filaments coiling at post-anthesis (Fig. 5F), pollen yellow (Fig. 6D), ovary pubescent (Fig. 5F); embryotega dorsal***Tradescantia* sect. *Mandonia* D.R.Hunt**
- Inflorescences pedunculate, cincinni bracts spatheaceous (Fig. 4C & 7E); flowers tubular, geniculate at anthesis and pre-anthesis, sepals unequal, irregularly fused (Figs 4C, D, 7E), stamens subequal, filaments straight at post-anthesis, pollen white (Fig. 4D), ovary glabrous; embryotega semilateral to lateral....**3**

- 3 Inflorescences axillary, perforating the leaf-sheath (Fig. 4A); sepals fleshy, vinous and tightly enclosing the capsule (forming a berry-like fruit) (Fig. 4E), petals sessile, rhomboid to obovate, white (Fig. 4C, D), stamens free from the petals ***Tradescantia* sect. *Campelia* (L.C.Rich.) D.R.Hunt**
- Inflorescences terminal, not perforating the leaf-sheath (Fig. 7E); sepals membranous, hyaline, loosely enclosing the capsule (Fig. 7E), petals clawed, ovate to elliptic, pink to purple (Fig. 7E), stamens epipetalous ***Tradescantia* sect. *Zebrina* (Schnizl.) D.R.Hunt**

***Tradescantia* sect. *Austrotradescantia* D.R.Hunt, Kew Bull. 35(2): 440. 1980.**

Diagnosis. The section is characterized by perennial herbs, with thin and fibrous roots, definite or indefinite base, rhizomes absent, leaves with asymmetric base, inflorescences terminal or at the apex of the stems, pedunculate, cincinni bracts leaf-like or rarely spathaceous, bracteoles inconspicuous, flowers flat, sepals equal, free, generally keeled, petals free, sessile, stamens 6 and equal, free, filaments straight at post-anthesis, basally densely bearded with long moniliform hairs, connectives rhomboid, anther sacs elliptic, ovary glabrous, stigma punctate, seeds costate, rarely rugose, embryotega inconspicuous and dorsal (Pellegrini 2015; Pellegrini et al. 2016).

Comments. *Tradescantia* sect. *Austrotradescantia* has been the subject of several recent studies (Pellegrini 2015, 2016, 2017; Pellegrini et al. 2015, 2016; Funez et al. 2016). Species diversity in this section is centered in Southeastern and Southern Brazil, where all of the accepted species occur. However, some species in the group have a wider distribution, reaching neighboring countries like Argentina, Bolivia, Paraguay, and Uruguay (Pellegrini 2015; Pellegrini et al. 2016). *Tradescantia* sect. *Austrotradescantia* has recently been revised, and its morphology thoroughly analyzed in a yet unpublished MSc thesis (Pellegrini 2015). As part of our revision of this section, we describe a new species, report the rediscovery and inclusion of *T. valida* in the section, and a new synonym for *T. crassula* (with a correction of its typification).

***Tradescantia crassula* Link & Otto, Icon. Pl. Rar. 2: 13, pl. 7. 1828.**

Figs 1, 8

Tropitria crassula (Link & Otto) Raf., Fl. Tell. 3: 68. 1837. Lectotype (designated here). BRAZIL. Rio Grande do Sul: Rio Pardo, fl., fr., s.dat., F. Sellow 3033 (B barcode B100521014!).

Tradescantia crassipes Graham, Edinburgh New Philos. J. Jan.–March: 388. 1829, nom. nud.

Tradescantia schwirkowskiana Funez et al., Phytotaxa 272 (1): 64. 2016. Holotype. BRAZIL. Santa Catarina: São Bento do Sul, borda da ferrovia às margens do Rio Banhados, fl., fr., 16 Nov 2015, L.A. Funez & P. Schwirkowski 5037 (FURB No. 50791!; isotypes: C n.v., HURB n.v.). **Syn. nov.**

Diagnosis. *Herbs* with a definite base, terrestrial, rupicolous or epiphytes. *Roots* thin, fibrous, cream to light brown, emerging from the basalmost nodes. *Stems* erect, succulent, rarely to densely branched at the base, sometimes branching at the upper half; internodes medium to dark green, glabrous, sometimes with a leaf-opposed longitudinal line of short, uniseriate, light brown to hyaline hairs in the terminal portion of the stems. *Leaves* distichously or spirally-alternate, sessile; sheaths light green, sometimes with green striations, glabrous, margin ciliate to setose, hairs hyaline; blades elliptic to broadly elliptic to ovate to broadly ovate to obovate, rarely lanceolate, falcate to complicate, succulent, glabrous on both sides, adaxially glossy light to medium to dark green, sometimes glaucous, abaxially light to medium green, turning olive-green to greyish green to brown when dry, obtuse to truncate, rarely cuneate, margin green, minutely ciliolate to ciliate, slightly revolute, apex acute to obtuse, rarely acuminate; midvein conspicuous to inconspicuous, adaxially impressed to inconspicuous, secondary veins inconspicuous on both sides, sometimes slightly conspicuous on both sides. *Synflorescences* terminal or axillar in the distal portion of the stems, composed of a solitary main florescence, 1 per leaf axis. *Inflorescences* (*main florescences*) consisting of a pedunculate double-cincinni fused back to back; peduncles green, glabrous, sometimes with a leaf-opposed longitudinal line of short, uniseriate, light brown to hyaline hairs; peduncle bracts absent; supernumerary bracts absent; cincinni bracts similar to each other, rarely unequal or reduced in some axillary inflorescences, broadly ovate to ovate, leaf-like, glabrous, adaxially light to medium to dark green, abaxially light to medium green, base cordate to obtuse, not saccate, margin entire to minutely ciliolate to sparsely setose near the base, apex acute; double-cincinni 8–28-flowered. *Flowers* bisexual, actinomorphic, flat (not forming a floral tube); floral buds broadly ovoid; pedicels green to vinaceous, glabrous, rarely sparsely glandular-pubescent; sepals 3, equal, free, ovate, cucullate, margin hyaline, apex acute, persistent in fruit, dorsally keeled, green, rarely vinaceous, setose, with long hyaline hairs along the keel; petals 3, equal, free, elliptic to ovate, rarely broadly ovate, not clawed (sessile), flat, white; stamens 6, arranged in two series, equal, filaments free from the petals and from each other, filaments straight at anthesis and post-anthesis, basally densely bearded with moniliform hairs, hairs as long as the stamens, white, anthers basifixed, rimose, connective expanded, rhomboid, yellow, anther sacs ellipsoid, divergent, yellow, pollen yellow; ovary sessile, subglobose to globose, white, smooth, glabrous, 3-loculate, locules equal, locule 2-ovulate, ovules uniseriate, style straight, white, cylindrical, conical at the apex, stigma punctate, pistil longer than the stamens. *Capsules* subglobose, light to medium brown when mature, smooth, glabrous, loculicidal, 3-valved, sometimes apiculate due to persistent style base. *Seeds* exarillate, 1–2 per locule, ellipsoid to narrowly trigonal, cleft towards the embryotega, ventrally flattened, testa grey to greyish brown, farinose, costate arranged in ridges radiating from the embryotega; embryotega dorsal, relatively inconspicuous, generally covered by a cream farina, without a prominent apicule; hilum linear, longer than $\frac{1}{2}$ the length of the seed.

Specimens seen. ARGENTINA. Misiones: Caingúas, pequeño campo a la entrada del Salto Golondrina, sobre Arroyo Guiray, fl., fr., 8 Nov 2000, M.E. Múlgura de Romero et al. 2470 (CTES, SI); General Manuel Belgrano, ruta nacional 101,

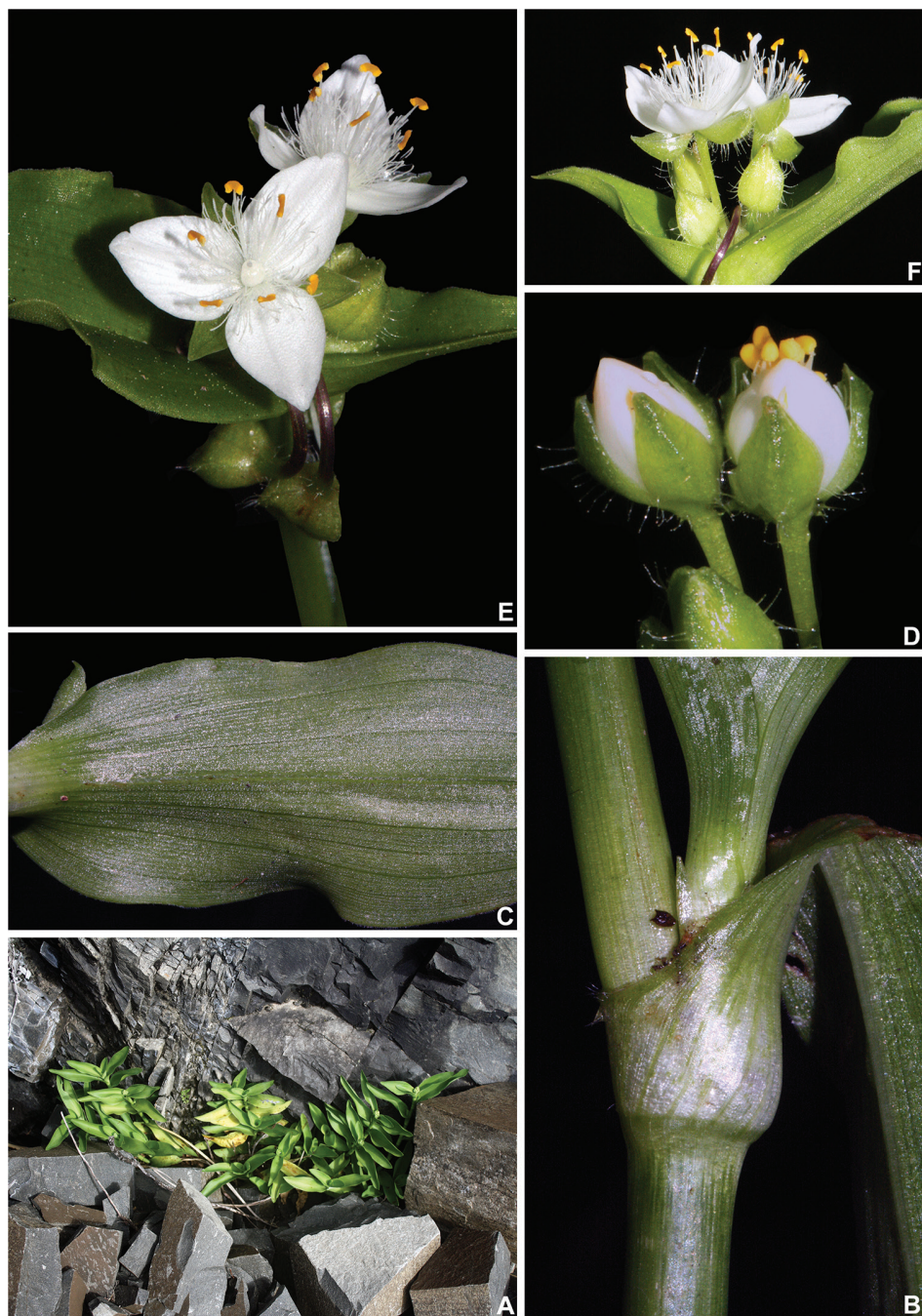


Figure 1. *Tradescantia crassula* Link & Otto. **A** habit, showing the erect stems, and distichously-alternate leaves with conduplicate blades **B** detail of the stem and leaf-sheath **C** detail of the abaxial side of the leaf-blade, showing the lack of hairs and the slightly conspicuous secondary veins **D** detail of floral buds, showing the setose hairs, restricted to the keels of the sepals **E** flower **F** detail of the inflorescence, showing the non-saccate cincinni bracts. Photographs by M.O.O. Pellegrini.

8 km de Bernardo de Irigoyen hacia San Antonio, Salto Andrecito, fl., 15 Oct 1996, O. Morrone et al. 1393 (CTES, SI). **BRAZIL. Minas Gerais:** Extrema, trilha para a Pedra das Flores, fl., 24 Oct 2009, G.H. Shimizu 226 (RB, UEC). **Rio Grande do Sul:** Barão, sudoeste de Garibaldi, Estrada para Carlos Barbosa, fl., fr., 22 Nov 2005, M.C. Machado & L.Y.S Aona 607 (UEC, HUEFS). **Santa Catarina:** Campo Belo do Sul, Fazenda Gateados, fr., 15 Jul 2008, M. Verdi et al. 2028 (FURB, RB); São Bento do Sul, Floresta Ombrófila Mista, fl., fr., 31 Dec 2013, P. Schwirkowski 197 (FURB). **São Paulo:** Jundiáí, Serra do Japi, fl., fr., 25 May 1994, J. Semir et al. 31648 (UEC); loc. cit., Trilha do Mirante, fl., fr., 18 Jul 1995, R. Mello-Silva et al. 1074 (SPF); loc. cit., Serra do Jundiáí, sentido bairro Eloy Chaves, próximo à represa do DAE, fl., 23 Jan 1998, E.R. Pansarin 136 (SP, UEC); Itararé, Fazenda Ibiriti (Ripasa), beira da estrada Itararé-Bonsucesso, fl., fr., 30 Oct 1993, V.C. Souza et al. 4531 (ESA, RB); São Paulo, Cidade Jardim, fl., fr., 11 Mar 1932, W. Hoehne s.n. (IPA 69219, SPF 17149).

Distribution and habitat. *Tradescantia crassula* occurs in Argentina and Brazil (in the states of Minas Gerais, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul) (Fig. 8). It is commonly found growing in rocky outcrops, grasslands and open areas, under full sunlight, as rupicolous or terrestrial. It is also found on roadsides and within the understory of open forests, as terrestrial or, more rarely, as an epiphyte.

Conservation status. *Tradescantia crassula* possesses a wide EOO (ca. 408,686.868 km²). Thus, following the IUCN recommendations (IUCN 2001), it should be considered Least Concern (LC).

Nomenclatural notes. Funez et al. (2016) indicate that Pellegrini (2015) erroneously designated the specimen *Sellow 3033* (B100521014) as the lectotype for *T. crassula*. However, their affirmation is incorrect according to the *Code* since the thesis lacks either a ISSN or an ISBN, and was never distributed to the general public (McNeill et al. 2012, Art. 29.1). The work cited by Funez et al. (2016) was a draft version of the first author's unpublished M.Sc. thesis, with many incomplete and partially incorrect data (Pellegrini, unpublished data), and therefore is not considered a effective publication by the *Code*. Furthermore, according to Art. 30.8 (McNeill et al. 2012), any thesis published on or after 1 January 1953 and stated to be submitted to a university for the purpose of obtaining a degree, does not constitute effective publication; unless it contains any kind of statement or other internal evidence that it is regarded as an effective publication by its author or publisher. Since no statement is made in the final version of the thesis (i.e. Pellegrini 2015), the publication does not meet any of the *Code's* requirements, and therefore cannot be treated as effectively published. In the final version, Pellegrini (2015) gives detailed information on the typification of *T. crassula*, which is effectively published here and corrects the typifications by Funez et al. (2016).

The date written on the original label, and treated by Funez et al. (2016) as the collections date, is "Dec. 1836". Also, it is possible to see in the label the names of Sellow and Humboldt. According to Stafleu and Cowan (1985), Friedrich Sellow lived from 1789–1831, and collected plant specimens in Southern Brazil and Uruguay 1819–1831, funded by Humboldt. This easily explains why both botanists are mentioned in the original label, and why the collector is to be considered as Sellow, instead of Humboldt or both

botanists. Furthermore, given that Sellow died in 1831 and his expeditions were done just before his death, it would be impossible for “Dec. 1836” to represent the actual collection date. We believe this date might correspond to the date when this specimen was acquired by Kunth, and placed into his personal herbarium. Finally, Link and Otto (1828) make direct reference to their new species being based on Sellow collections. According to the *Code* (McNeill et al. 2012, Art. 9.2), the *Sellow 3033* (B100521014) specimen is a suitable choice for a lectotype, superseding the lectotypification of the original illustration, done by Funez et al. (2016). The epitypification by Funez et al. (2016) should be disregarded entirely because the original illustration is informative enough to correctly apply the name *T. crassula*. All the diagnostic features of this species (see comments below) are visible and sufficient for appropriate diagnosis, in the original illustration.

Taxonomic notes. The species in this section are especially variable morphologically and when in cultivation or growing in shaded areas they can change their vegetative morphology quite drastically. Few characters in the vegetative organs were observed to be constant in the *T. crassula* group and thus are of little taxonomic relevance. This can be exemplified by the phyllotaxy and pubescence of the leaf-blades, which have been shown to vary greatly due to ecological features (Pellegrini 2015, 2016). On the other hand, the pubescence of the internodes, leaf-sheaths, and of the margin of the leaf-blades were observed to be constant and reliable for species delimitation. As previously indicated in other *Tradescantia* sections (Anderson and Woodson 1935), the pubescence of the pedicels and sepals seem to be highly stable within each species, easily observable, and thus, reliable for species delimitation. As aforementioned, *T. crassula* is highly variable in vegetative morphology. All studied individuals always presented glabrous leaf-blades, setose sepals with long hairs along the keel, and white petals. The specimens cited by Funez et al. (2016) as representing *T. schwirkowskiana*, fit perfectly the circumscription adopted by us for *T. crassula*, showing variation only in the degree of branching of the stems, color of the leaf-blades, and degree of impression of the secondary veins. All of this morphological variation can be easily explained by the ecological features of the area where the specimens were collected (i.e. shaded moist forests in mountainous regions from the state of Santa Catarina). Aside from that, the authors state that *T. crassula* possesses spirally-alternate leaves and a rhizomatous base. While developing our studies for the taxonomic revision of *T. sect. Austrotradescantia* and a morphological phylogeny for the genus (Pellegrini 2015), we analyzed 50% of the species in the genus and observed that all species of *Tradescantia* produce spirally-alternate leaves when young. This feature is normally lost during development of most species of *T. sect. Austrotradescantia*, but is always retained by *T. valida* G.Brückn. (see comments below), sometimes retained by *T. cerinthoides* Kunth (Pellegrini 2015, 2016), and rarely retained by *T. crassula* (Pellegrini, pers. obs.). No species in *Tradescantia* were observed to produce rhizomes (Pellegrini 2015). The only known drought resistance strategy observed in the genus was the production of tuberous roots; present in all species of *T. sect. Mandonia*, *T. sect. Parasetcreasea*, *T. sect. Separothesa*, *T. sect. Setcreasea* and sect. *Tradescantia*, and exclusively in *T. commelinoides* Schult. & Schult.f. from *T. sect. Cymbispatha* (Pellegrini 2015). Thus, *T. schwirkowskiana* is here synonymized under *T. crassula*.

***Tradescantia chrysophylla* M.Pell., sp. nov.**

urn:lsid:ipni.org:names:60474204-2

Figs 2, 8

Diagnosis. Similar to *T. cymbispatha* due to its habit with an indefinite base, creeping stems with ascending apex, sessile succulent leaves with flat blades homogeneously covered by indumenta, inconspicuous secondary veins, saccate cincinni bracts, broadly ovoid floral buds, sepals without keels, and pistil the same length as the stamens. It can be differentiated by its velutine to hispid, golden to light brown indumentum covering almost the entire plant, strongly unequal cincinni bracts, and pedicels and sepals glandular-pubescent, or with a mixture of glandular and eglandular hairs.

Type. BRAZIL. São Paulo: Biritiba Mirim, Estação Biológica de Boracéia, fl., 24 Nov 1983, A. Custódio Filho 1910 (holotype: RB!; isotype: SP!).

Description. *Herbs* ca. 11–27 cm tall, with an indefinite base, terrestrial or rupicolous, rarely epiphyte. *Roots* thin, fibrous, cream to light brown, emerging from the nodes touching the substrate. *Stems* creeping to ascending at the apex, delicate to slightly succulent, densely branched; internodes 1.5–8.2 cm long at base, distally shorter, dark green to vinaceous, velutine to hispid, hairs golden to light brown. *Leaves* distichously-alternate, sessile; sheaths 0.4–1 cm long, green to vinaceous with dark green to purple striations, velutine to hispid, margin densely setose, hairs golden; blades broadly elliptic to broadly ovate, 1.8–7.6 × 0.9–3.4 cm, flat, succulent, velutine to hispid on both sides, hairs golden to light brown, adaxially dark green, abaxially vinaceous, turning dark brown to olive-green on both sides when dry, base cordate to rounded, margin ciliolate, apex acute, sometimes acuminate; midvein conspicuous, adaxially impressed, secondary veins inconspicuous, adaxially inconspicuous, abaxially inconspicuous, becoming more evident abaxially when dry. *Synflorescences* terminal or axillar in the distal portion of the stems, composed of a solitary main florescence, 1 per leaf axis. *Inflorescences* (*main florescences*) consisting of a pedunculate double-cincinni fused back to back; peduncles (0.4–)1.1–9.5 cm long, vinaceous, velutine to hispid, hairs golden to light brown; basal bract inconspicuous, tubular, hyaline, glabrous; peduncle bracts absent; supernumerary bracts absent; cincinni bracts strongly unequal among themselves, elliptic to ovate to broadly ovate, 0.9–6.6 × 0.4–3.1 cm, leaf-like, velutine to hispid, hairs golden to light brown, adaxially dark green, abaxially vinaceous, base cordate to round, saccate, margin ciliolate, apex acute; double-cincinni (4–)6–12-flowered; bracteoles inconspicuous, imbricate, linear-triangular to triangular, hyaline. *Flowers* bisexual, actinomorphic, flat (not forming a floral tube), 1.1–1.6 cm diam.; floral buds broadly ovoid, apex acute; pedicels upright at anthesis and pre-anthesis, reflexed at post-anthesis, 0.9–1.3 cm long, glandular-pubescent, rarely with a mixture of glandular and eglandular, golden to light brown hairs; sepals 3, equal, free, ovate, cucullate, margin hyaline, apex acute, persistent in fruit, 4.7–5.8 × 2.6–4 mm, without dorsal keels, glandular-pubescent or with a mixture of glandular and eglandular, golden to light brown hairs; petals 3, equal, free, elliptic to ovate, rarely broadly ovate, not clawed (sessile), flat, 8.8–9 × 5.7–6.2 mm, white; stamens 6,

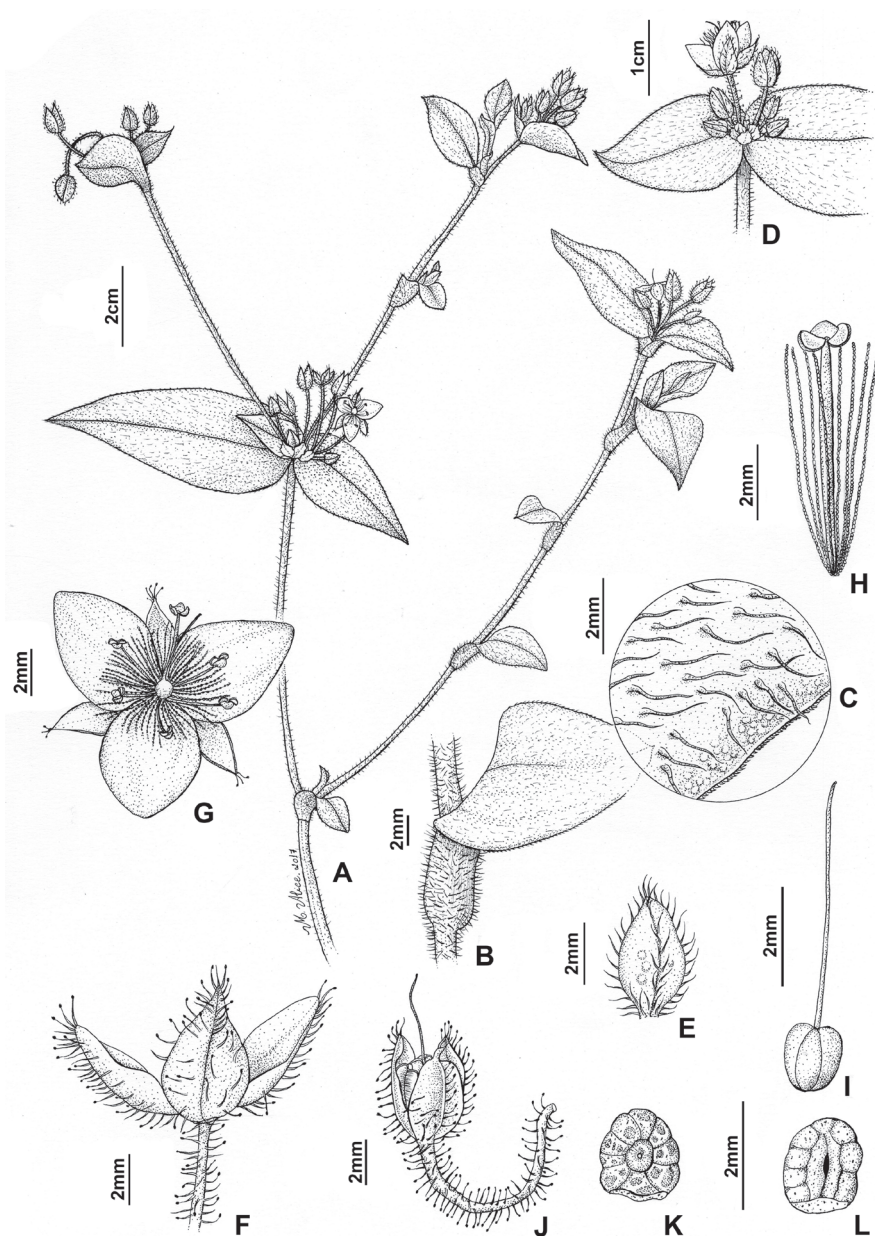


Figure 2. *Tradescantia chrysophylla* M.Pell. **A** habit **B** detail of the stem and leaf-sheath, showing the hispid indumentum, and detail of the sessile leaf-blade **C** detail of the hispid hairs of the leaf-blade and of the ciliolate margin **D** detail of the inflorescence, showing the unequal cincinni bracts **E** detail of the bracteole **F** detail of the pedicel and sepals, showing the glandular hairs **G** frontal view of the flower **H** stamen, showing the filament with basal, dense and long moniliform hairs, the rhomboid connective, and the ellipsoid anther sacs **I** detail of the gynoecium, showing the punctate stigma **J** mature, partially open capsule, still covered by the persistent sepals. **K–L** seed: **K** dorsal view of a seed, showing the costate testa and dorsal embryo **L** ventral view of the seed, showing the linear hilum. Line drawing by M.A. Rezende.

arranged in two series, equal, filaments free from the petals and from each other, filaments 6–6.2 mm long, straight at anthesis and post-anthesis, basally densely bearded with moniliform hairs, hairs as long as the stamens, white, anthers basifixed, rimose, 0.6–0.8 × 0.3–0.7 mm, connective expanded, rhomboid, yellow, anther sacs ellipsoid, divergent, yellow, pollen yellow; ovary sessile, subglobose, 1.5–1.7 × 1.2–1.4 mm, white, smooth, glabrous, 3-loculate, locules equal, locule 2-ovulate, ovule uniseriate, style straight, white, cylindrical, conical at the apex, 4–4.2 cm long, stigma punctate, pistil the same length as the stamens. *Capsules* subglobose to globose, 2.7–3.2 × 2.2–2.8 mm, light to medium brown when mature, smooth, glabrous, loculicidal, 3-valved, sometimes apiculate due to persistent style base. *Seeds* exarillate, 1–2 per locule, 1.1–1.5 × 1.0–1.4 mm, ellipsoid to narrowly trigonal, not cleft towards the embryotega, ventrally flattened, testa grey to greyish brown, farinose, costate arranged in ridges radiating from the embryotega; embryotega dorsal, relatively inconspicuous, generally covered by a cream farina, without a prominent apicule; hilum linear, ½ the length of the seed.

Specimens seen (paratypes). **BRAZIL.** **Paraná:** Campo Largo, Caverna do Pinheirinho, fl., fr., 13 Oct 1996, G. Tiepolo & A.C. Svolenski 716 (EFC, MBM). **Rio de Janeiro:** Itatiaia, Serra do Itatiaia, Maromba, fl., 23 Oct 1931, C. Porto 2101 (RB). **Santa Catarina:** Rio do Sul, estrada Rio do Sul-Lontras, fl., 3 Dec 2013, A.L. Gasper et al. 3270 (FURB). Rodeio, borda da floresta, fl., fr., 10 Oct 2015, L.A. Funez 4549 (FURB). Urubici, Salto do rio Avenal, fl., fr., 16 Oct 2004, G. Hatschbach et al. 78097 (MBM). São Miguel D'Oeste, forest above rio Reperi-guaçu, Peperi, fl., fr., 21 Oct 1964, L.B. Smith & R. Reitz 12775 (FLOR, HBR, NY, US). **São Paulo:** Jundiá, mata de planalto na Serra do Japi, fl., 11 Aug 1976, H.F. Leitão-Filho & G.J. Shepherd 2536 (MBM, NY, UEC); loc. cit., ca. 10 km SW de Jundiá, fl., fr., 8 Oct 1976, H.F. Leitão-Filho et al. 3175 (E, MBM, NY, UEC, UFG, US). Salesópolis, Estação Biológica de Boracéia, estrada para a barragem da SABESP no Rio Guaratuba, fl., 5 Sep 1994, R. Simão-Bianchini et al. 505 (RB, SP, UEC).

Etymology. The epithet “*chrysophylla*” means golden leaves and is given after the golden hairs that cover the whole plant, but especially the leaves.

Distribution and habitat. *Tradescantia chrysophylla* is endemic to Brazil, more precisely to the states of Rio de Janeiro, São Paulo, Paraná and Santa Catarina (Fig. 8). It can be found growing as a terrestrial, rupicolous or as an epiphyte, understory in shaded and moist forests.

Phenology. It was found in bloom and fruit from August to December, but peaking during October.

Conservation status. *Tradescantia chrysophylla* possesses a wide EOO (ca. 173,649.709 km²), but a considerably narrow AOO (ca. 36.000 km²). Since it is known from very few and fragmented collections, following the IUCN (2001) recommendations, *T. chrysophylla* should be considered Endangered [EN, A2cde+ B2ab(ii, iii, iv)+D2].

Discussion. *Tradescantia chrysophylla* is morphologically similar to *T. cymbispatha* C.B. Clarke, *T. fluminensis* Vell. and *T. mundula* Kunth due to their indefinite base,

creeping stems with ascending apex, saccate cincinni bracts, petals always white, pistil as long as the stamens, seeds with uncleft testa towards the embryotega, and hilum $\frac{1}{2}$ the length of the seed. However, it can be easily differentiated from *T. fluminensis* and *T. mundula* by its sessile succulent leaves, blades homogeneously covered by indumentum, and inconspicuous secondary veins (*vs.* leaves membranous, blades glabrous or unevenly covered by indumentum, and impressed secondary veins), floral buds broadly ovoid (*vs.* ovoid to narrowly ovoid), and sepals without keels (*vs.* keeled sepals). *Tradescantia chrysophylla* is considerably more similar to *T. cymbispatha* due to their sessile, succulent leaves homogeneously covered by indumenta, inconspicuous secondary veins, and sepals without keels. Nonetheless, in *T. chrysophylla* the indumentum is velutine to hispid and golden to light brown (*vs.* strigose and hyaline in *T. cymbispatha*), the cincinni bracts are strongly unequal (*vs.* equal), and the pedicels and sepals are glandular-pubescent with golden to light brown hairs or covered by with a mixture of glandular and eglandular hairs (*vs.* velutine, covered by eglandular hyaline hairs). Furthermore, *T. chrysophylla* can be differentiated from almost all the species of *T.* sect. *Austrotradescantia* by its golden to light brown indumentum covering almost the entire plant. The only other species known to possess a similarly colored indumentum is *T. cerinthoides* (Pellegrini 2015, 2016). *Tradescantia chrysophylla* can be easily differentiated by its indefinite habit base (*vs.* definite in *T. cerinthoides*), prostrate stems (*vs.* ascending to erect), saccate cincinni bracts (*vs.* non-saccate), pistil the same length as the stamens (*vs.* longer than the stamens), petals always white (*vs.* ranging from white to pink to lilac), seed not cleft towards the embryotega (*vs.* cleft), and hilum $\frac{1}{2}$ the length of the seed (*vs.* longer than $\frac{1}{2}$ the length).

***Tradescantia valida* G.Brückn., Notizbl. Bot. Gart. Berlin–Dahlem 11: 510. 1932.**
Figs 3, 8

Type. BRAZIL. cult. in Hort. Bot. Münster/W., fl., fr., 28 Apr 1932, s.leg. s.n. (holotype: B barcode B 100296487!).

Description. *Herbs* ca. 30–70 cm tall, with indefinite base, rupicolous, rarely terrestrial. *Roots* thin, fibrous, cream to light brown, emerging from the nodes touching the substrate. *Stems* erect, succulent, little branched only at the base; internodes 1.8–7 cm long at base, distally shorter, green, sometimes with vertical reddish purple striations, glabrous. *Leaves* spirally-alternate, sessile; sheaths 0.4–1.8 cm long, light green, sometimes with vertical green or reddish purple striations, glabrous, margin setose, with long hyaline hairs; blades linear elliptic to linear lanceolate to lanceolate, rarely ovate, 2.7–18.2 × 1.1–2.5 cm, falcate to complicate, succulent, glabrous, adaxially light to medium green, abaxially light green, rarely tinted vinaceous to completely vinaceous, turning olive-green to light brown when dry, base truncate to obtuse, margin green to vinaceous, setose at base or until the middle with long hyaline hairs, slightly revolute, apex acute to acuminate; midvein conspicuous to inconspicuous, secondary veins inconspicuous, becoming more evident on both sides when dry. *Synflorescences* terminal or axillar in



Figure 3. *Tradescantia valida* G.Brückn. Holotype of *T. valida* (B barcode B100296487). Photograph courtesy of the Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin.

the distal portion of the stems, composed of a solitary main florescence, 1 per leaf axis. *Inflorescences* (main florescences) consisting of a pedunculate double-cincinni fused back to back; peduncles 3.5–52 cm long, green, glabrous; basal bract inconspicuous, tubular, hyaline, glabrous; peduncle bracts absent; supernumerary bracts present, 1–3 per inflorescence, similar in shape and size to the cincinni bracts; cincinni bracts unequal among themselves, lanceolate to ovate, rarely broadly ovate, $1\text{--}3.5 \times 0.3\text{--}1.2$ cm, spatheaceous, glabrous, light-green, abaxially slightly lighter, base truncate to obtuse, not saccate, margin green, setose at base or until the middle with long hyaline hairs, apex acute; double-cincinni (4–)6–26-flowered; bracteoles inconspicuous, imbricate, linear-triangular to triangular, hyaline. *Flowers* bisexual, actinomorphic, flat (not forming a floral tube), 1–1.5 cm diam.; floral buds broadly ellipsoid, apex acuminate; pedicels upright at anthesis and pre-anthesis, reflexed at post-anthesis, 0.7–2 cm long, green, glabrous, rarely sparsely glandular-pubescent, if present hairs hyaline; sepals 3, equal, free, ovate, cucullate, margin hyaline, apex acute, persistent in fruit, $4.8\text{--}7.3 \times 1.5\text{--}3$ mm, green, without dorsal keels, glabrous, rarely sparsely pilose at the apex, hairs eglandular, hyaline; petals 3, equal, free, elliptic to ovate, rarely broadly ovate, not clawed (sessile), flat, $5.2\text{--}8.6 \times 2.7\text{--}5.4$ mm, white to white with pink apex to light pink; stamens 6, arranged in two series, equal, filaments free from the petals and from each other, filaments 2.8–5 mm long, straight at anthesis and post-anthesis, basally densely bearded with moniliform hairs, hairs as long as the stamens, white, anthers basifixed, rimose, $0.8\text{--}1 \times 1\text{--}1.2$ mm, connective expanded, rhomboid, yellow, anther sacs ellipsoid, divergent, yellow, pollen yellow; ovary sessile, subglobose to globose, $1\text{--}1.7 \times 1\text{--}1.3$ cm, white, smooth, glabrous, 3-loculate, locules equal, locule 2-ovulate, ovule uniseriate, style straight, white, cylindrical, conical at the apex, 4–5.8 cm long, stigma punctate, pistil longer than the stamens. *Capsules* subglobose to broadly oblongoid, $2.8\text{--}4.2 \times 1.8\text{--}3$ mm, light to medium brown when mature, smooth, glabrous, loculicidal, 3-valved, sometimes apiculate due to persistent style base. *Seeds* exarillate, 1–2 per locule, $1.4\text{--}3 \times 1\text{--}1.8$ mm, ellipsoid to trigonal, cleft towards the embryotega, ventrally flattened, testa grey to greyish brown, farinose, costate arranged in ridges radiating from the embryotega; embryotega dorsal, relatively inconspicuous, generally covered by a cream farina, without a prominent apicule; hilum linear, longer than $\frac{1}{2}$ the length of the seed.

Specimens seen. **BRAZIL. Rio Grande do Sul:** Jaguari, ca. 12.5 km ao norte de Jaguari na BR-287 em direção a Santiago, fl., fr., Dec 2005, L.Y.S. Aona & M.C. Machado 958 (UEC 3ex); loc. cit., gruta linha 1, fl., fr., 27 Dec 1985, J.N.C. Marchiori 149 (HDCF).

Distribution and habitat. *Tradescantia valida* is endemic to Brazil, more precisely to the state of Rio Grande do Sul (Fig. 8). It can be found growing as rupicolous, rarely as a terrestrial, in rocky walls.

Phenology. It was found in bloom and fruit in December and April.

Conservation status. *Tradescantia valida* is only known from the cultivated type collection and collections in Jaguari, state of Rio Grande do Sul. Thus, in accordance with the IUCN recommendations (IUCN 2001), it should be considered as Data Deficient (DD), until further information on the species becomes available.

Discussion. *Tradescantia valida* is closely related to the remaining three species in the *T. crassula* group, due to its erect habit, definite base, sessile, conduplicate to falcate, succulent leaves, generally with inconspicuous secondary veins, cincinni bracts non-saccate at base, pistil longer than the stamens, hilum longer than $\frac{1}{2}$ the length of the seed, and for preferentially inhabiting open areas and rocky outcrops (Pellegrini 2015, 2016). *Tradescantia valida* can be differentiated easily from all remaining species of the *T. crassula* group by its spatheaceous cincinni bracts and by the presence of supernumerary bracts. The presence of spatheaceous cincinni bracts is a character previously reported in *T. sect. Austrotradescantia* exclusively for *T. umbraculifera* Hand.-Mazz., a member of a clade named *T. fluminensis* group by Pellegrini (2015), and thus quite remarkable in this distantly related species. Aside from that, the presence of supernumerary bracts is unique within *T. sect. Austrotradescantia*, but well-known in species from *T. sect. Cymbispatha* (Pellegrini 2015; Pellegrini et al. 2016) and *T. sect. Mandonia* (Grant 2000; Pellegrini 2015).

In the *T. crassula* group, *T. valida* is similar to *T. cerinthoides* due to its sepals without dorsal keels. However, they can be easily differentiated due to its generally linear elliptic to linear lanceolate to lanceolate leaf-blades (*vs.* elliptic to broadly elliptic or ovate to broadly ovate or obovate to broadly obovate, in *T. cerinthoides*), glabrous with margins setose at the base or until the middle (*vs.* pubescent on both sides or only abaxially, rarely glabrous on both sides with ciliate margins), and pedicels and sepals glabrous or only sparsely pubescent with eglandular hairs (*vs.* evenly densely velutine to hispid, sometimes with a mixture of glandular and eglandular hairs). *Tradescantia valida* is much more similar to *T. crassula* and *T. seubertiana* M.Pell., due to their leaf-blades and floral pubescence. These species can be easily differentiated by the pubescence of the margin of their leaf-sheaths (ciliate to shortly-setose in *T. crassula*; glabrous in *T. seubertiana*; and long-setose in *T. valida*), the pubescence of their sepals (long-setose along the keels in *T. crassula*; glabrous in *T. seubertiana*; and glabrous or with few hairs at the apex in *T. valida*), and by the shape of their floral buds (broadly ovoid *T. crassula*; ellipsoid in *T. seubertiana*; and ellipsoid in *T. valida*).

Updated key to the *Tradescantia crassula* group (modified from Pellegrini 2016)

- 1 Leaf-blades pubescent on both sides or only abaxially, rarely glabrous on both sides; pedicels and sepals densely velutine to hispid, sometimes with a mixture of glandular and eglandular hairs ***Tradescantia cerinthoides* Kunth**
- Leaf-blades glabrous on both sides, secondary veins adaxially inconspicuous; pedicels glabrous, rarely sparsely glandular-pubescent, sepals glabrous or with hairs restricted to the dorsal keel **2**
- 2 Leaf-blades with margins setose at base or until the middle with long hairs; supernumerary bracts present, cincinni bracts spatheaceous; sepals not dorsally keeled ***Tradescantia valida* G.Brückn.**
- Leaf-blades with margin entire or ciliolate to ciliate; supernumerary bracts absent, cincinni bracts leaf-like; sepals dorsally keeled **3**

- 3 Leaf-sheaths margins glabrous, base of the blades cordate to slightly amplexicaulous to obtuse; cincinni bracts unequal; floral buds ellipsoid; sepals glabrous; petals light pink to pink *Tradescantia seubertiana* M.Pell.
- Leaf-sheaths margins ciliolate to ciliate, base of the blades obtuse to truncate; cincinni bracts equal; floral buds broadly ovoid; sepals sparsely setose along the keel; petals white..... *Tradescantia crassula* Link & Otto

***Tradescantia* sect. *Campelia* (Rich.) D.R.Hunt, Kew Bull. 41(2): 404. 1986.**

Fig. 4

Diagnosis. The section is characterized by perennial herbs, with thin fibrous roots, definite base, without rhizomes, leaves with symmetric or slightly asymmetric base, inflorescences axillary, pedunculate, cincinni bracts spathaceous, bracteoles conspicuous and linear, flowers tubular, sepals unequal, basally conate, not keeled, petals free, shortly-clawed, stamens 6 and subequal, free, filaments straight at post anthesis, medially sparsely bearded with moniliform hairs, connectives sagittate, anther sacs round, ovary glabrous, stigma capitate, seeds smooth to faintly rugose, embryotega inconspicuous and semilateral (Hunt 1986; Pellegrini 2015).

Comments. *Tradescantia* sect. *Campelia* is monospecific and represented by *T. zanonina* (L.) Sw. It was considered by Hunt (1986) to be unique within the genus due to its fleshy pedicel and sepals covering the capsule, giving the fruit a berry-like appearance, which is consumed by birds and other small animals (Hunt 1986; Pellegrini, pers. obs.). Nonetheless, the morphological similarity to *Tradescantia* sect. *Zebrina* is indisputable, as pointed out by Hunt (1986) and here reaffirmed by us. *Tradescantia* sect. *Zebrina* is highly variable in the following characters: (1) the position of the inflorescence; (2) if it perforates the leaf-sheaths or not; (3) the degree of conation between the sepals, the petals; and (4) the degree of connation between the petals and stamens. Thus, both sections are distinguished solely based on the consistency of their calyx (Pellegrini, pers. obs.).

***Tradescantia* sect. *Mandonia* D.R.Hunt, Kew Bull. 35(2): 441. 1980.**

Diagnosis. The section is characterized by perennial herbs, with tuberous roots, definite base, without rhizomes, leaves with symmetric or slightly asymmetric base, inflorescences mainly axillary, sessile, cincinni bracts much reduced or rarely leaf-like in the terminal inflorescences, bracteoles inconspicuous, flowers flat, rarely tubular, sepals equal, free, not keeled, petals free, sessile, stamens 6 and equal, free or epipetalous, filaments coiling at post anthesis, medially sparsely bearded with moniliform hairs, connectives quadrangular to rectangular, rarely rhomboid, anther sacs C-shaped, ovary pubescent, stigma truncate to capitate, seeds scrobiculate to rugose, rarely costate, embryotega conspicuous and dorsal (Hunt 1980; Pellegrini 2015).

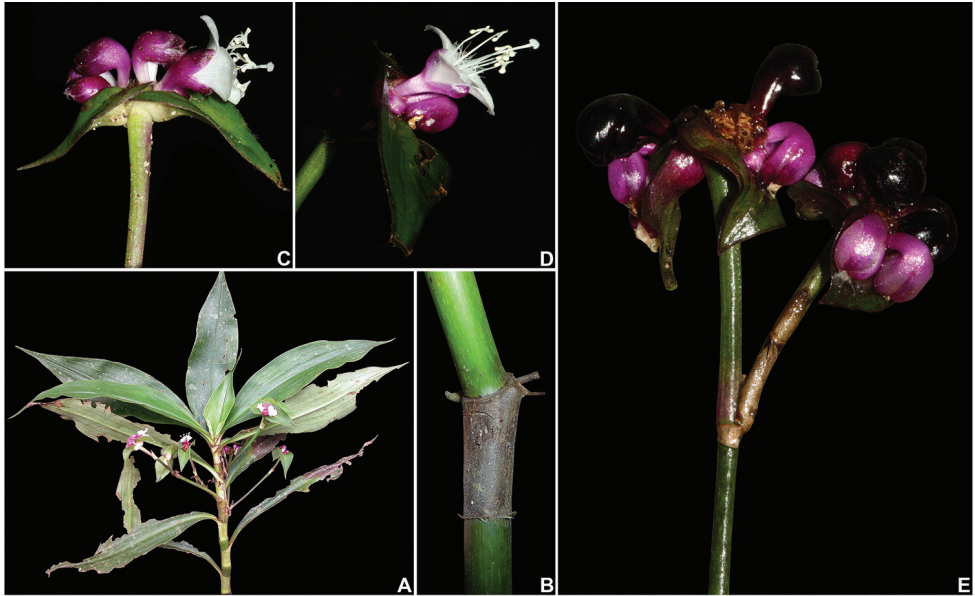


Figure 4. *Tradescantia zanoniana* (L.) Sw. **A** habit, showing the axillary inflorescences perforating the leaf-sheaths **B** detail of the leaf-sheath **C** detail of the inflorescence, showing the spatheaceous, saccate cincinni bracts, geniculate flowers, and basally connate sepals **D** side view of a flower, showing the shallowly-tubular flower, subequal stamens, sagittate connectives, round anther sacs, and trilobate stigma **E** detail of a branched synflorescence, bearing berry-like fruits. Photograph A by A.P. Maceda, B by P. Schwirkowski, C–E by M.O.O. Pellegrini.

Comments. *Tradescantia* sect. *Mandonia* is a poorly understood group, currently represented by 12 species (Hunt 1980, 1986b, 2007; Grant 2000, 2004; Zamudio et al. 2013). This section possesses a very interesting disjunctive distribution, being restricted to Seasonally Dry Tropical Forests throughout the Neotropics. Species delimitation is especially complicated in this group, due to great vegetative plasticity within species, and conserved reproductive features. Most species can be easily identified based on their allopatric distributions, but hardly differentiated based solely on their morphological features (Pellegrini, unpublished data). In South America, *T.* sect. *Mandonia* is currently represented exclusively by two species, *T. ambigua* Mart. ex Schult. & Schult.f. and *T. boliviana*. *Tradescantia boliviana* has hitherto been considered exclusive to Argentina, Bolivia, Paraguay, and Peru (Grant 2004). However, after analyzing several herbaria we came across specimens representing *T. boliviana* that reached the Brazilian territory, in the state of Mato Grosso do Sul. Thus, we present an identification key differentiating both species, illustrations, a distribution map, and the needed comments and typifications.

Leaves flat, abaxially hispid; pedicel and sepals velutine, connective rectangular, ovary and capsules densely velutine to velutine; hilum $\frac{1}{2}$ the length of the seed..... *Tradescantia ambigua* Mart. ex Schult. & Schult.f.

Leaves conduplicate, abaxially densely velutine; pedicel and sepals hispid or glandular-pubescent, connective quadrangular, ovary and capsules velutine to sparsely velutine at apex; hilum as long as the seed..... *Tradescantia boliviana* (Hassk.) J.R.Grant

Figs 5, 8

Tradescantia ambigua var. *glabriuscula* C.B. Clarke, Monogr. Phan. 3: 292. 1881. Lectotype (designated here). BRAZIL. Piauí, shady woods between São Gonçalo do Piauí and Campos, fl., Feb 1819, G. Gardner 2334 (K barcode K000363268!; isoelectotype: BM barcode BM001209590!).

Diagnosis. *Herbs* perennial, with a definite base, terrestrial to rupicolous. *Roots* thick, tuberous, brown to dark-brown, densely to sparsely pilose with brown to dark-brown hairs emerging from the rhizome and from the basal-most nodes. *Stems* erect, succulent, unbranched, rarely branched near the base; internodes green to vinaceous to reddish brown, sometimes with green striations, sparsely velutine, becoming glabrous at age, hairs hyaline. *Leaves* spirally-alternate, evenly distributed along the stems, sessile, the apical ones gradually smaller than the basal ones; sheaths green, hispid, hairs hyaline, margins hispid, hairs hyaline; lamina crass, flat, light to medium green on both sides, lanceolate to ovate, rarely obovate, adaxially sparsely hispid, becoming glabrous when mature, abaxially densely hispid, hairs hyaline, base truncate to amplexicaulous, margins vinaceous to reddish brown, ciliate, apex acuminate; midvein conspicuous, impressed adaxially, prominently obtuse abaxially, secondary veins inconspicuous to slightly conspicuous on both sides. *Inflorescences* (*main florescences*) consisting of a sessile double-cincinni fused back to back, axillary in the uppermost nodes; peduncles inconspicuous; basal bract inconspicuous, tubular, hyaline, glabrous; peduncle bracts absent; supernumerary bracts sometimes present, 1–3 per inflorescence, similar in shape and size to the cincinni bracts; cincinni bracts reduced, light green, hispid, base non-saccate; cincinni 6–12-flowered; bracteoles inconspicuous, imbricate, linear-triangular to triangular, hyaline. *Flowers* bisexual, actinomorphic, flat (not forming a floral tube); floral buds ovoid, light to medium green, rarely pink; pedicels light to medium green, rarely pink, velutine to hispid, hairs eglandular, hyaline; sepals 3, equal, ovate, cucul-

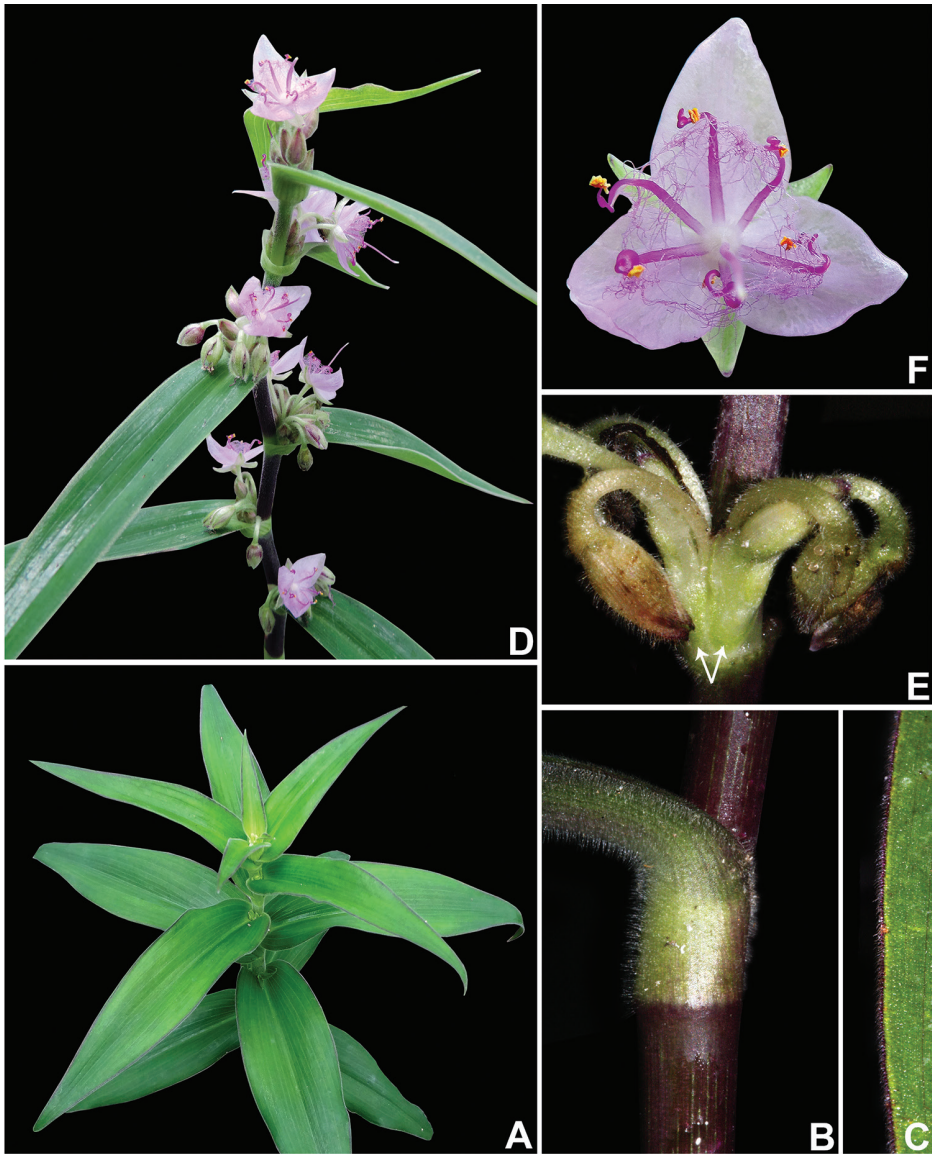


Figure 5. *Tradescantia ambigua* Mart. **A** sterile habit, showing the amplexicaulous leaf-blades **B** detail of the stem and leaf-sheath, showing the densely hispid leaf-sheath and blade **C** detail of the leaf-blade, showing the reddish, ciliate margin, and the sparsely hispid blade **D** fertile habit, showing the axillary, sessile inflorescences **E** removed leaf, exposing the sessile inflorescence and showing the reduced cincinni bracts (arrows) **F** post-anthesis flower, showing the apically spirally-coiled filaments. Photograph A by E.O. Moura, D & F by L.J. Leitão, B–C & E by M.O.O. Pellegrini.

late, dorsally not keeled, light to medium green, rarely pink, velutine to hispid, hairs eglandular, hyaline, apex acute, margins hyaline light-green, persistent in fruit; petals 3, equal, sessile, elliptic to ovate to rhomboid, white to pale lilac to lilac to light pink to

pink, base cuneate, margins entire, apex acute; stamens 6, equal, filaments light pink to pink to dark pink, rarely white, medially densely bearded with moniliform, light pink to pink to dark pink hairs, straight at anthesis, coiling at post anthesis, connective expanded, rectangular, yellow to orange, anthers sacs curved, yellow, pollen yellow; ovary subglobose, 3-loculate, white, smooth, densely velutine, style straight, white to light pink to pink, stigma capitate, white to light pink, pistil longer than the stamens. *Capsules* subglobose, apiculate due to persistent style apex, light green when immature, light brown when mature, velutine, smooth, 3-valved. *Seeds* uniseriate, 2 per locule, ellipsoid to broadly ellipsoid, not cleft towards the embryotega, ventrally flattened, testa grey to greyish brown, farinose, scrobiculate arranged in ridges radiating from the embryotega; embryotega dorsal, conspicuous, with a prominent apicule; hilum linear, $\frac{1}{2}$ the length of the seed.

Specimens seen. BRAZIL. Alagoas: Arapiraca, estrada em direção de Jaramataia, ca. 40km da cidade de Arapiraca, fl., 13 Jun 1980, V.C. Lima et al. 77 (IPA); Pão de Açúcar, caminho para Ilha do Ferro, fl., fr., 21 Jun 2002, R.P. Lyra-Lemos 6828 (HUEFS, MAC); Poço das Trincheira, Sítio Saco do Ramalho, fl., fr., 24 Aug 1983, M.N.R. Staviski et al. 643 (MAC, MG). **Bahia:** Cachoeira, Morro Belo, Vale dos Rios Paraguaçu e Jacuípe, fl., fr., Aug 1980, Grupo Scardino et al. 513 (CEPEC); Caculé, ca. 4.7 km E da sede municipal, estrada que leva à torre de televisão, fl., 30 Mar 2001, J.G. Jardim et al. 3213 (CEPEC, HUEFS, RB); Feira de Santana, distrito de Ipuacu, fl., fr., 26 Jul 2003, F. França et al. 4798 (HUEFS, HRCB); loc. cit., fl., 19 May 2005, A.P.L. Couto et al. 96 (HUEFS); loc. cit., inselberg Monte Alto, fl., 19 Jun 2006, E. Melo & B.M. Silva 4453 (HUEFS); loc. cit., fl., fr., 8 Jul 2006, C.T. Lima et al. 39 (HUEFS); Itaberaba, Fazenda Morros, fl., fr., 15 Sep 1984, G. Hatschbach 48199 (MBM); Milagres, Morro Pé da Serra, fl., 16 Mar 1997, F. França et al. 2174 (HUEFS, UEC); Paulo Afonso, Raso da Catarina, Mata das Pororocas, fl., 10 Jun 1983, L.P. Queiroz 561 (ALCB, HUEFS, IPA); Riachão do Jacuípe, fl., fr., 6 Jun 2009, E. Melo et al. 6244 (HUEFS). **Ceará:** Aiuaba, Estação Ecológica de Aiuaba, Gameleira de Cima, fl., 9 Apr 1997, L.W. Lima-Verde et al. 570 (EAC); loc. cit., fl., 9 Apr 1997, L.W. Lima-Verde et al. 573 (EAC); Carnaubal, Planalto do Ibiapaba, fl., 30 Apr 2010, E.M. Marreira et al. 84 (HUEFS, HUVA); Crateús, Sertão de Crateús, Ibiapaba Norte, Picote, fl., fr., 21 May 1997, M.A. Figueiredo s.n. (EAC25685); General Sampaio, RPPN Fancy Nunes, fl., 25 May 2007, M.F. Moro et al. 137 (EAC); Ipueiras, Olho D'água dos Galvão, Nova Fátima, fl., fr., 20 Apr 2014, A.S.F. Castro 2802 (EAC); Itapagé, Serrote do Meio, Pitombeira, fl., 30 Mar 2002, A.S.F. Castro 1182 (EAC); Meruoca, Serra de Meruoca, Sítio Santo Antônio, fl., 15 Feb 1957, A. Fernandes s.n. (EAC1699); loc. cit., fl., 3 Mar 1962, A. Fernandes s.n. (EAC2158); Monsenhor Tabosa, Serra Branca/Serra das Matas, fl., 6 Mar 2000, A.S.F. Castro 804 (EAC); Novo Oriente, Baixa Fria, fl., fr., 4 May 1991, F.S. Araújo 445 (EAC); Pentecoste, Serra do Tamanduá, fl., 31 Mar 2001, A. Andrade s.n. (EAC30590); Santa Quitéria, Serra do Pajé, Fazenda Itan de Cima, fl., fr., 7 May 1997, L.W. Lima-Verde 733 (EAC); loc. cit., fl., fr., 7 May 1997, L.W. Lima-Verde 734 (EAC); loc. cit., Fazenda Itataia, fl., 24 Apr 1984, A. Fernandes et al. s.n. (EAC12489); loc. cit., Subida

da Serra, cerca de 2.8km NE da Fazenda Itataia, fl., 27 Apr 2012, J. Paula-Souza et al. 11037 (EAC, ESA, RB); Tianguá, Chapada da Ibiapaba, Cachoeira do Frade, fl., fr., 30 Apr 1987, A. Fernandes & Matos s.n. (EAC15125, IPA69126). **Goiás:** Lavandeira, 5.5km de Lavandeira em direção a Aurora do Tocantins, fl., 25 Jan 2005, J. Paula-Souza et al. 4654 (ESA, RB). **Minas Gerais:** s.loc., s.dat., fl., A.F.M. Glaziou 14362 (US); Januária, Brejo do Amparo, Serra do Brejo, fl., 3 Jan 1970, J.P. Carauta 1058 (RB); loc. cit., 15 km na estrada a W de Januária para a Serra das Araras, fl., fr., 20 Apr 1973, W.R. Anderson et al. 9220 (MO, UB); loc. cit., Barreiro, estrada vicinal a partir do trevo do aeroporto, fl., 4 Apr 2016, C.N. Fraga 3654 (RB); Pains, st., 23 Jan 1991, M.A. Rollo s.n. (RB00898260, SPF). **Paraíba:** Pocinhos, Mubuco, fl., fr., 8 Jul 1994, A.M. Miranda & L.P. Félix 1844 (HST, PEUFR, RB, US); Remígio, Agreste, Escola Agrônômica do Nordeste, fl., fr., 8 Aug 1958, J.C. Moraes 1854 (EAN, RB); São José dos Cordeiros, fl., 23 Mar 2003, I.B. Lima et al. 83 (HUEFS). **Pernambuco:** Alagoinha, Serra do Gavião, fl., fr., 8 Aug 2000, A. Viana et al. 75 (IPA); Arcoverde, Estação Experimental, fl., fr., 22 Jul 1971, Andrade-Lima 71-6399 (IPA); Betania, Serra dos Arrombadores, fl., 6 Apr 2002, S.M.F. Neto et al. 2 (IPA); Buíque, Parque Nacional do Catimbau, perto da entrada da trilha do cânion, fl., fr., 16 May 2006, E.A. Rocha et al. 1481 (IPA); loc. cit., Vale do Catimbau, trilha das Torres, fl., fr., 18 Jun 2008, R. Pereira et al. 2760 (HUEFS, IPA); Pesqueira, Serra do Gavião, fl., fl., 19 Jun 2005, M. Oliveira 1811 (IPA); Ouricuri, margem da estrada Lagoa-Ouricuri, fl., 4 May 1971, E.P. Heringer et al. 499 (IPA, PEUFR, R, RB, UB); São Caetano, RPPN Pedra do Cachorro, Subida florestal do afloramento rochoso granítico, fl., fr., 19 Jun 2011, K. Mendes, 700 (ASE). **Rio Grande do Norte:** Bodó, fl., 4 May 2014, E.O. Moura et al. 161 (UFRN); Florânia, rodovia para Tenente Laurentino ca. 6 km da sede municipal, Serra de Santana, fl., 29 May 2010, J.G. Jardim et al. 5768 (RB, UFRN); Serra de São Bento, fl., L.M. Versieux et al. 548 (HURB, RB, UFRN). **Sergipe:** Canindé de São Francisco, fl., 1 Sep 2014, G.S. Freire 116 (ASE); Frei Paulo, 6km após o povoado Mocambo, entrada para mata, fl., 26 Jun 1981, M. Fonseca 517 (ASE); loc. cit., fl., fr., 6 Aug 1987, G. Viana 1925 (ASE, HURB); Nossa Senhora da Glória, Fazenda Olhos d'Água, fl., fr., 06 Aug 1982, E. Gomes 114 (ASE); loc. cit., fl., fr., 1 Sep 1983, G. Viana 765 (ASE, HURB); loc. cit., fl., 6 May 1986, G. Viana 1456 (ASE); Porto da Folha, povoado Lagoa do Rancho, fl., fr., 20 Jul 2006, E. Córdula et al. 115 (HUEFS, UFP); loc. cit., Fazenda São Pedro, fl., 19 Apr 2011, D.G. Oliveira 150 (ASE, MAC); loc. cit., fl., fr., 6 Aug 2012, A.P. Prata et al. 3212 (ASE); loc. cit., fl., fr., 5 Aug 2014, L.A.S. Santos 1158 (ASE, RB). **Without state:** s.loc., fl., M.A. Glaziou 14362 (P, US).

Distribution and habitat. *Tradescantia ambigua* is endemic to Northeastern Brazil (states of Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe), also reaching the states of Goiás and Minas Gerais. It grows in moist and shady areas, between shrubs and patchy forests in the Caatinga and Cerrado domains (Fig. 8).

Phenology. It was found in bloom and fruit from January to August.

Conservation status. *Tradescantia ambigua* possesses a wide EOO (ca. 1,057,693.924 km²), and following the IUCN recommendations (IUCN 2001), it should be considered

Least Concern (LC). However, when taking the AOO into consideration, it is considerably reduced (ca. 216.000 km²). Furthermore, The Caatinga and Cerrado domains are greatly threatened by human activities such as deforestation, cattle breeding, and various crops. Thus, following the IUCN (2001) recommendations, *T. ambigua* should be considered Endangered [EN, A2c+B2ab(ii, iii, iv, v)+C2a(i)].

Nomenclatural notes. When describing *T. ambigua*, Schultes and Schultes (1830) mention that their new species is based on a Martius specimen from the Province of Bahia, but with no reference to herbaria or collector number. While consulting M we came across a specimen (*Martius 140*) matching perfectly the protologue, and annotated in Martius's handwriting. Thus, it is here designated as the lectotype.

When describing *T. ambigua* var. *glabriuscula*, Clarke (1881) only lists the collection *Gardner 2334*. However, Clarke makes no reference to the herbaria in which this specimen might be distributed. After analyzing several collections, we found specimens of *Gardner 2334* at BM and K. According to Stafleu and Cowan (1976), Clarke had access to both collections, and many of the type specimens for names described by him were commonly from either of the two herbaria. The specimen at K is composed of a much longer stem, containing a greater number of leaves, inflorescences and flowers. Added to that, it is annotated on Clarke's handwriting, making it the obvious choice for a lectotype.

Morphological notes. *Tradescantia ambigua*, as most species in *T.* sect. *Mandonia*, presents a high degree of morphological variation. The plants vary greatly in size, branching of the stem, shape of the leaves, pubescence of the leaves, pubescence of the pedicels and sepals, and shape and color of the petals. Nonetheless, this variation has no obvious geographical pattern and seems rather random across its distribution range. Thus, don't recognize any infraspecific taxa for *T. ambigua*.

***Tradescantia boliviana* (Hassk.) J.R.Grant, Novon 14(3): 299. 2004.**

Figs 6, 8

Skofitzia boliviana (Hassk.) Hassk. & Kanitz, Oesterr. Bot. Z. 22: 147. 1872.

Mandonia boliviana Hassk., Flora 54: 260. 1871. Lectotype (designated by Grant 2004). BOLIVIA. Larecaja: viciniis Sorata montis colles Ullontigi ad scopulorum-ra dicemi n regionet emperata, fl., fr., Feb–Apr 1858, G. Mandon 1239 (L barcode L0374955!; isolectotypes: F barcode F0076407F!, G barcode G00489633!, GH n.v., K n.v., P 3ex barcodes P00376711!, P00376712!, P00376713!).

Tradescantia ambigua var. *pilosula* Hoehne, Relat. Commiss. Linhas. Telegr. Estrateg. Matto Grosso Amazonas 5, 5: 14. 1915. Lectotype (designated here). BRAZIL. Mato Grosso do Sul: Corumbá, fl., Feb 1911, F.C. Hoehne 4499 (R barcode R000004848!). **Syn. nov.**

Diagnosis. *Herbs* perennial, with a definite base, terrestrial to rupicolous. *Roots* thick, tuberous, brown to dark-brown, densely to sparsely pilose with brown to dark-brown hairs, emerging from the rhizome and from the basal most nodes. *Stems* erect, succulent,

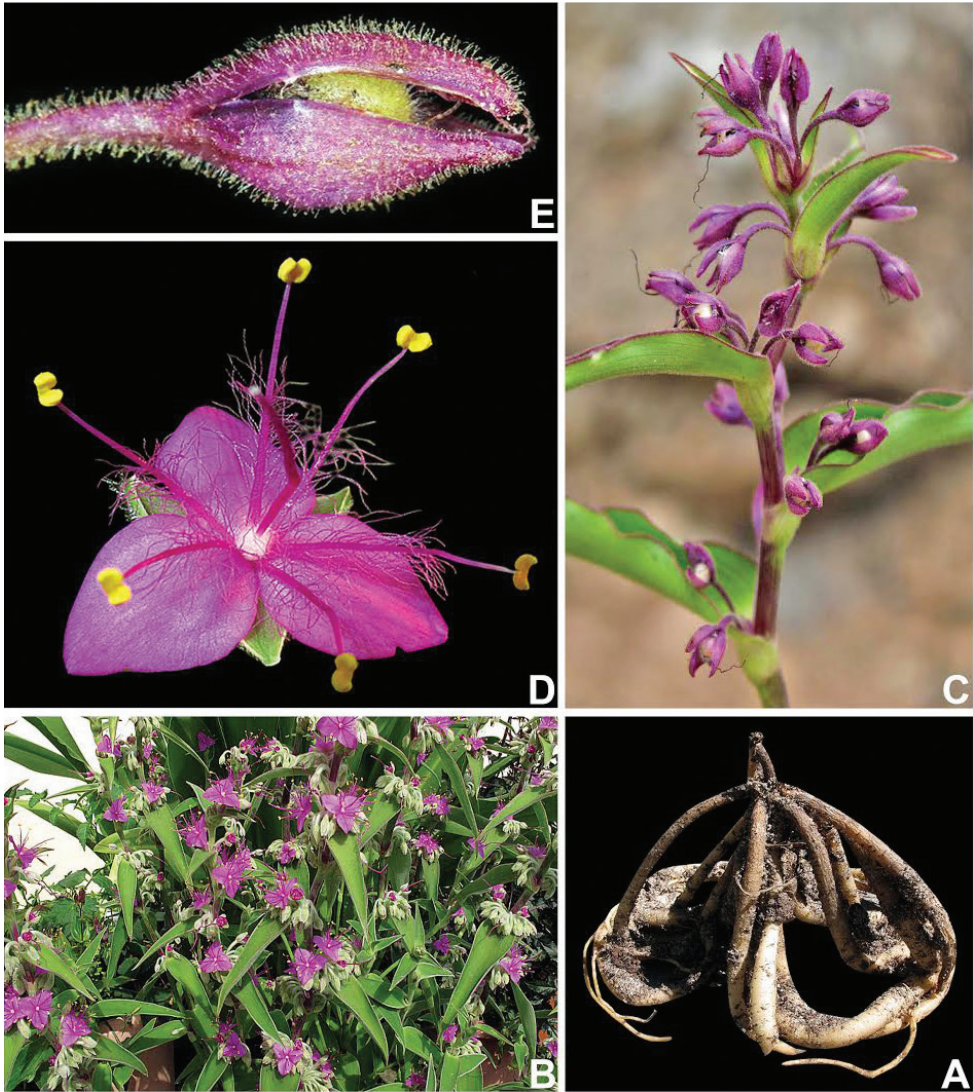


Figure 6. *Tradescantia boliviana* (Hassk.) J.R.Grant. **A** detail of the tuberous roots **B** habit **C** detail of fertile branch, showing the conduplicate leaf-blades, and axillary inflorescences **D** front view of a flower at anthesis, showing the rectangular connectives and C-shaped anther sacs **E** detail of an immature capsule, showing the densely glandular-pubescent pedicel and sepals, and the capsule apically velutinous. Photograph A–B & D by P. Christian (RarePlants.co.uk), C & E by Instituto Darwinion.

unbranched, rarely branched near the base; internodes green to vinaceous to reddish brown, sometimes with vinaceous striations, densely velutinous, sometimes becoming glabrous at age, hairs hyaline to light brown. *Leaves* spirally-alternate, evenly distributed along the stems, sessile, the apical ones gradually smaller than the basal ones; sheaths green, densely velutinous, hairs hyaline to light brown, margins ciliate, hairs hyaline to light brown; lamina succulent conduplicate, medium to dark green adaxially, light to medium

green abaxially, narrowly lanceolate to lanceolate, rarely ovate, adaxially sparsely velutine, sometimes becoming glabrous at age, abaxially densely velutine, hairs light brown, base truncate to rounded, margins vinaceous to reddish brown, ciliate, apex acute; midvein conspicuous, impressed adaxially, prominently obtuse abaxially, secondary veins inconspicuous to slightly conspicuous on both sides. *Inflorescences* (*main florescences*) consisting of a sessile double-cincinni fused back to back, axillary in the uppermost nodes; peduncles inconspicuous; basal bract inconspicuous, tubular, hyaline, glabrous; peduncle bracts absent; supernumerary bracts sometimes present, 1–3 per inflorescence, similar in shape and size to the cincinni bracts; cincinni bracts reduced, light green, hispid, base non-saccate; cincinni (4–)8–22-flowered; bracteoles inconspicuous, imbricate, linear-triangular to triangular, hyaline. *Flowers* bisexual, actinomorphic, flat (not forming a floral tube); floral buds narrowly ovoid, dark pink to vinaceous; pedicels dark pink to vinaceous, densely glandular-pubescent, hairs light brown; sepals 3, equal, ovate, cucullate, dorsally not keeled, dark pink to vinaceous, rarely green, densely glandular-pubescent, hairs light brown, apex acute, margins hyaline light-green, persistent in fruit; petals 3, equal, sessile, broadly ovate, medium to dark pink to mauve, rarely white or light pink to lilac, base cuneate, margins entire, apex acute; stamens 6, equal, filaments light medium to dark pink to mauve, medially bearded with moniliform, medium to dark pink to mauve hairs, straight at anthesis, coiling at post anthesis, connective expanded, quadrangular, yellow to orange, anthers sacs curved, yellow, pollen yellow; ovary oblongoid, 3-loculate, white, smooth, velutine at apex, style straight, medium to dark pink, stigma capitate, white to light pink, pistil longer than the stamens. *Capsules* broadly oblongoid, apiculate due to persistent style apex, green when immature, brown when mature, sparsely velutine at the apex, smooth, 3-valved. *Seeds* uniseriate, 2 per locule, ellipsoid to broadly ellipsoid, not cleft towards the embryotega, ventrally flattened, testa grey to greyish brown, farinose, scrobiculate arranged in ridges radiating from the embryotega; embryotega dorsal, conspicuous, with a prominent apicule; hilum linear, as long as the seed.

Specimens seen. BRAZIL. Mato Grosso do Sul: Campo Grande, Empraba Gado de Corte, fl., fr., 28 Feb 2009, V.J. Pott 10452 (CGMS, HURB); Corumbá, fl., Feb 1911, F.C. Hoehne 4723 (R); loc. cit., Mineração Corumbaense Reunida SA, paredão próximo ao paiol de explosivos, fl., fr., 23 Feb 2005, G.A. Damasceno-Junior et al. 3488 (COR, K); loc. cit., Serra Urucum, fl., fr., 24 Feb 2005, A. Pott et al. 12655 (CGMS, HMS); loc. cit., Fazenda Banda Alta, fl., 11 Jan 2007, A. Takahasi & S.M. Ribas 1175 (COR); Ladário, Fazenda São Sebastião do Carandá, fl., fr., 13 Mar 2003, G.A. Damasceno-Junior et al. 2773 (COR); Nioaque, Assentamento Andalucia, fl., 6 Dec 2008, L.C.S. Magalhães & G.A. Damasceno-Júnior 138 (CGMS, HURB); loc. cit., fl., fr., 9 Jan 2009, L.C.S. Magalhães & T.S. Amaral 194 (CGMS, HURB); loc. cit., fl., fr., 9 Jan 2009, L.C.S. Magalhães & T.S. Amaral 195 (CGMS); loc. cit., fl., fr., 8 Feb 2009, L.C.S. Magalhães & T.S. Yule 278 (CGMS).

Distribution and habitat. *Tradescantia boliviana* restricted to Argentina, Bolivia, Paraguay, Peru, and Brazil (state of Mato Grosso do Sul). It commonly grows as rupicolous in rocky walls and outcrops, under full sunlight, in the Chaco and Pantanal domains (Fig. 8).

Phenology. It was found in bloom and in fruit from December to June.

Conservation status. *Tradescantia boliviana* possesses a wide EOO (ca. 2,249,457.700 km²), and based solely on this criterion it should be considered Least Concern (LC). Nonetheless, its AOO is considerably reduced (ca. 172.000 km²), added to that fact that most of the studied specimens are at least more than 20 years old. Thus, following the IUCN (2001) recommendations, *T. boliviana* should be considered Endangered [EN, A2bcd+B2ab(ii, iii, iv, v)+C1+C2a(i)].

Nomenclatural notes. In the protologue of *T. ambigua* var. *pilosula*, Hoehne (1915) mentions two collections of his own when describing this new variety. The author makes no reference as to the herbarium in which each specimen is placed or to the existence of possible duplicates. According to Stafleu and Cowan (1979), Hoehne's types are generally at SP with duplicates in several other herbaria. However, after two visits to the SP we were unable to locate any of the specimens (Hoehne 4499, 4723). Nonetheless, Stafleu and Cowan (1979) make an important remark that until 1917, Hoehne was living and working in Rio de Janeiro. After analyzing the collection of R, we came across both specimens placed in the general collection. Both specimens were annotated by Hoehne, but the specimen Hoehne 4499 possesses a beautiful illustration attached to it, showing the details of the plants' floral morphology. Thus, it is designated by us as the lectotype for *T. ambigua* var. *pilosula*.

Morphological notes. *Tradescantia boliviana* is a morphologically variable species across its distribution. Nonetheless, in the same way as *T. ambigua*, there is no obvious geographical pattern in this variation. The presence of glandular hairs in the pedicels and sepals can be observed in some of the individuals, but aside from that they don't seem to differ in any other aspect from the other specimens. This variation is peculiar, but not unrecorded in the genus, and a similar scenario is described by Pellegrini (2015, 2016) for *T. cerinthoides* (*T. sect. Austrotradescantia*) and by Faden (1993) for *T. crassifolia* (*T. sect. Mandonia*).

After analyzing the type specimens for *T. ambigua* var. *pilosula*, we noticed that the pedicels and sepals are hispid, the connectives are quadrangular, and the ovary velutine to sparsely velutine at apex. Added to that, the distribution of the specimens collected by Hoehne is congruent with the distribution of *T. boliviana*, but disjunctive from *T. ambigua*. Thus, we consider *T. ambigua* var. *pilosula* a synonym of *T. boliviana*.

***Tradescantia* sect. *Zebrina* (Schnizl.) D.R.Hunt, Kew Bull. 41(2): 404. 1986.**

Fig. 7

Diagnosis. The section is characterized by perennial herbs, with thin fibrous roots, definite or indefinite base, without rhizomes, leaves with symmetric to asymmetric base, inflorescences terminal or axillary, pedunculate, cincinni bracts spathaceous, bracteoles conspicuous and linear, flowers tubular, sepals unequal, basely to completely conate, keeled or not, petals free or conate, long-clawed, stamens 6 and subequal, epipetalous, filaments straight at post anthesis, medially sparsely bearded with

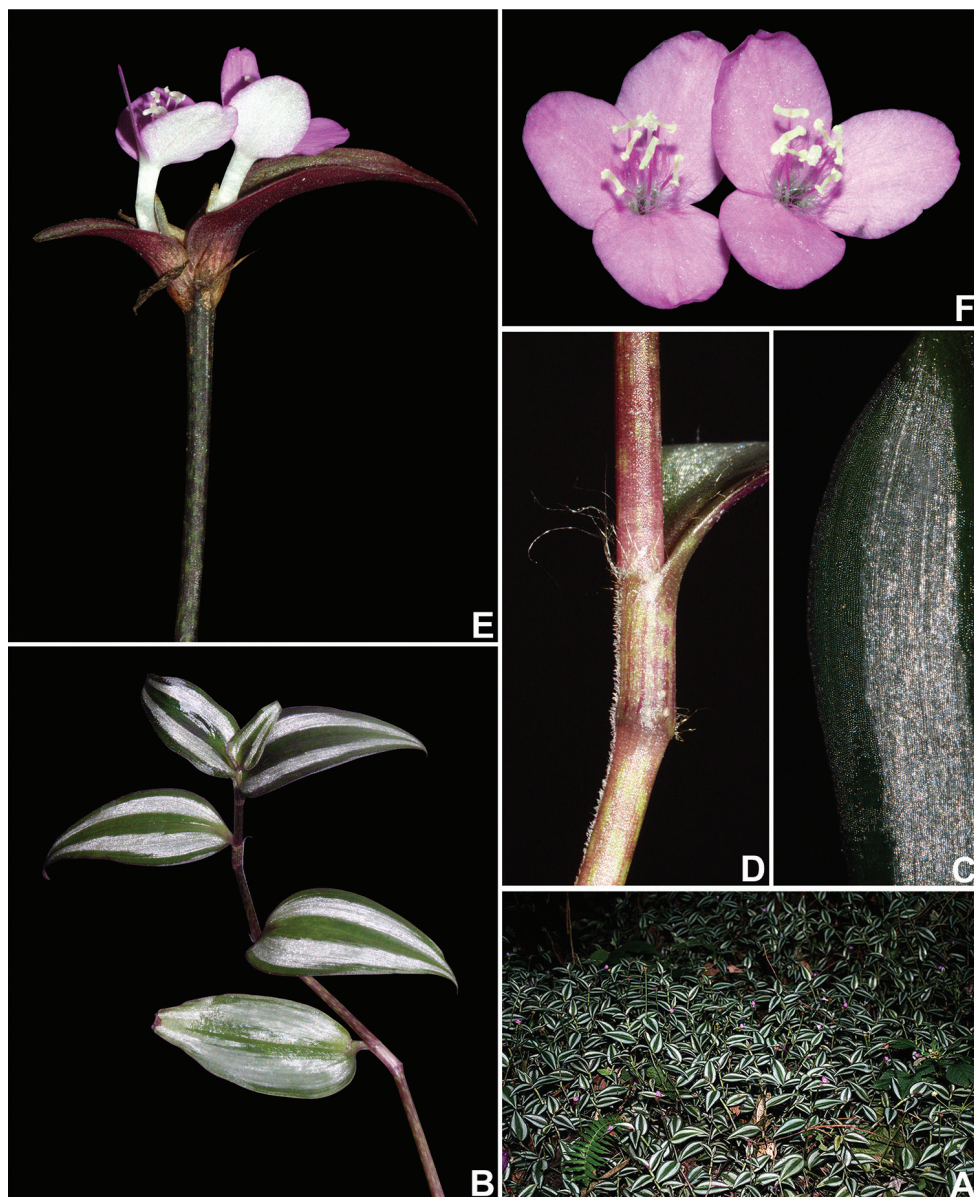


Figure 7. *Tradescantia zebrina* Heynh. ex Bosse. **A** habit **B** detail of a branch, showing the subpetiolate basal leaves, and blades with silver stripes **C** detail of the abaxial side of the leaf-blade **D** detail of the stem and leaf-sheath **E** detail of the terminal inflorescence, showing the spatheous, saccate, unequal, conduplicate cincinni bracts, and long-tubular flowers with clawed petals **F** flowers. Photographs by M.O.O. Pellegrini.

moniliform hairs, connectives sagittate to linearly-tapered, anther sacs round, ovary glabrous, stigma capitate, seeds rugose, embryotega inconspicuous and semilateral (Hunt 1986; Pellegrini 2015).

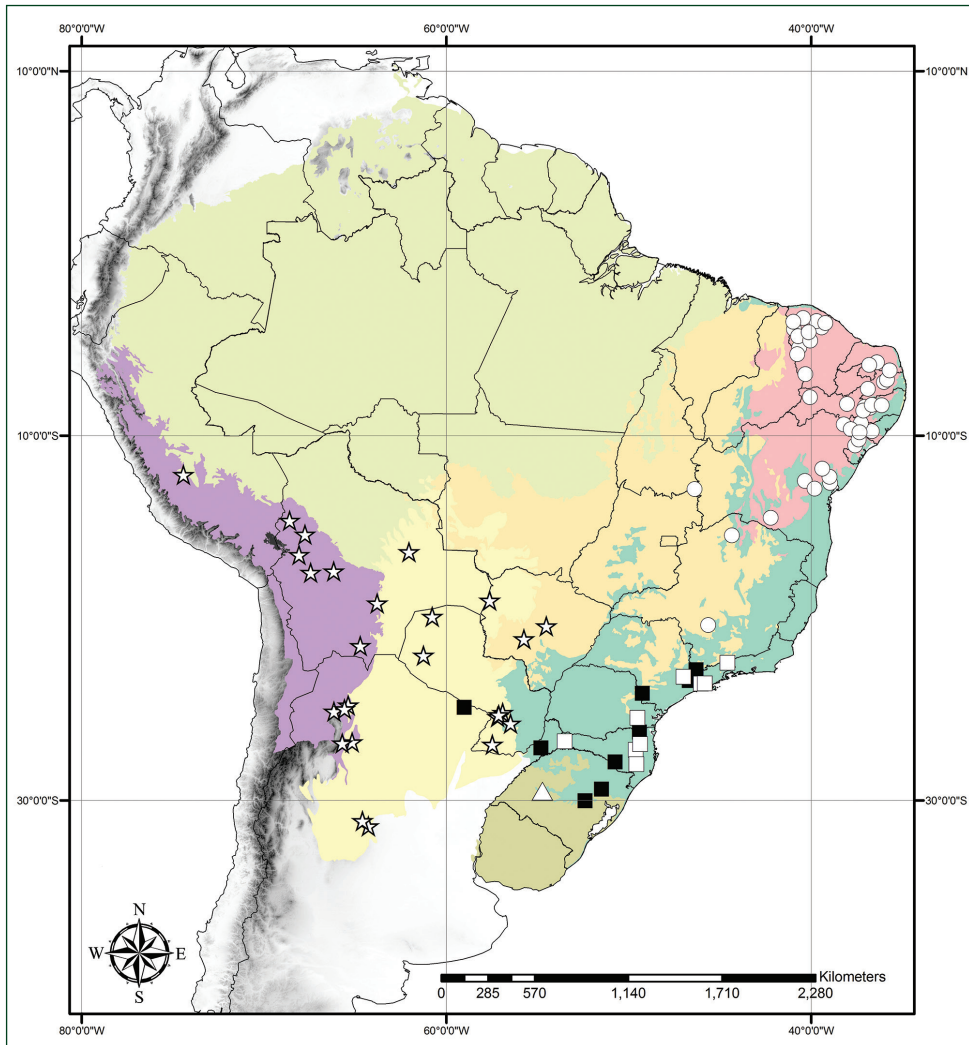


Figure 8. Distribution map of studied *Tradescantia* L. in the South American domains. **Full squares**– *T. crassula*; **White squares**– *T. chrysophylla*; **Triangles**– *T. valida*; **Circles**– *T. ambigua*; **Stars**– *T. boliviana*. Light green– Amazon Forest; Orange– Cerrado; Red– Caatinga; Yellow– Chaco and Pantanal; Olive-green– Pampa; Dark green– Atlantic Forest; Purple– Andean Yungas.

Comments. *Tradescantia* sect. *Zebrina* is a small group, composed of ca. five species, ranging from Mexico to Venezuela. *Tradescantia zebrina* Heynh. ex Bosse is widely cultivated worldwide, and occurs in Brazil as an invasive species (Hunt 1986; Pellegrini 2017). As aforementioned, the section is small but morphologically diverse, being poorly differentiated from *T.* sect. *Campelia* and *T.* sect. *Corinna*. As stated by Hunt (1986), these three sections seem to blur into one another, with several species being originally assigned to one group and subsequently transferred to another.

Conclusion

Tradescantia, like many other genera in Commelinaceae, is a taxonomically complicated and morphologically diverse genus. In order to safely propose taxonomic novelties, it is necessary to possess a broader knowledge on the group, especially regarding the morphological plasticity within each species. This can only be achieved with extensive field and herbaria research, complemented with the cultivation and observation of some individuals. Many recent studies of Brazilian Commelinaceae have been narrowly focused, and proposed new species and several typifications (Funez et al. 2016; Hassemer et al. 2016a, 2016b; Hassemer 2017). As demonstrated by us in the present work, this can lead to the unnecessary description of new names, causing the inflation of accepted species and their conservation assessments. Perhaps the most unfortunate result of such studies is the potential for incorrect typification and application of names (e.g. Funez et al. 2016; Hassemer et al. 2016b; Hassemer 2017). Thus, we strongly suggest that future typifications and descriptions of new taxa in Commelinaceae be carried out as part of a broader and more detailed taxonomic framework.

Acknowledgments

We would like to thank the staff and curators of the visited herbaria. We would also like to thank Morgan R. Gostel for revising the English and making suggestions for the improvement of this manuscript; Rafael Felipe de Almeida for the graphical support and valuable suggestions on an early version of the manuscript; Maria Alice de Rezende for the line drawing; Edwesley Otaviano de Moura and Leonardo Jales Leitão for field photos of *T. ambigua*; Instituto Darwinion and RarePlants.co.uk for the field photos of *T. boliviana*; A.P. Maceda and Paulo Schwirkowski for the photos of *T. zanonía*; and Kate Hertweck for suggestions during the review process. MOOP thanks CAPES for his Master scholarship granted from 2013–2015 (UFRJ) and for his current PhD scholarship (USP), besides Fundação Flora de Apoio à Botânica and Smithsonian Institution for his REFLORA grant. CMS and RCF would like to thank the CNPq for their productivity scholarships. This study was carried out as part of the first author's Master degree in Biodiversity and Evolutionary Biology at Programa de Pós-Graduação em Biodiversidade e Biologia Evolutiva, Instituto de Biologia, Universidade Federal do Rio de Janeiro — IB/UFRJ.

References

- Anderson ES, Woodson Jr RE (1935) The species of *Tradescantia* indigenous to the United States. Contributions, Arnold Arboretum 9: 1–132.
- Bachman S, Moat J, Hill AW, Torre J, Scott B (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: Smith V, Penev L (Eds) e-Infra-

- structures for data publishing in biodiversity science. *ZooKeys* 150: 117–126. doi: 10.3897/zookeys.150.2109
- Burns JH, Faden RB, Steppan SJ (2011) Phylogenetic studies in the Commelinaceae subfamily Commelinoideae inferred from nuclear ribosomal and chloroplast DNA sequences. *Systematic Botany* 36(2): 268–276. <https://doi.org/10.1600/036364411X569471>
- Clarke CB (1881) Commelinaceae. In: De Candolle A (Ed.) *Monographiae Phanerogamarum*, vol. 3. Sumptibus G. Masson, Paris, France, 113–324, t. I–VIII.
- eMonocot (2010) eMonocot, Version 1.0.2. <http://e-monocot.org/> [accessed: 1.20.2017]
- Evans TM, Sytsma KJ, Faden RB, Givnish TJ (2003) Phylogenetic relationships in the Commelinaceae: II. A cladistic analysis of *rbcL* sequences and morphology. *Systematic Botany* 28: 270–292.
- Faden RB (1991) The morphology and taxonomy of *Aneilema* R. Brown (Comelinaceae). *Smithsonian Contributions to Botany* (Washington, DC) 76: 1–181. <https://doi.org/10.5479/si.0081024X.76>
- Faden RB (1993) *Tradescantia crassifolia* (Comelinaceae), an overlooked species in the southwestern United States. *Ann. Missouri Bot. Gard.* 80(1): 219–222. <https://doi.org/10.2307/2399825>
- Faden RB (1998) Commelinaceae. In: Kubitzki K (Ed.) *The Families and Genera of Vascular Plants* (Vol. 4). Springer Verlag, Berlin, 109–128. https://doi.org/10.1007/978-3-662-03531-3_12
- Faden RB, Hunt DR (1991) The Classification of the Commelinaceae. *Taxon* 40(1): 19–31. <https://doi.org/10.2307/1222918>
- Funez LA, Hassemer G, Ferreira JPR (2016) Description of *Tradescantia schwirkowskiana* (Comelinaceae), a narrow endemic new species from Santa Catarina, Southern Brazil, and typification of *T. crassula*. *Phytotaxa* 272(1): 63–72. <https://doi.org/10.11646/phytotaxa.272.1.3>
- Grant JR (2000) New Mesoamerican species of *Dichorisandra* and *Tradescantia* section *Mandonia* (Comelinaceae). *Novon* 10(2): 117–123. <https://doi.org/10.2307/3393009>
- Grant JR (2004) *Tradescantia boliviana* (Comelinaceae), a new combination for an overlooked South American species. *Novon* 14(3): 299–300.
- Hassemer G, Ferreira JPR, Funez LA, Aona LYS (2016) Identity and typification of *Commelina vilavelhensis* (Comelinaceae), and typification of *C. robusta* and *C. scabrata*. *Phytotaxa* 260(2): 144–156. <https://doi.org/10.11646/phytotaxa.260.2.4>
- Hassemer G, Ferreira JPR, Funez LA, Medeiros JDM (2016) *Commelina catharinensis* (Comelinaceae): a narrow endemic and endangered new species from Santa Catarina, Southern Brazil. *Phytotaxa* 246(1): 49–60. <https://doi.org/10.11646/phytotaxa.246.1.4>
- Hassemer G (2017) Taxonomic and nomenclatural notes on Neotropical *Commelina* (Comelinaceae), and an identification key for Brazil, Guyana, Paraguay, Suriname and Uruguay. *Phytotaxa* 303(2): 101–117. <https://doi.org/10.11646/phytotaxa.303.2.1>
- Hertweck KL, Pires JC (2014) Systematics and evolution of inflorescence structure in the *Tradescantia* alliance (Comelinaceae). *Syst. Bot.* 39(1): 105–116. <https://doi.org/10.1600/036364414X677991>
- Hoehne FC (1915) Botanica. In: *Historia Natural. Relatório da Comissão de Linhas Telegraficas Estrategicas de Matto-Grosso ao Amazonas* anexo 5, pt. 5: 14.

- Hunt DR (1975) The Reunion of *Setcreasea* and *Separotheca* with *Tradescantia* – American Commelinaceae: I. Kew Bulletin 30(3): 443–458. <https://doi.org/10.2307/4103068>
- Hunt DR (1980) Sections and series in *Tradescantia* – American Commelinaceae: IX. Kew Bulletin 35(2): 437–422. <https://doi.org/10.2307/4114596>
- Hunt DR (1986a) *Campelia*, *Rhoeo* and *Zebrina* united with *Tradescantia* – American Commelinaceae: XIII. Kew Bulletin 41(2): 401–405. <https://doi.org/10.2307/4102948>
- Hunt DR (1986b) New names and a new species in *Tradescantia* – American Commelinaceae: XIV. Kew Bulletin 41(2): 406. <https://doi.org/10.2307/4102949>
- Hunt DR (2007) A new species of *Tradescantia* (Commelinaceae) from Mexico. Kew Bulletin 62(1): 141–142.
- IBGE [Instituto Brasileiro de Geografia e Estatística] (2012) Manual Técnico da vegetação Brasileira: sistema fitogeográfico, inventário das formações florestais e campestres, técnicas e manejo de coleções botânicas, procedimentos para mapeamentos (2nd edn), Vol. 1. IBGE, Rio de Janeiro, 272 pp.
- IUCN (2001) The IUCN red list of threatened species, version 2010.4. IUCN Red List Unit, Cambridge. <http://www.iucnredlist.org/> [accessed: 2.6.2016]
- Link JHF, Otto CF (1828) Icones plantarum selectarum Horti Regii Botanici Berolinensis cum descriptionibus et colendi ratione (Vol. 2). Zehn Hefte, Berlin, 13–24. [t. 7–12]
- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, Prud'Homme Van Reine WF, Smith GF, Wiersema JH, Turland NJ (Eds) (2012) International Code of Botanical Nomenclature (Melbourne Code). Adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. Regnum Vegetabile 154. A.R.G. Gantner Verlag KG, Sweden, 240 pp.
- Panigo E, Ramos J, Lucero L, Perreta M, Vegetti A (2011) The inflorescence in Commelinaceae. Flora 206(4): 294–299. <https://doi.org/10.1016/j.flora.2010.07.003>
- Pellegrini MOO (2015) Filogenia e revisão taxonômica de *Tradescantia* L. sect. *Austrotradescantia* D.R.Hunt (Commelinaceae). MsC thesis, Instituto de Biologia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil. <https://doi.org/10.12705/641.3>
- Pellegrini MOO (2016) A new species of *Tradescantia* L. sect. *Austrotradescantia* D.R.Hunt (Commelinaceae) from Southern Brazil. Phytotaxa 265(1): 79–84.
- Pellegrini MOO (2017) *Tradescantia*. Flora do Brasil 2020 em construção. Jardim Botânico do Rio de Janeiro. <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB126851> [accessed: 1.1.2017]
- Pellegrini MOO, Forzza RC, Sakuragui CM (2015) A nomenclatural and taxonomic review of *Tradescantia* L. (Commelinaceae) species described in Vellozo's *Flora fluminensis* with notes on Brazilian *Tradescantia*. Taxon 64(1): 151–155.
- Pellegrini MOO, Forzza RC, Sakuragui CM (2016) (Con)Fused bracts: The identity and application of *Tradescantia cymbispatha* C.B.Clarke (Commelinaceae) and a neglected new *Tradescantia* species from Bolivia. Systematic Botany 41(4): 950–958. <https://doi.org/10.1600/036364416X694053>
- Radford AE, Dickison WC, Massey JR, Bell CR (1974) Vascular Plant Systematics. Harper & Row Publishers, New York, 891 pp.

- Spjut RW (1994) A Systematic Treatment of Fruit Types. The New York Botanical Garden, New York, 181 pp.
- Stafleu FA, Cowan RS (1976) Taxonomic literature. A selective guide to botanical publications and collections with dates, commentaries and types (ed. 2, Vol. 1). Regnum Vegetabile 94. A.R.G. Gantner Verlag, Rugell, Sweden, 1136 pp.
- Stafleu FA, Cowan RS (1979) Taxonomic literature. A selective guide to botanical publications and collections with dates, commentaries and types (ed. 2, Vol. 2). Regnum Vegetabile 94. A.R.G. Gantner Verlag, Rugell, Sweden, 991 pp.
- Stafleu FA, Cowan RS (1985) Taxonomic literature. A selective guide to botanical publications and collections with dates, commentaries and types (ed. 2, Vol. 5). Regnum Vegetabile 112. A.R.G. Gantner Verlag, Rugell, Sweden, 1066 pp.
- The Plant List (2013) The Plant List – Version 1.1. <http://www.theplantlist.org/> [accessed: 8.12.2016]
- Thiers B (2017) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Gardens' Virtual Herbarium. <http://sweetgum.nybg.org/ih/> [accessed: 1.15.2017, continually updated]
- Wade DW, Evans TM, Faden RB (2006) Subtribal relationships in the tribe Tradescantieae (Commelinaceae) based on rbcL and ndhF sequences. *Aliso* 22(1): 520–526.
- Weberling F (1965) Typology of inflorescences. *Botanical Journal of the Linnean Society* 59: 15–221. <https://doi.org/10.1111/j.1095-8339.1965.tb00058.x>
- Weberling F (1989) Morphology of flowers and inflorescences. Cambridge University Press, Cambridge, 1–348.
- Zamudio S, Espejo-Serna A, López-Ferrari AR, Ceja-Romero J (2013) Una nueva especie de *Tradescantia* (Commelinaceae) del estado de Querétaro, Mexico. *Acta Botanica Mexicana* 102: 25–30.

Nomenclatural novelties and notes in *Penstemon* (Plantaginaceae)

Craig C. Freeman¹

¹ R.L. McGregor Herbarium, Division of Botany, Biodiversity Research Institute, University of Kansas, Lawrence, Kansas 66047-3729, USA

Corresponding author: Craig C. Freeman (ccfree@ku.edu)

Academic editor: P. de Lange | Received 29 March 2017 | Accepted 30 March 2017 | Published 25 April 2017

Citation: Freeman CC (2017) Nomenclatural novelties and notes in *Penstemon* (Plantaginaceae). PhytoKeys 80: 33–39. <https://doi.org/10.3897/phytokeys.80.12962>

Abstract

Seven nomenclatural novelties in *Penstemon* (Plantaginaceae) are proposed for taxa that will be included in the forthcoming treatment of the genus in the Flora of North America North of Mexico series. Three additional novelties are made for Mexican taxa outside the flora area. *Penstemon xylus* A. Nelson is determined to be the correct name for the species heretofore called *P. tusharensis* N. Holmgren.

Keywords

Penstemon, Plantaginaceae

Introduction

Field and herbarium studies of the genus *Penstemon* Schmidel (Plantaginaceae) for a treatment in the forthcoming Volume 17 of the Flora of North America North of Mexico (FNA) (Freeman in prep.) necessitate some nomenclatural changes for consistency in infraspecific rank, following FNA editorial guidelines. Three additional changes are made affecting two species that occur entirely in Mexico. Nomenclatural notes accompany some of the changes.

Methods

Information about type specimens is based on protologues, major online nomenclatural indices (Tropicos - <http://www.tropicos.org/>; The International Plant Names Index - <http://www.ipni.org/>; JSTOR Global Plants – <https://plants.jstor.org/>), herbarium specimens, and websites of individual herbaria (BR [<http://www.botanicgarden.be/>], CAS [<http://www.calacademy.org/scientists/botany-collections>], CM [<http://www.carnegiemnh.org/botany/collection.html>], F [<https://www.fieldmuseum.org/node/5196>], GH [<http://huh.harvard.edu/pages/digital-resources>], JE [<http://herbarium.univie.ac.at/database/search.php>], K [http://apps.kew.org/herbcat/navigator.do?_ga=1.106533571.1517483332.1489782412], MICH [<http://quod.lib.umich.edu/cgi/i/image/image-idx?xc=1;page=searchgroup;g=herb-ic>], MIN [<http://bellatlas.umn.edu/collections/index.php>], MO [<http://www.tropicos.org/>], NY [<http://sweetgum.nybg.org/science/vh/>], RM [<http://rmh.uwyo.edu/data/search.php>], S [<http://herbarium.nrm.se/search/specimens/>], US [<http://collections.nmnh.si.edu/search/botany/?ti=3>]). Herbarium abbreviations follow *Index Herbariorum* (Thiers 2016, continuously updated, <http://sweetgum.nybg.org/science/ih/>). A digital image was examined for each specimen for which a barcode number is given in the type citation, followed by the source. Specimens examined for which no online digital images are available are not accompanied by barcode numbers.

Nomenclatural novelties

***Penstemon cardinalis* var. *regalis* (A.Nelson) C.C.Freeman, stat. nov.**

urn:lsid:ipni.org:names:77162263-1

Basionym. *Penstemon regalis* A.Nelson, Amer. J. Bot. 21: 578–579. 1934; *Penstemon cardinalis* subsp. *regalis* (A.Nelson) G.T. Nisbet & R.C. Jacks.

Type. USA. NEW MEXICO: near Carlsbad Cavern, Jun 1930, G. Convis 75 (holotype: RM, RM0004319 [JSTOR image]).

In the protologue, Nelson (1934) stated that the type was collected in May 1930. The date on the type specimen is June 1930.

***Penstemon crandallii* var. *procumbens* (Greene) C.C.Freeman, stat. nov.**

urn:lsid:ipni.org:names:77162264-1

Basionym. *Penstemon procumbens* Greene, Pl. Baker. 3: 23–24. 1901; *Penstemon crandallii* subsp. *procumbens* (Greene) D.D. Keck.

Type. USA. COLORADO: Keblar Pass, in large mats on bare banks, 7 Aug 1901, C.F. Baker 733 (holotype: NDG, NDG45968 [JSTOR image]; isotypes: ARIZ, ARIZ-BOT-0005070 [JSTOR image], CAS, CAS0006571 [CAS website image], GH, GH00091383 [GH website image], JE, JE00002724 [JE website image], K,

K000979692 [K website image], MO, MO-2217162 [MO website image], NY, NY00130478 [NY website image], RM, RM0004309 [JSTOR image], RM0004310 [JSTOR image], RSA, RSA0006207 [JSTOR image]), US, US00122356, [US website image], US011177691 [US website image]; probable isotypes: PH, PH00018550 [JSTOR image], RSA, RSA0006208 [JSTOR image]).

Label data on PH00018550 indicate the specimen was collected by Baker in 1900. Francis W. Pennell annotated the specimen as a probable isotype of Baker 733; David D. Keck annotated it as an isotype.

***Penstemon crandallii* var. *ramaleyi* (A.Nelson) C.C.Freeman, comb. & stat. nov.**
urn:lsid:ipni.org:names:77162265-1

Basionym: *Penstemon ramaleyi* A. Nelson, Univ. Wyoming Publ. 3: 106. 1937.

Type. USA. COLORADO. Saguache Co.: Villa Grove, 3 mi W, 9 Jul 1935; F. Ramaley & K.R. Johnson 15116 (holotype: RM, RM0004316 [JSTOR image]; isotypes: COLO, COLO00396432 [JSTOR image], K, K000979786 [K website image], MO).

***Penstemon eatonii* var. *exsertus* (A.Nelson) C.C.Freeman, stat. nov.**
urn:lsid:ipni.org:names:77162266-1

Basionym. *Penstemon exsertus* A. Nelson, Amer. J. Bot. 18: 438. 1931; *Penstemon eatonii* subsp. *exsertus* (A. Nelson) D.D. Keck.

Type. USA. ARIZONA: In Salt River Canyon, on the Apache Trail, 4 May 1925, A. Nelson 10624 (holotype: RM, RM0004214 [JSTOR image]).

***Penstemon linarioides* var. *coloradoensis* (A.Nelson) C.C.Freeman, stat. nov.**
urn:lsid:ipni.org:names:77162267-1

Basionym. *Penstemon coloradoensis* A. Nelson, Bull. Torrey Bot. Club 26: 355. 1899; *Penstemon linarioides* subsp. *coloradoensis* (A. Nelson) D.D. Keck.

Type. USA. COLORADO: Mancos, common on sage plains and foothills throughout the La Platas, 23 Jun 1898, C.F. Baker, F.S. Earle, and S.M. Tracy 70 (lectotype: RM, RM0004187 [JSTOR image]; isolectotypes: CAS, CAS0006620 [CAS website image], F, F0072589F [JSTOR image], GH, GH00091215 [GH website image], K, K000979702 [K website image], KSC, MICH, MICH1108038 [MICH website image], MO, MO-100230852, NDG, NDG45904 [JSTOR image], NEB, NEB-v-0000619 [JSTOR image], NY, NY00091049 [NY website image], OS, OS0000264 [JSTOR image], RM, RM0004188 [JSTOR image], RSA, RSA0006119 [JSTOR image], RSA0006120 [JSTOR image], US, US00122246 [US website image]; probable isolectotype: NDG, NDG45695 [JSTOR image]).

In describing *Penstemon coloradoensis*, Nelson (1899) stated “*I have before me specimens from two collections made near Mancos, Colo., by Messrs. Baker, Earle, and Tracy, 1898 and distributed as P. caespitosus Nutt. Also from two collections by Professor Crandall, from Hotchkiss, Colo., 1892, and from Durango, 1898, both distributed as P. linarioides Sileri Gray.*” Nelson (1899) did not designate a holotype; the collections he cited are syntypes. Keck (1937) designated C.F. Baker, F.S. Earle, and S.M. Tracy 70 (RM) as the lectotype, of which there currently are two sheets, suggesting a second-step lectotypification might be necessary. Accession labels on the two sheets indicate they were received from the herbaria of F.S. Earle in 1899 (RM0004187; accession number 13703) and George E. Osterhout in 1938 (RM0004188; accession number 165282), subsequent to Keck’s lectotype designation. RM0004187 bears annotations by A. Nelson (*Penstemon coloradoensis* A. N. n. sp., without date), F.W. Pennell (*P. coloradoensis*, type, 1916), and D.D. Keck (*P. linarioides* A. Gray subsp. *coloradoensis* (A. Nelson) D.D. Keck, type, 1936). RM0004188, the later accession, was not annotated by Nelson, Pennell, or Keck. Whether Nelson had another sheet at RM that was lost, destroyed, or sent elsewhere, or had access to a sheet from some other herbarium, is not known. Of the two sheets currently at RM, only RM0004187 appears to have been there when Nelson described *P. coloradoensis* and later seen by Keck when he lectotypified the name. RM0004187 is taken as the lectotype, RM0004188 is taken as an isolectotype, and no second-step lectotypification is needed. As an aside, the sheet at KSC is *P. crandallii* A. Nelson var. *crandallii*.

***Penstemon miniatus* var. *apateticus* (Straw) C.C.Freeman, stat. nov.**

urn:lsid:ipni.org:names:77162268-1

Basionym. *Penstemon apateticus* Straw, Bol. Soc. Bot. México 24: 42–43. 1959; *Penstemon miniatus* subsp. *apateticus* (Straw) Straw.

Type. MÉXICO. DISTRITO FEDERAL: Serrania de Ajusco, 10000 ft, Aug–Sep 1896, C.G. Pringle 6463 (holotype: CAS, CAS0003847 [JSTOR image]; isotypes: BR, BR0000008418234 [BR website image], CM, CM2018 [CM website image], F, F0072654F [F website image], GH, GH00091520 [GH website image], JE, JE00000356 [JE website image], MIN1001915 [MIN website image ; this specimen bears a second barcode, 189693, at the top of the sheet], MO, MO-155225 [MO website image], NDG, NDG45615 [JSTOR image], NY, NY00130560 [NY website image], PH, PH00020963 [JSTOR image], S, S10-20448 [S website image], US, US00122215 [US website image]).

***Penstemon miniatus* var. *townsendianus* (Straw) C.C.Freeman, comb. & stat. nov.**

urn:lsid:ipni.org:names:77162269-1

Basionym. *Penstemon apateticus* subsp. *townsendianus* Straw, Bol. Soc. Bot. México 24: 44. 1959.

Type. MÉXICO. CHIHUAHUA: collected in the Sierra Madres near Colonia Garcia, altitude 8000 ft, 1 Aug 1899, C.H.T. Townsend & C.M. Barber 211 (holotype: US, US00122217 [US website image]; isotypes: A, A00091591 [GH website image], F, F0072655F [F website image], GH, GH00091522 [GH website image], MO, MO-155224 [MO website image], NDG, NDG45616 [JSTOR image], NY, NY00130562 [NY website image], US, US01100658 [US website image]; probable isotype: NY, NY00130561 [NY website image]).

Straw (1959) designated US sheet number 568154 (=US00122217) as the holotype. He cited a second specimen at US as an isotype; that specimen is US sheet number 347089 (=US01100658). The label on NY00130561 does not bear the collector's name or number; it was collected 5 mi SE of Colonia Garcia at an altitude of 7500 ft. Straw annotated the specimen as being Townsend and Barber 211.

***Penstemon pseudospectabilis* var. *connatifolius* (A.Nelson) C.C.Freeman, stat. nov.**
urn:lsid:ipni.org:names:77162270-1

Basionym. *Penstemon connatifolius* A. Nelson, Amer. J. Bot. 18: 437–438. 1931; *Penstemon pseudospectabilis* subsp. *connatifolius* (A. Nelson) D.D. Keck.

Type. USA. ARIZONA: Steep banks, Apache Trail, 3 May 1925, A. Nelson 10314 (holotype: RM, RM0004190 [JSTOR image]; isotypes: NO, NO0109834 [JSTOR image], NY NY00091052 [NY website image], RSA, RSA0006126 [JSTOR image]).

***Penstemon spectabilis* var. *subinteger* C.C.Freeman, stat. nov.**
urn:lsid:ipni.org:names:77162271-1

Basionym. *Penstemon spectabilis* subsp. *subinteger* D.D. Keck, Amer. Midl. Naturalist 18: 817–818. 1937.

Type. MÉXICO. BAJA CALIFORNIA: Santa Maria Plains, 15 mi S of Hamilton Ranch, plants 2–3 ft high, corolla bluish at lips, throat and tube with less blue than red, 8 Apr 1931, I.W. Wiggins 5207 (holotype: CAS, CAS003886 [CAS website image]; isotypes: CAS, CAS0003887 [CAS website image], F, F0072666F [F website image], GH, GH0091585 [GH website image], K, K000528837 [K website image], MICH, MICH1108051 [MICH website image], MO, MO-155229 [MO website image], NY, NY00130580 [NY website image], NY00130581 [NY website image], PH, PH00018576 [JSTOR image], RM, RM0004355 [RM website image], US, US00122381 [US website image]).

***Penstemon secundiflorus* var. *versicolor* (Pennell) C.C.Freeman, comb. & stat. nov.**
urn:lsid:ipni.org:names:77162272-1

Basionym. *Penstemon versicolor* Pennell, Contr. U.S. Natl. Herb. 20: 358–359. 1920.

Type. USA. Colorado. Pueblo Co.: clayey loam, mesa NE of Pueblo, ca 4700 ft, 5 Jun 1915, F. W. Pennell 5732 (holotype: NY, NY00029690 [NY website image]; isotypes: COLO, COLO00396481 [JSTOR image], US, US00122397 [US website image]).

Nomenclatural note

***Penstemon xylus* A. Nelson, Bot. Gaz. 31–32. 1902.**

Penstemon caespitosus var. *suffruticosus* A. Gray in A. Gray et al., Syn. Fl. N. Amer. 2: 270. 1878 (non *Penstemon suffruticosus* Douglas ex Benth.); *Penstemon tusharensis* N.H. Holmgren, Brittonia 31: 106. 1979, nom. illeg.

Type. USA. Utah. Beaver, 1877, Palmer s.n. (holotype: GH, GH00091198 [GH website image]); probable isotype: ISC, ISC-v-0000867 [JSTOR image].

The correct name for this taxon at the rank of species has been the source of confusion. With the earlier name *Penstemon suffruticosus* Douglas ex Benth. blocking transfer of A. Gray's varietal epithet *suffruticosus* at the rank of species, Rydberg (1901) published *P. suffrutescens* in an attempt to provide a substitute. However, in doing so, he flagged *P. suffrutescens* as a new species (sp. nov.). He also provided a brief diagnosis and cited a specimen (USA. Colorado. Ridgway, woods, altitude 7500 ft, 20 Jun 1895, F. Tweedy 170; holotype: NY, NY00130526 [NY website image]) different from that of Gray's type for *P. caespitosus* var. *suffruticosus*. Rydberg's name must be considered a validly published species name—not an avowed substitute for Gray's name. As noted by Holmgren (1979), the specimen cited by Rydberg is referable to *P. crandallii*, where *P. suffrutescens* must be placed as a synonym.

Nelson (1902) published *Penstemon xylus* and clearly stated it was a new name (nom. nov.) for Gray's *P. caespitosus* var. *suffruticosus*. Nelson cited a specimen (USA. Colorado. Sapinero, 1898, H.N. Wheeler 446 [COLO, COLO00396499 [JSTOR image], NY, NY00130556 [NY website image], RM, RM0004372 [JSTOR image]) that he believed was referable to A. Gray's concept of *P. caespitosus* var. *suffruticosus*. However, it too is referable to *P. crandallii*. Holmgren (1979), believing that neither Rydberg's nor Nelson's name could be applied to Gray's *P. caespitosus* var. *suffruticosus* because of the specimens cited by each author, published *P. tusharensis* as an avowed substitute. In spite of Nelson having cited a specimen that is not referable to *P. caespitosus* var. *suffruticosus*, *P. xylus* must stand as the avowed substitute for *P. caespitosus* var. *suffruticosus* at the rank of species, making *P. tusharensis* illegitimate and superfluous.

Acknowledgments

I thank Kanchi Gandhi (GH), Werner Greuter (B), Richard Rabeler (MICH), Nicholas Turland (B), James Zarucchi (MO), and an anonymous reviewer for their helpful comments on the draft manuscript and/or nomenclatural advice. Ernie Nelson kindly provided information about specimens of *Penstemon coloradoensis* at RM.

References

- Freeman CC (in prep) *Penstemon* (Plantaginaceae). In: Flora of North America Editorial Committee (Eds) 1993+. Flora of North America North of Mexico. 16+ vols. New York and Oxford. Vol. 17.
- Holmgren NH (1979) Nomenclatural changes in some Intermountain penstemons. *Brittonia* 31: 104–107. <https://doi.org/10.2307/2806680>
- Keck DD (1937) Studies in *Penstemon* IV. The section *Ericopsis*. *Bull. Torrey Bot. Club* 64: 357–381. <https://doi.org/10.2307/2481121>
- Nelson A (1899) New plants from Wyoming.—IX. *Bull. Torrey Bot. Club* 26: 350–358. <https://doi.org/10.2307/2478041>
- Nelson A (1902) Contributions from the Rocky Mountain Herbarium. III. *Bot. Gaz.* 21–35. <https://doi.org/10.1086/328257>
- Nelson A (1934) Rocky Mountain Herbarium studies. II. *Amer. J. Bot.* 21: 573–582. <https://doi.org/10.2307/2436108>
- Rydberg PA (1901) Studies on the Rocky Mountain flora.—VI. *Bull. Torrey Bot. Club* 28: 499–513. <https://doi.org/10.2307/2478562>
- Straw RM (1959) Los Penstemons de México. I. Sobre la confusion entre *Penstemon lanceolatus* y *Penstemon imberbis*. *Bol. Soc. Bot. México* 24: 39–52.
- Thiers B (2016) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> [continuously updated]

Selaginella guihaia (Selaginellaceae): A new spikemoss species from southern China and northern Vietnam around the Gulf of Tonkin

Yu-Dong Wu^{1,2,*}, Hong-Rui Zhang^{1,2,*}, Xian-Chun Zhang¹

1 State Key Laboratory of Systematic and Evolutionary Botany, Institute of Botany, Chinese Academy of Sciences, Beijing, 100093, China **2** University of Chinese Academy of Sciences, Beijing 100049, China

Corresponding author: Xian-Chun Zhang (zhangxc@ibcas.ac.cn)

Academic editor: A. Troia | Received 9 November 2016 | Accepted 2 May 2017 | Published 17 May 2017

Citation: Wu Y-D, Zhang H-R, Zhang X-C (2017) *Selaginella guihaia* (Selaginellaceae): A new spikemoss species from southern China and northern Vietnam around the Gulf of Tonkin. PhytoKeys 80: 41–52. <https://doi.org/10.3897/phytokeys.80.11126>

Abstract

Selaginella guihaia **sp. nov.** (Selaginellaceae), a new species of spikemoss from southern China and northern Vietnam around the Gulf of Tonkin (Beibu Gulf), is described and illustrated. Morphological and molecular comparisons of the new species with other similar species (*S. doederleinii*, *S. ornata* and *S. trachyphylla*) are provided. The morphological and molecular evidence clearly indicates *S. guihaia* is a distinct species. Morphologically *S. guihaia* differs from other species by its obviously white-margined leaves, the ventral leaves scabrous on upper surfaces throughout the basiscopic or also rarely present on upper halves, and the ovate axillary leaves.

Keywords

Lycopodiophyta, lycophytes, taxonomy, new species, *rbcL*, ITS

Introduction

Selaginella P. Beauv. (Selaginellaceae) is the largest lycophyte genus with about 700–800 species and distributed in all the continents except Antarctica (Jermy 1990; Tryon and Lugardon 1991; Zhang 2004; Zhang et al. 2013; Zhou and Zhang 2015; Zhou et al. 2016; Weststrand and Korall 2016a, b; PPG I 2016). However, the highest species diversity occurs in the tropics and subtropics. The genus is characterized by the presence

* These authors contributed equally to this work and should be considered co-first authors.

of rhizophores, single veined leaves with ligule, sporangia borne axillary on the upper surface of sporophylls and bearing two types of spores (heterospory) (Webster 1992). Among several herbaria collections of *Selaginella doederleinii* Hieron., we found that the leaves of some specimens are obvious white-margined with ventral leaves that are often scabrous on the upper surface. We also observed and collected similar plants in the field. These turned out to be a rather common and widely distributed undescribed species in the mountainous areas of southern China (Guangxi and Hainan) and North Vietnam around the Gulf of Tonkin (Beibu Gulf). With evidences from morphological characters and molecular analysis, we described these plants as a new species herein.

Materials and methods

Morphology characters were examined from the dried herbarium specimens studied from PE (herbaria acronyms according to Thiers 2016). All the characters were examined under stereomicroscope using NIS-Elements D 3.10 imaging software from Nikon Instruments (<http://www.nikoninstruments.com>). Voucher specimens (see Appendix 1) are deposited at PE.

We downloaded 60 sequences ITS and *rbcL* from Genbank representing 32 species in *Selaginella* and those species involves the major clades of the phylogenetic analysis of *Selaginella* (Zhou et al. 2016). In this study, we newly sequenced four species, including two samples of the possible new taxon and four samples of its putative relatives, *S. ornata* (Hook. & Grev.) Spring, *S. doederleinii* Hieron. and *S. trachyphylla* A. Braun. Total genomic DNA was isolated from silica-dried material using the Plant Genomic DNA Kit (Tiangen Biotech, Beijing, China) following the manufacturer's protocols. One plastid region *rbcL* and one nuclear region ITS were amplified for the possible new taxon and its putative closely related taxa. The *rbcL* region was amplified with newly designed primers *rbcL* 192F (5' CACGTGGACTACCGTTTGG A3') and 1324R (TACCCTCAAGAGCGGGATCA3'). The primers were designed in Primer 3.0 (Untergasser et al. 2012) using the published chloroplast genomes of *Selaginella moellendorffii* Hieron. (Smith 2009) and *S. uncinata* (Desv.) Spring (Tsuiji et al. 2007). The PCR protocol of *rbcL* region followed Zhou et al. (2016). The ITS region was amplified using the primers and PCR protocol described in Arrigo et al. (2013). All PCR products were directly sequenced using ABI 3730XL analyzer (Applied Biosystems, Foster City, California, USA). Newly obtained sequences were assembled with ContigExpress and then aligned with the downloaded sequences using Clustal X v.1.83 (Thompson et al. 1997) followed by manual adjustment in BioEdit v.7.1.11 (Hall 1999). The full length of the ITS region were sequenced but only 5.8S and part of ITS2 region were used because of a large number of insertions and deletions in ITS1 and ITS2 (Zhou et al. 2016); the ambiguous regions were excluded prior to analysis as previously done in similar studies (Arrigo et al. 2013; Zhou et al. 2016). ILD (Incongruence Length Difference) test (Farris et al. 1995) was performed on PAUP* v.4.0b10 (Swofford 2002) to test if there is conflict between nuclear and chloroplast

genes. The combined dataset (*rbcL* and ITS) were analyzed with the maximum parsimony (MP), maximum likelihood (ML) and Bayesian inference (BI) methods. MP analyses were carried out using PAUP* v.4.0b10 (Swofford 2002). All characters were weighted equally and gaps were treated as missing data. The most parsimonious trees were obtained with heuristic searches of 1000 replicates random stepwise sequence addition (RAS), with tree bisection–reconnection (TBR) branch swapping, and 10 trees from each random sequence addition were saved were used to obtain the most parsimonious trees. MP bootstrap values (MP_{BS}) were calculated with 1000 replicates. jModelTest 0.1.1 (Posada 2008) was used to select the appropriate substitution model for ML and BI analyses. The ML analyses were conducted using the web server RAxML–HPC2 on XSEDE (Stamatakis 2014), and ML bootstrap values (ML_{BS}) were calculated applying 1000 bootstrap replicates with the GTRCAT substitution model. Bayesian analyses and posterior probability (BI_{pp}) calculation were conducted in MrBayes 3.2.6 (Ronquist et al. 2012) implemented on the CIPRES Science Gateway Portal (Miller et al. 2010). Four Markov chain Monte Carlo chains were run, each beginning with a random tree and sampling one tree every 1000 generations of 10 000 000 generations. After checking all the ESS>200 in Tracer v1.5 (Rambaut et al. 2009), the first 25% of samples were discarded as burn-in, and the remaining trees were used to calculate a 50% majority-rule consensus topology and posterior probability values.

Results

The ILD test results showed no obvious conflict existing between the two datasets, *rbcL* and ITS ($P = 0.02$). Thus, the datasets were combined. The combined data matrix included up to 1460 nucleotides for each of the 36 taxa with 845 constant characters, 512 parsimony informative characters, consistency index (CI) = 0.56, retention index (RI) = 0.79. The three phylogenetic analyses (MP, ML, BI) inferred congruent topologies. The Best ML tree is presented in Figure 1.

The molecular evidence showed that two samples of *Selaginella guihaia* were grouped together with strong support (BS = 99, PP = 0.99), and then formed a moderately supported clade with *S. doederleinii* and *S. commutata* Alderw.

Our phylogenetic analyses and morphological evidence reveal that the possible new taxon *Selaginella guihaia* is different from the morphologically similar species *S. doederleinii*, *S. ornata* and *S. trachyphylla* that co-occur in the same region. The overall morphology and the growth habit of *S. guihaia* resemble those of *S. ornata*, however, the former has monomorphic (vs. dimorphic) sporophylls. Furthermore, consistent with the sporophylls variations, *S. guihaia* and *S. ornata* were separately placed into two large clades in the molecular phylogenetic tree. Although *S. doederleinii* and *S. trachyphylla* were placed closely with *S. guihaia* in the molecular phylogenetic analysis, the distinct white-margined leaves of *S. guihaia* is different from both these species. The ventral leaves of *S. guihaia* are scabrous near the lower part of leaf epidermis but rarely on the upper part, whereas the ventral leaves of *S. trachyphylla* are scabrous throughout the leaf epidermis.

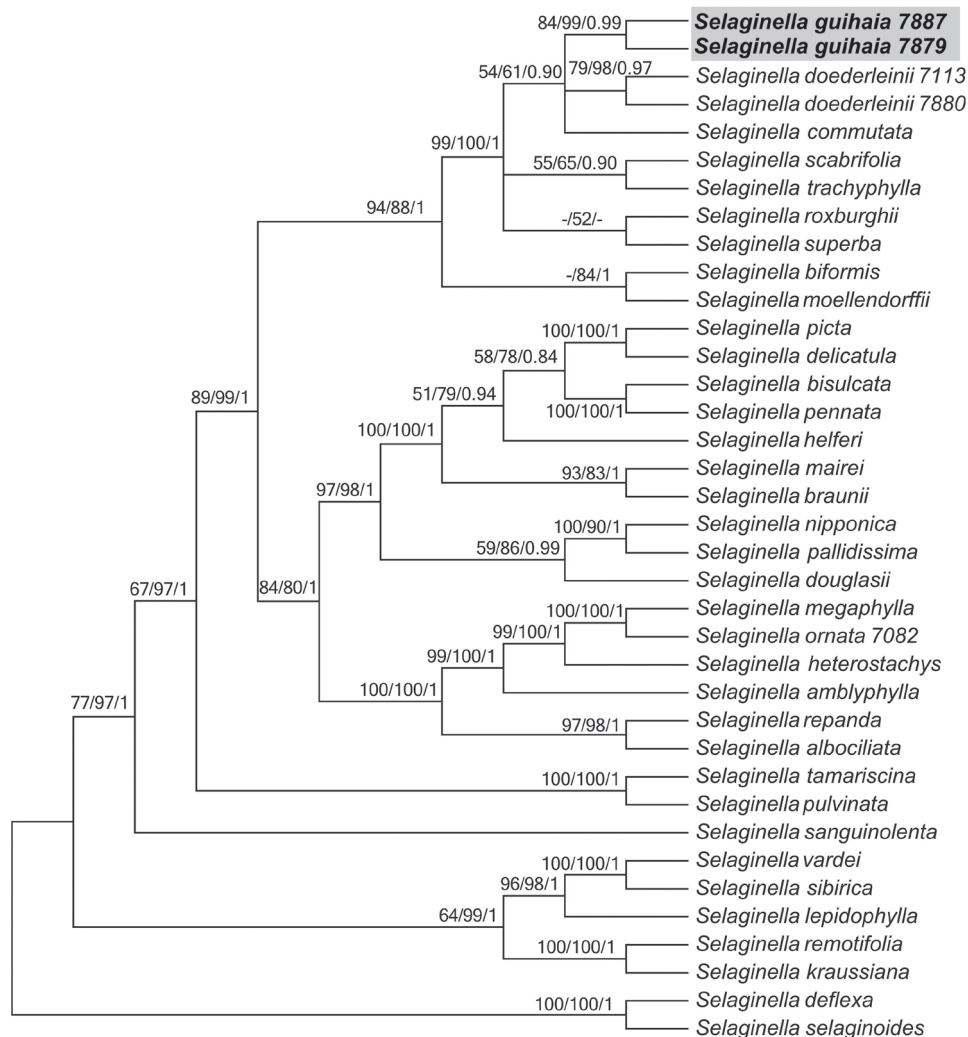


Figure 1. The 50% majority rule consensus tree derived from maximum likelihood showing the position of *Selaginella guihaiia*. Support values (MP_{BS} , $ML_{BS} > 50\%$, $BI_{PP} > 0.8$) are shown above the main branches; the dash (–) indicates $BS < 50\%$. The new species is shown in bold.

Taxonomic treatment

Selaginella guihaiia X.C.Zhang, sp. nov.

urn:lsid:ipni.org:names:60474541-2

Figs 2, 3, 4

Diagnosis. The new species is similar to *S. doederleinii*, *S. ornata* and *S. trachyphylla* in the habit and the morphology of dorsal leaves, ventral leaves, axillary leaves and sporophylls. However, *S. guihaiia* can be easily recognized by its obvious white-margined

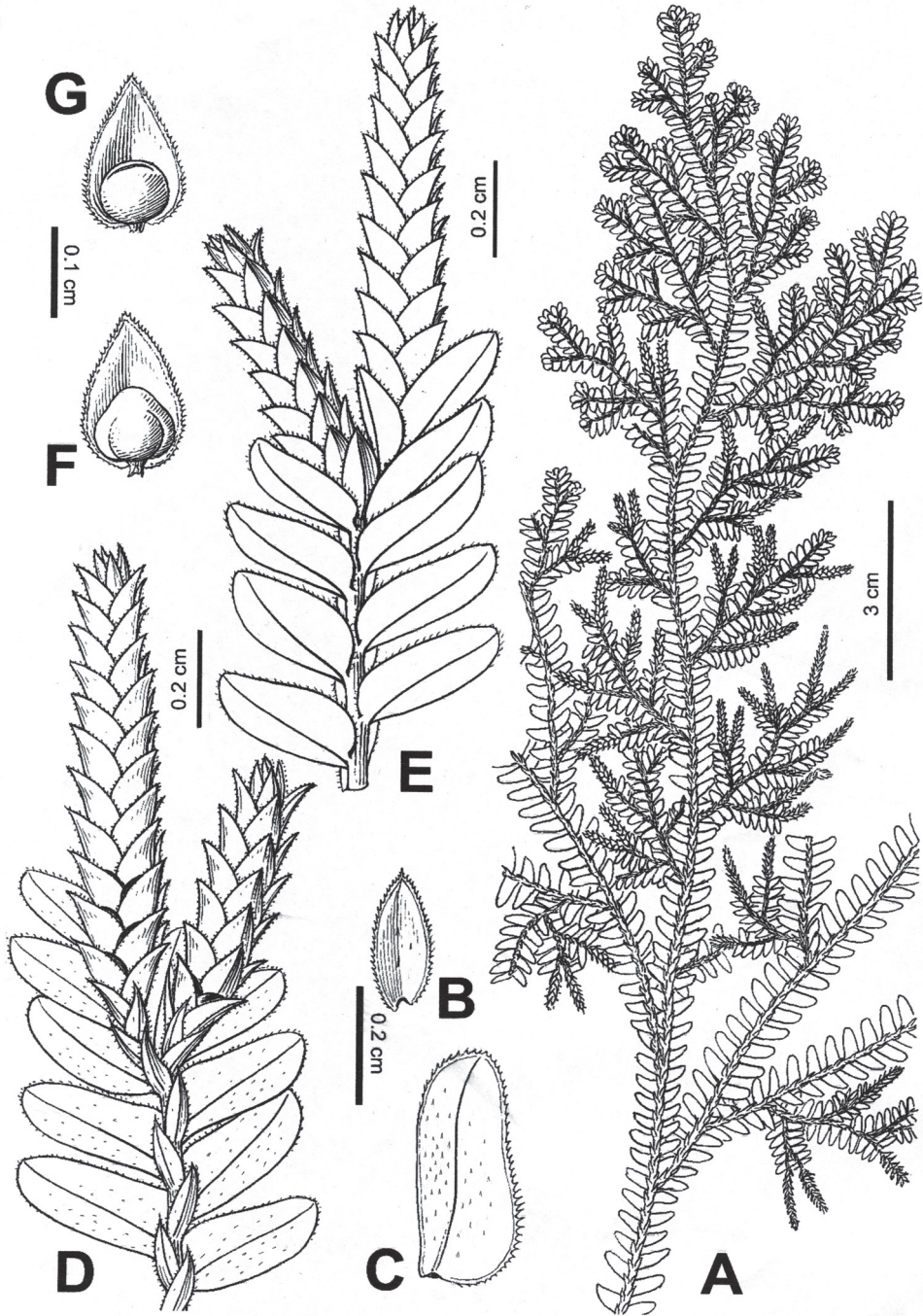


Figure 2. *Selaginella guibaia* X.C.Zhang **A** Habit **B** Dorsal leaf **C** Ventral leaf **D** Part of main stem showing ventral leaves, dorsal leaves, and strobili **E** Part of main stem showing ventral leaves, axillary leaves, and strobili **F** Megasporophyll **G** Microsporophyll (Drawn by C.Z. Ji from *Beijing Youth Expedition 0980*, PE).

leaves. The white-margin is about three cells wide in *S. guihaia*, but it is only one cell wide in *S. doederleinii*, *S. ornata*, and *S. trachyphylla*.

Type. CHINA, Guangxi: Pingxiang, Mt. Daqingshan, alt. 600m, 27 Aug 1986, *Beijing Youth Expedition 0980* (Holotype: PE![No. 1365103]) (Figure 3).

Description. *Terrestrial.* Evergreen, suberect or ascending from decumbent base, 20–50 cm. *Rhizophores* branched from base to middle of main stem. *Main stems* pinnately branched from lower part upward, stramineous, 1.5–2 mm in diam. in lower part, oval or subquadrangular, glabrous; primary leafy branches 3–10 pairs, 2 or 3 pinnately branched, secondary branches once pinnately branched, tertiary branches forked, branchlets sparse, adjacent primary branches on main stem 1–6 cm apart, leafy portion of main stem including leaves 0.8–1.8 mm wide at middle, ultimate branches 3–6 mm wide including leaves. *Axillary leaves* on branches symmetrical, ovate, 0.9–1.7 × 1.7–3.7 mm, bases exauriculate, margins denticulate, obviously white-margined. *Dorsal leaves* on branches imbricate, ovate, 0.9–2.3 × 0.3–0.9 mm, carinate, base cuneate or obliquely subcordate, margins denticulate, obviously white-margined, apices acuminate to aristate, parallel to axis. *Ventral leaves* on branches contiguous or overlapping, slightly ascending, oblong-falcate, 2.1–4.4 × 0.8–1.9 mm, upper surfaces on lower scabrous halves of the laminae or also rarely scabrous on upper half; basiscopic base margin entire, margin subentire, denticulate at base; acroscopic base rounded, overlapping stem and branches, margin denticulate in basal half, obviously white-margined. *Strobili* solitary or in pairs, terminal, compact, tetragonal, 0.8–1.4 × 0.4–0.8 mm; sporophylls monomorphic, ovate-triangular, carinate, margins denticulate, obviously white-margined, apices acuminate; sporangia pale yellow to pale brown; megasporangia spherical; microsporangia elliptic-oblong, relatively thick, marginal cells differentiated; megaspores whitish, microspores pale yellow.

Specimens examined. **China.** **Guangxi:** Ningming, 31 Dec 2015, *X.C.Zhang & al.* 7879 (PE); Ningming, 1 Jan 2016, *X.C.Zhang & al.* 7886 (PE), *X.C.Zhang & al.* 7887 (PE), *X.C.Zhang & al.* 7899 (PE), *X.C.Zhang & al.* 7900 (PE); Shangsi, 17 Sep 2009, Mt. Shiwandashan, 600 m, *R.H.Jiang* 059 (PE); Shangsi, Mt. Shiwandashan 10 Jun 2009, 380m, *S.Y. Dong* 2932 (IBSC); Fangchenggang, Fulong Village, Mt. Pinglong, 360 m, 19 Sep 2009, *R.H. Jiang* 145 (PE); Fangchenggang, Nale Village, 250 m, 20 Sep 2009, *R.H.Jiang* 174 (PE); Shangsi, 22 Sep 2009, Mt. Shiwandashan, 680 m, *R.H.Jiang* 220 (PE); Fusui, Lucheng, 200–370 m, 26 Apr 1957, *S.Q. Chen* 12074 (PE); Shang-sze (= Shangsi), Shap Man Taai Shan (= Mt. Shiwandashan), 11–30 Jul 1934, *W.T.Tsang* 23870 (BM); **Hainan:** Baisha, Yinggeling, 1000 m, 27 Aug 2005, *S.Y.Dong* 1450 1464 (PE). **Vietnam:** Tien-yen, Kau Nga Shan and Vicinity, 23–30 Sep 1940, *W.T.Tsang* 30553 (PE); Chuk-phai, Ha-coi, Taai Wong Mo Shan and Vicinity, *W.T.Tsang* 29052 (P); Dam-ha, Sai wong Mo Shan, 18 Jul – 9 Sep 1940, *W.T.Tsang* 30273 (P); Tien-yen, Kau Nga Shan and Vicinity, 23 Sep – 7 Oct. 1940, *W.T.Tsang* 30582 (P); Chuk-phai, Ha-coi, Taai Wong Mo Shan and Vicinity, 18 Nov – 2 Dec 1936, *W.T.Tsang* 27196 (P); Tonkin, Kau Nga Shan and vicinity, Sept. 23 – Oct. 7. 1940, *W.T.Tsang* 30582 (B).



Figure 3. Type of *Selaginella guihaiia* X.C.Zhang, sp. nov. (PE).

Distribution and ecology. Widely distributed in southern China (Guangxi and Hainan) and northern Vietnam around the Gulf of Tonkin (Beibu Gulf), growing in evergreen broad-leaved forests at 250 to 1000 m a.s.l. (Figures 4, 5).



Figure 4. *Selaginella guihaia* X.C.Zhang, sp. nov. **A** Dorsal view of branch **B** Ventral view of branch. **C** Strobilus **D** Rhizophore **E** Habit.

Etymology. The specific epithet “*guihaia*” alludes to the ancient Chinese name for the remote geographic region where the species occurs.

Conservation status. We evaluated the conservation status of *Selaginella guihaia* according to the IUCN (2012) criteria for risk assessment: *S. guihaia* falls into the Least Concern (LC) category. *S. guihaia* is in fact known from many localities from southern China and northern Vietnam around the Gulf of Tonkin.

Key to *Selaginella guihaia* and similar species

- 1 Sporophylls dimorphic, dorsal sporophylls longer than ventral ones; megaspores reddish brown ***S. ornata***
- Sporophylls monomorphic, dorsal sporophylls the same length as the ventral ones; megaspores whitish

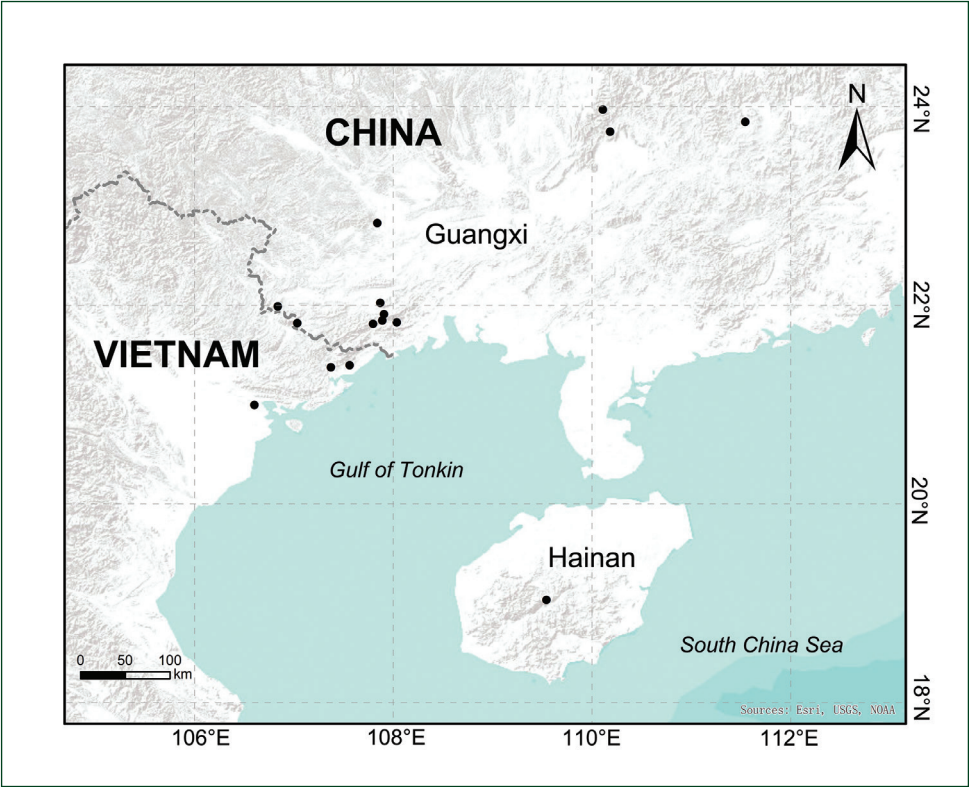


Figure 5. Distribution map of *Selaginella guibaia* X.C.Zhang, sp. nov.

- 2 Ventral leaf upper surfaces glabrous; basiscopic base slightly dilated; microspores yellow-orange *S. doederleinii*
- Ventral leaf upper surfaces scabrous; basiscopic base entire; microspore pale yellow
- 3 Leaves with obvious white margin (three cells wide); ventral leaves scabrous on upper surfaces only on the basiscopic halves (rarely also on upper halves); axillary leaves ovate *S. guibaia*
- Leaves without obvious white margin (only one cell wide); ventral leaves scabrous on upper surfaces throughout the leaf surface; axillary leaves narrowly ovate to triangular.....*S. trachyphylla*

Acknowledgments

This study was supported by the National Natural Science Foundation of China (31670205). We would like to thank the three reviewers for their valuable comments and suggestions.

References

- Arrigo N, Therrien J, Anderson CL, Windham MD, Haufler CH, Barker MS (2013) A total evidence approach to understanding phylogenetic relationships and ecological diversity in *Selaginella* subg. *Tetragonostachys*. *American Journal of Botany* 100: 1672–1682. <https://doi.org/10.3732/ajb.1200426>
- Farris JS, Källersjö M, Kluge AG, Bult C (1995) Testing significance of incongruence. *Cladistics* 10: 315–319. <https://doi.org/10.1111/j.1096-0031.1994.tb00181.x>
- Hall TA (1999) BioEdit: A user-friendly biological sequence alignment editor and analysis program for Windows 95/98/ NT. *Nucleic Acids Symposium Series* 41: 95–98.
- IUCN (2012) IUCN Red List Categories and Criteria, Version 3.1. 2nd Ed., IUCN, Gland.
- Jermey AC (1990) Selaginellaceae. In: Kubitzki K, Kramer KU, Green PS (Eds) *The Families and Genera of Vascular Plants, Pteridophytes and Gymnosperms*. Springer, Berlin, 1st edn, Vol. 1, 39–45. https://doi.org/10.1007/978-3-662-02604-5_11
- Miller MA, Pfeiffer W, Schwartz T (2010) “Creating the CIPRES Science Gateway for inference of large phylogenetic trees”. In: *Proceedings of the Gateway Computing Environments Workshop (GCE)*. Gateway Computing, New Orleans. 1–8. <https://doi.org/10.1109/gce.2010.5676129>
- Posada D (2008) jModelTest: Phylogenetic model averaging. *Molecular Biology and Evolution* 25: 1253–1256. <https://doi.org/10.1093/molbev/msn083>
- Rambaut A, Drummond AJ (2009) Tracer v1.5. <http://beast.bio.ed.ac.uk/Tracer>
- Ronquist F, Teslenko M, Van der Mark P, Ayres DL, Darling A, Höhna S, Larget B, Liu L, Suchard MA, Huelsenbeck JP (2012) Mrbayes 3.2: Efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* 61: 539–542. <https://doi.org/10.1093/sysbio/sys029>
- Smith DR (2009) Unparalleled GC content in the plastid DNA of *Selaginella*. *Plant Molecular Biology*, 71(6): 627–639. <https://doi.org/10.1007/s11103-009-9545-3>
- Stamatakis A (2014) Raxml version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics*, 30(9): 1312–1313. <https://doi.org/10.1093/bioinformatics/btu033>
- Swofford DL (2002) PAUP*: Phylogenetic analysis using parsimony (*and other methods), Version 4.0b10, Sinauer, Sunderland, Massachusetts.
- The Pteridophyte Phylogeny Group (2017) A community-derived classification for extant lycophytes and ferns. *Journal of Systematics and Evolution*. 54: 563–603. <https://doi.org/10.1093/nar/25.24.4876>
- Thiers B (2016) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG (1997) The ClustalX windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25: 4876–4882.
- Tryon AF, Lugardon B (1991) Spores of the Pteridophyta: Surface, Wall Structure, and Diversity Based on Electron Microscope Studies. Springer, New York, 606–621. https://doi.org/10.1007/978-1-4613-8991-0_35

- Tsuji S, Ueda K, Nishiyama T, Hasebe M, Yoshikawa S, Konagaya A et al. (2007) The chloroplast genome from a lycophyte (microphylophyte), *Selaginella uncinata*, has a unique inversion, transpositions and many gene losses. *Journal of Plant Research*, 120(2): 281–290. <https://doi.org/10.1007/s10265-006-0055-y>
- Untergasser A, Cutcutache I, Koressaar T, et al. (2012) Primer3—new capabilities and interfaces. *Nucleic Acids Research*, 40(15): e115. <https://doi.org/10.1093/nar/gks596>
- Webster TR (1992) Developmental problems in *Selaginella* (Selaginellaceae) in an evolutionally context. *Annals of the Missouri Botanical Garden*, 79(3): 632. <https://doi.org/10.2307/2399757>
- Weststrand S, Korall P (2016a) A subgeneric classification of *Selaginella* (Selaginellaceae). *American Journal of Botany* 103: 2160–2169. <https://doi.org/10.3732/ajb.1600288>
- Weststrand S, Korall P (2016b) Phylogeny of Selaginellaceae: There is value in morphology after all! *American Journal of Botany* 103: 2136–2159. <https://doi.org/10.3732/ajb.1600156>
- Zhang XC (2012) *Lycophytes and Ferns of China*, Peking University Press, Beijing, p. 70.
- Zhang XC (2004) Selaginellaceae. In: Wu ZY (Ed.) *Flora Reipublicae Popularis Sinicae*. Science Press, Beijing, Vol. 6, 86–219.
- Zhang XC, Nooteboom HP, Kato M (2013) Selaginellaceae. In: Wu ZY, Raven PH, Hong DY (Eds) *Flora of China*. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, Vol. 2–3, 37–66.
- Zhou XM, Zhang LB (2015) A classification of *Selaginella* (Selaginellaceae) based on molecular (chloroplast and nuclear), macromorphological, and spore features. *Taxon* 64: 1117–1140. <https://doi.org/10.12705/646.2>
- Zhou XM, Rothfels CJ, Zhang L, He ZR, Pechon TL, He H, Lu NT, Knapp R, Lorence D, He XJ, Gao XF, Zhang LB (2016) A large-scale phylogeny of the lycophyte genus *Selaginella* (Selaginellaceae: Lycopodiopsida) based on plastid and nuclear loci. *Cladistics*, 32: 360–389. <https://doi.org/10.1111/cla.12136>

Appendix

Plant materials used in this study. Information is presented in the following order: taxon name, locality (if available), collection number (if available), ITS GenBank accession number, *rbcL* GenBank accession number, references (if available). –, sequences not available. *, sequences obtained in this study.

Selaginella albociliata P. S. Wang, KT161648, KT161379. *Selaginella amblyphylla* Alston, KT161650, KT161381. *Selaginella biformis* A. Braun ex Kuhn, KT161664, KT161396. *Selaginella bisulcata* Spring, KT161674, KT161406. *Selaginella braunii* Baker, KT161685, KT161419. *Selaginella commutata* Alderw., KT161693, KT161430. *Selaginella deflexa* Brackenridge, AF418999, AF093253. *Selaginella delicatula* (Desv.) Alston, KT161699, KT161441. *Selaginella doederleinii* Hieron., CHINA, Guizhou, X.–C. Zhang et al. 7113 (PE), KY06835*, KY068356*. X.–C. Zhang et al. 7880 (PE), KY068357*, KY068352*. *Selaginella douglasii* (Hook. & Grev.) Spring, –, AF419049. *Selaginella guihaia* X.C. Zhang,

CHINA, Guangxi, X.-C. Zhang 7879 (PE), KY068358*, KY068353*. X.-C. Zhang 7887(PE), CHINA, Guangxi, KY068359*, KY068354*. *Selaginella helferi* Warb., KT161723, KT161470. *Selaginella heterostachys* Baker, KT161729, KT161480. *Selaginella kraussiana* A. Braun. KT161746, KT161498. *Selaginella lepidophylla* (Hook. & Grev.) Spring, AF419002, AF419051. *Selaginella mairei* Levl., KT161764, KT161518. *Selaginella megaphylla* Baker, KT161768, KT161524. *Selaginella moellendorffii* Hieron., KT161777, KT161531. *Selaginella nipponica* Franch. et Sav., KT161786, KT161542. *Selaginella ornata* Spring, CHINA, Guizhou, X.-C. Zhang et al. 7082 (PE), KY068360*, KY068355*. *Selaginella pallidissima* Spring, KT161796, KT161556. *Selaginella pennata* Spring, KT161798, KT161558. *Selaginella picta* A. Braun ex Baker, KT161800, KT161561. *Selaginella pulvinata* (Hook. et Grev.) Maxim., KT161811, KT161576. *Selaginella remotifolia* Spring, KT161814, KT161580. *Selaginella repanda* (Desv.) Spring, KT161816, KT161582. *Selaginella roxburghii* (Hook. & Grev.) Spring, –, EU140945. *Selaginella sanguinolenta* (L.) Spring, KT161822, KT161589. *Selaginella scabrifolia* Ching & C.H.Wang, KT161824, KT161593. *Selaginella selaginoides* (L.) Link, AF419000, AF419048. *Selaginella sibirica* (Milde) Hieron., AF419032, AF419076. *Selaginella superba* Alston, KT161842, KT161616. *Selaginella tamariscina* (P.Beauv.) Spring, –, AB574655. *Selaginella trachyphylla* A.Braun ex Hieron., –, KT161620. *Selaginella vardei* Levl., KT161853, KT161628.

Two new combinations, lectotypifications and a new name for Costa Rican *Palicourea* s.l.

Andreas Berger¹

¹ Division of Systematic and Evolutionary Botany, Department of Botany and Biodiversity Research, University of Vienna, Rennweg 14, A-1030 Vienna, Austria

Corresponding author: Andreas Berger (andi.berger@univie.ac.at)

Academic editor: Peter de Lange | Received 20 April 2017 | Accepted 7 May 2017 | Published 19 May 2017

Citation: Berger A (2017) Two new combinations, lectotypifications and a new name for Costa Rican *Palicourea* s.l. PhytoKeys 80: 53–63. <https://doi.org/10.3897/phytokeys.80.13330>

Abstract

Species of the complex and diverse genera *Psychotria* and *Palicourea* are common but little-known elements in many tropical forest ecosystems. DNA-phylogenetic studies and a re-evaluation of morphological characters have recently shown that species of *Psychotria* subg. *Heteropsychotria* are nested within *Palicourea* s.l., which was traditionally separated by exhibiting a bird-pollinated (vs. insect-pollinated) pollination syndrome. In order to render both genera monophyletic groups, species of subg. *Heteropsychotria* need to be transferred to *Palicourea* s.l. For Central American species, most of the necessary combinations have already been made. In the course of ongoing research on the phytochemical characterization of species and clades of Costa Rican *Palicourea* s.l., the nomenclature of Mesoamerican species was revised. As a result, two new combinations and a new name are proposed here: *Palicourea horquetensis* (Dwyer & Hayden) A. C. Berger & C. M. Taylor is based on *Rudgea horquetensis* Dwyer & Hayden, *Palicourea tonduzii* (K. Krause) A. C. Berger is based on *Cephaelis tonduzii* K. Kraus and *Palicourea longiinvolucrata* A. C. Berger replaces *Psychotria hispidula* Standl. In addition, two lectotypes are designated.

Keywords

Palicourea, *Psychotria*, Rubiaceae, Mesoamerica, taxonomy

Introduction

Species of the complex and diverse genera *Psychotria* L. (1759: 929) and *Palicourea* Aubl. (1775: 172–175) are prominent but little-known elements in tropical forest ecosystems. Both have long been considered closely related, and *Palicourea* was differentiated from *Psychotria* by characters associated with hummingbird rather than insect pollination. Species of *Palicourea* are typically found in the understory of rainforests and are especially frequent in high elevation habitats where *Psychotria* and other related genera are less speciose (Taylor 1996, 1997).

Both genera were traditionally classified in the tribe Psychotrieae. Recently, however, DNA-phylogenetic studies and a re-evaluation of morphological characters have shown that species of *Psychotria* subg. *Heteropsychotria* Steyerl. (1972: 484) are more closely related to *Palicourea*. Consequently, views shifted towards a narrower concept of *Psychotria* and Psychotrieae which peaked in the ongoing segregation of hundreds of species and the establishment of the sister tribe Palicoureeae (Nepokroeff et al. 1999, Razafimandimbison et al. 2014, Robbrecht and Manen 2006).

Species of *Psychotria* subg. *Heteropsychotria* and *Palicourea* cannot be distinguished by vegetative or fruit characters. In addition, both groups show similar accumulation of alkaloids (e.g., Berger et al. 2012, 2015, 2017, in review), flavonoids (e.g., Berger et al. 2016) and a group of defensive peptides termed cyclotides (Koehbach et al. 2013). As traditionally defined, both groups deviate only in a suite of traits associated with pollination syndromes: Flowers in subg. *Heteropsychotria* are arranged in open, somewhat grouped to densely capitate inflorescences with inconspicuously colored inflorescence axes, though some species have inflorescences subtended by showy bracts. Flowers are usually sessile or subsessile and have small, white, to greenish or yellow corollas with short and straight tubes in bee-pollinated or white and long-tubed corollas in moth-pollinated species. (e.g., Steyerl 1972, Taylor 1996).

By contrast, species of *Palicourea* are hummingbird-pollinated, frequently have long-pedunculate and open inflorescences, colored inflorescence axes, large and long pedicellate flowers and vividly colored corollas with well-developed tubes. Corollas have a gibbous, nectar-accumulating swelling at their base that is protected by an internal ring of hairs. In many plant groups, bird-pollinated flowers have repeatedly evolved in groups of bee-pollinated ancestors and are not phylogenetically informative at the generic level (e.g., Castellanos et al. 2004, Fenster et al. 2004, Pirie et al. 2016). Similarly, it was hypothesized that pollinator shift has occurred multiple times in *Palicourea* s.l. and that bird pollinated species (i.e., the traditional concept of *Palicourea*) repeatedly evolved out of bee-pollinated ancestors (i.e., the traditional concept of *Psychotria* subg. *Heteropsychotria*) or vice versa (Taylor 1996, 1997).

In order to render both *Palicourea* and *Psychotria* monophyletic groups, most species of *Psychotria* subg. *Heteropsychotria* have to be transferred to *Palicourea* s.l. The combined group includes more than 800 species, is variable in flower characters, but is supported by vegetative and fruit characters as well as by DNA phylogenetic data (Razafimandimbison et al. 2014). The process of transferring species of subg. *Heteropsychotria* was started

with the publications of Taylor et al. (2010), Taylor (2015a, 2015b) and Taylor and Hollowell (2016), which provided combinations for species belonging to newly defined sections within *Palicourea* s.l. Finally, Mexican, Mesoamerican and Venezuelan species were transferred by Borhidi (2011, 2017a, 2017b), and species occurring in the Guianas were transferred by Delprete and Kirkbride (2016).

In the course of ongoing research on the phytochemical characterization of species and clades of Costa Rican *Palicourea* s.l., the nomenclature of Mesoamerican species was revised and the need for a new name and two new combinations became apparent. These are proposed here. In addition, a complete synonymy, an enumeration of type specimens and two lectotypifications are provided for these three species.

Methods

The present work is based on an extensive study of herbarium specimens, digital images and relevant literature including regional (e.g., Manual de Plantas de Costa Rica, Taylor 2014) and overregional floras (e.g., Flora Mesoamericana, Lorence and Taylor 2012). In addition, extensive fieldwork was performed in Costa Rica in 2010, 2013, 2015 and 2016.

For all names, protologues were checked to verify or revise author and page citations, information on collectors and localities. Subsequently, the type category applying to each name was assessed in accordance with the ICN (Melbourne code, McNeill et al. 2012; see also McNeill 2014). Retrieved information was managed with the international JACQ herbarium database (<http://herbarium.univie.ac.at/database>) hosted at the herbarium WU. For citation of type collections, localities have been simplified and ecological and morphological details have been omitted. For all retrieved type specimens, herbarium acronyms and barcodes are given. For specimens seen either digitally or physically, their barcodes are followed by an exclamation mark.

For the three nomenclatural novelties, both possible author abbreviations of my name are preoccupied: Berger stands for Ernst Friedrich Berger (1814–1853) and A. Berger stands for Alwin Berger (1871–1931). Therefore, I have adopted the abbreviation A. C. Berger that includes my second forename Christoph, which I have never used before in my publications.

Taxonomy

***Palicourea horquetensis* (Dwyer & Hayden) A. C. Berger & C. M. Taylor, comb. nov.**
urn:lsid:ipni.org:names:77162933-1

Basionym. *Rudgea horquetensis* Dwyer & Hayden, Ann. Missouri Bot. Gard. 54(2): 145–146, 1967.—**Type:** PANAMA. Chiriquí: Distr. Boquete, Cerro Horqueta, ca. 1980 m, 26 Jul 1940, C. von Hagen & W. von Hagen 2156 (holotype: NY barcode 133202!).

- = *Coussarea nebulosa* Dwyer, Ann. Missouri Bot. Gard. 67(1): 131, 1980a. ≡ *Psychotria nebulosa* (Dwyer) C. M. Taylor, Novon 5(2): 205, 1995, nom. illeg. hom., non *Psychotria nebulosa* K. Krause, Bot. Jahrb. Syst. 57(1): 46–47, 1920. ≡ *Palicourea nebulosa* (Dwyer) C. M. Taylor, Novon 20(4): 488, 2010.—**Type:** PANAMA. Chiriquí: Monte Rey near Boquete, ca. 1170 m, 20 Jul 1971, *T. B. Croat 15868* (lectotype, designated by Taylor (1995): PMA barcode 1189! ex MO 2162999 [sheet # 1/2]; isolectotype: MO barcode MO 312217! [sheet # 2/2]).
- = *Rudgea chiriquiensis* Dwyer, Ann. Missouri Bot. Gard. 67(2): 476, 1980b. ≡ *Coussarea chiriquiensis* (Dwyer) C. M. Taylor, Fieldiana, Bot., n.s. 33: 113, 1993.—**Type:** PANAMA. Chiriquí: Cerro Colorado, along road above San Félix, 29 km above bridge over Río San Félix, 7.9 km above turnoff to Escopeta, 1500 m, 14 Jul 1976, *T. B. Croat 37071* (lectotype, designated by Taylor (1995): MO barcode MO-312257!; isolectotype: PMA barcode 1163! ex MO 2389189).

Nomenclatural remarks. *Rudgea horquetensis* Dwyer & Hayden was accepted as a species of *Rudgea* by most authors including Lorence (1999) and Correa et al. (2004). Lorence and Taylor (2012) were the first to exclude it from *Rudgea*, but did not suggest any further placement. Based on morphological characters, the species clearly belongs to the nocturnally flowering species group of *Palicourea* (Taylor et al. 2010) and is here treated as conspecific with *Psychotria* or *Palicourea nebulosa*. *Rudgea horquetensis* is the oldest available name for the taxon and a respective new combination is proposed here.

Typification. The protologue of *Coussarea nebulosa* states that the holotype is located at MO. At the time of publication two sheets of the type collection have been accessioned at MO, making the holotype designation ambiguous. In 1975, Dwyer annotated both sheets as *Coussarea nebulosa*, but did not specify what sheet he intended to be the holotype. Hence, both specimens represent syntypes (ICN, Art. 40.2 & Note 1; see also McNeill 2014). Later, the specimens were annotated as sheet “1” and “2 of 2”, respectively. Sheet 1 was also annotated as holotype by C. M. Taylor in 1988.

Taylor (1995) cited the above-mentioned sheets as “holotype, MO 2162999; isotype, MO 4043108” which has to be considered a valid (though indirect) lectotypification according to the ICN (Art. 7.10, 9.9, 9.23; see also McNeill 2014). Later, Lorence (1999) cited the specimens as “Holotype MO 2162995; Isotype MO 4043108”. The last digit of the numbering stamp on the corresponding sheet is hardly legible as a “9”, possibly explaining the error in citation. In the last revision of the group (Taylor et al. 2010), the erroneous type citation of Lorence (1999) was repeated. In a repatriation project in 2001 (C. M. Taylor, pers. comm.), the lectotype (specimen 1) was deaccessioned and distributed to PMA. The sheet still bears a respective MO accession number stamp.

A similar case of indirect lectotypification is found in *Rudgea chiriquiensis*. The species was described with reference to two collections at that time housed at MO, one of which was later distributed to PMA. Likewise, lectotypification (of the MO sheet) was achieved by Taylor (1995).

Distribution. *Palicourea horquetensis* is only known from few sites in Costa Rica and Panama.

***Palicourea tonduzii* (K. Krause) A. C. Berger, comb. nov.**

urn:lsid:ipni.org:names:77162934-1

Basionym: *Cephaelis tonduzii* K. Krause, Bot. Jahrb. Syst. 54(3, Beibl. 119): 45–46, 1916. Non *Psychotria tonduzii* Standl., J. Wash. Acad. Sci. 15(13): 287, 1925b.—**Type:** COSTA RICA. Cartago: Tuis, 650 m, Nov 1897, *A. Tonduz 11461* (lectotype, designated here: fragm. F barcode V0068631F! ex B; syntype, or possibly holotype: B † [photo: F neg. BN-773!]).= *Cephaelis discolor* Pol., Linnaea 41(5–6): 572–573, 1877. ≡ *Uragoga angosturensis* Kuntze, Revis. Gen. Pl. 2: 954, 1891, nom. nov., non *Uragoga discolor* (Benth.) Kuntze, Revis. Gen. Pl. 2: 960, 1891. Non *Psychotria discolor* (Griseb.) Rolfe, Bull. Misc. Inform. Kew 1893: 258, 1893, nec *Palicourea discolor* K. Krause, Bot. Jahrb. Syst. 54(3, Beibl. 119): 40–41, 1916.—**Type:** COSTA RICA. Cartago: Angostura, Nov 1875, *H. Polakowsky 384* (lectotype, designated here: fragm. F barcode V0068625F! ex B; syntype, or possibly holotype: B † [photo: F neg. BN-722!]).= *Evea guapilensis* Standl., J. Wash. Acad. Sci. 15(5): 104–105, 1925a. ≡ *Cephaelis guapilensis* (Standl.) Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 4(8): 295, 1929. ≡ *Psychotria guapilensis* (Standl.) Hammel, Selbyana 12: 139, 1991. ≡ *Palicourea guapilensis* (Standl.) Borhidi, Acta Bot. Hung. 59(1–2): 17, 2017a.—**Type:** COSTA RICA. Limón: Vicinity of Guápiles, 300–500 m, 12–13 Mar 1924, *P. C. Standley 37025* (holotype: US barcode 00129829!).= *Evea nana* Standl., J. Wash. Acad. Sci. 15(5): 105, 1925a. ≡ *Cephaelis nana* (Standl.) Standl., J. Wash. Acad. Sci. 17(7): 171, 1927. **Type:** PANAMA. Colón: Hills N of Frijoles, 19 Dec 1923, *P. C. Standley 27550* (holotype: US barcode 1153871!).= *Cephaelis nicaraguensis* Standl., Trop. Woods 16: 46, 1928.—**Type:** NICARAGUA. Atlántico Norte: Puerto Cabezas [Bragman's Bluff], bank of Kukalaya River, 60 m, 08 Dec 1927, *F. C. Englesing 58* (holotype: F barcode V0068627F!; isotype: fragm. G barcode G00300772! ex F).**Nomenclatural remarks.** The earliest published name for the species is *Cephaelis discolor* but combinations under *Psychotria* and *Palicourea* are preoccupied by *Psychotria discolor* (Griseb.) Rolfe and *Palicourea discolor* K. Krause. The next available name *Cephaelis tonduzii* K. Krause cannot be used in *Psychotria* because of the earlier *Psychotria tonduzii* Standl. Hence, the next name *Evea guapilensis* Standl. was adopted and the species became known as *Psychotria guapilensis* (Standl.) Hammel. Recently, Borhidi (2017a) transferred the species to *Palicourea* and proposed the name *Palicourea guapilensis* (Standl.) Borhidi.However, he overlooked that the earlier published name *Cephaelis tonduzii* K. Krause is still available under *Palicourea* and ought to have been adopted. The corresponding new combination is provided here. It is fortunate that the correct name for this showy species honors Swiss botanist Adolphe Tonduz (1862–1921), a long-term employee at the Museo Nacional de Costa Rica (CR) and one of the most prolific plant collectors in the country.

Typification. *Cephaelis tonduzii* was described with reference to an entire gathering by Tonduz. Krause did not cite a particular herbarium specimen and all possible duplicates are therefore syntypes (ICN, Art. 40.2 & Note 1; see also McNeill 2014). In addition, he was based at B and his working herbarium was destroyed during World War II. Collections made by Tonduz are widely distributed and more or less complete sets are found in CR and US (Staffleu and Cowan 1976–1988). Nevertheless, the only known original material of *Cephaelis tonduzii* is a fragment at F.

The fragment originates from the type at B, as shown by information given on the label. It consists of a capsule with a leaf and part of an inflorescence, which is mounted together with a photograph (“Berlin negative”) of the original B specimen. The removed leaf is clearly recognizable on the photograph providing a definite link between both. Although not the best choice, the fragment at F appears to be the only extant original material and is here designated as lectotype.

A similar situation is found in *Cephaelis discolor*, which was based on a gathering of H. Polakowsky. Likewise, the only known original material is a fragment at F that originated from B. It consists of a leaf, some bracts and fruits in a capsule, which is mounted together with a photograph of the B specimen, likewise destroyed. The fragment at F is here designated as lectotype.

Distribution. *Palicourea tonduzii* is known from Nicaragua, Costa Rica, Panama and Ecuador (Taylor 2014).

***Palicourea longiinvolucrata* A. C. Berger, nom. nov.**

urn:lsid:ipni.org:names:77162935-1

Basionym/replaced synonym: *Psychotria hispidula* Standl. ex Steyerf., Acta Biol. Venez. 4(1): 97–98, 1964. ≡ *Palicourea hispidula* (Standl. ex Steyerf.) Borhidi, Acta Bot. Hung. 59(1–2):17, 2017a, nom. illeg. hom., non *Palicourea hispidula* Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 11(5): 227, 1936.—**Type:** COLOMBIA. Valle del Cauca: Río Calima, La Trojita, 5–50 m, 19 Feb–10 Mar 1944, J. Cuatrecasas 16359 (holotype: F barcode V0070450F!; isotypes: BC 623883!, U barcode 0006197!, US barcode 00138790!, VEN n.v.).

- *Psychotria involucrata* sensu Standley (1938, p.p.), non Sw., nom. superfl.
- *Psychotria hoffmannseggiana* sensu Burger & Taylor (1993, p.p.), non (Roem. & Schult.) Müll. Arg.

Nomenclatural remarks. Borhidi (2017a) attempted to transfer this species to *Palicourea*, but overlooked the preexisting *Palicourea hispidula* Standl. This renders his name an illegitimate later homonym (ICN, Art. 53.1). Here, the new name *Palicourea longiinvolucrata* is proposed that alludes to the long involucre (15–20 mm) and floral bracts (6–15 mm) that help differentiate this species from the closely related *Palicourea hoffmannseggiana* (Roem. & Schult.) Borhidi (3.5–15 mm, 0.5–2 mm). Two further species, *Palicourea gracilentia* (Müll. Arg.) Delprete & J. H. Kirkbr. (3–7 mm,

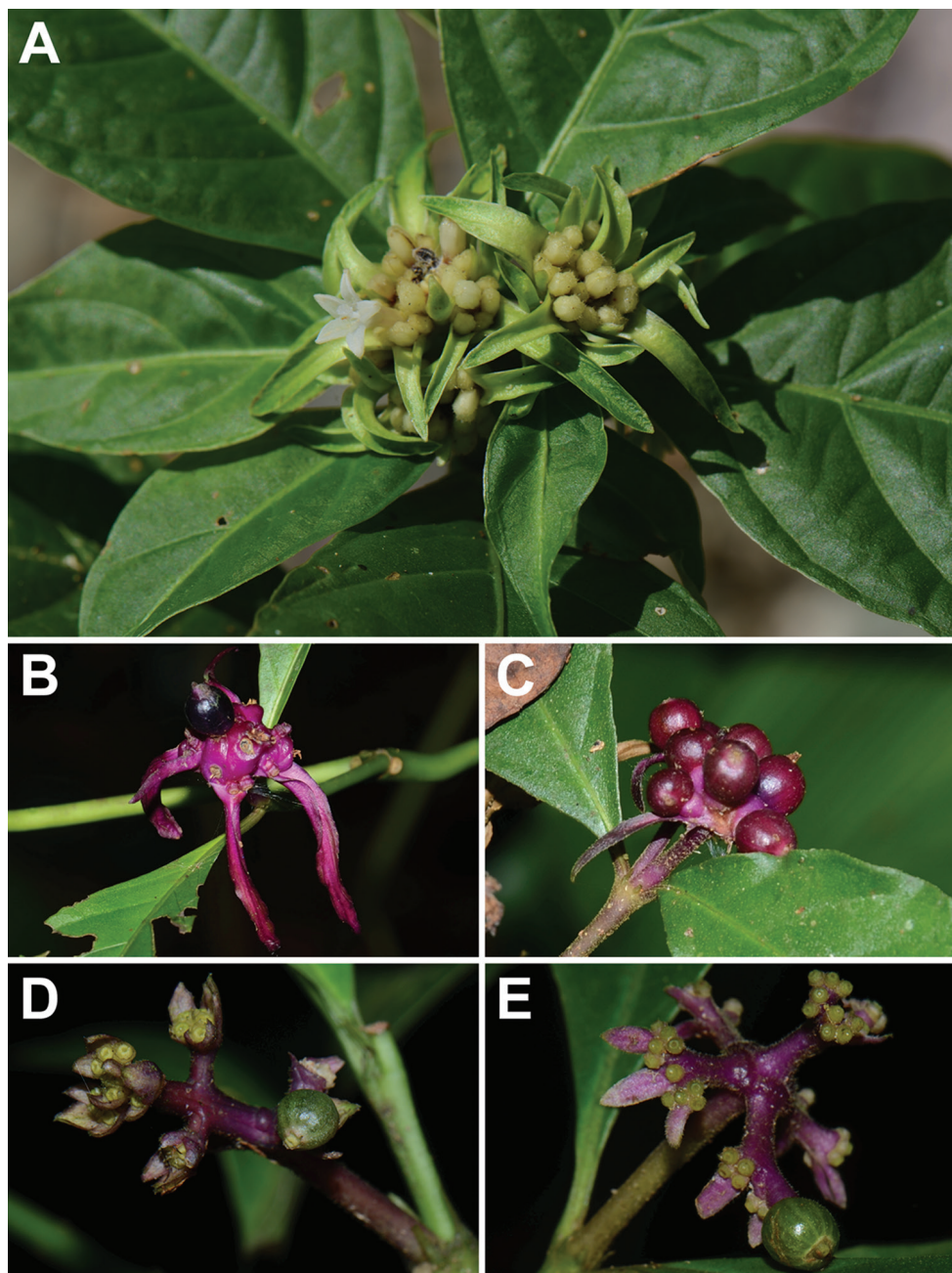


Figure 1. *Palicourea longinvolucrata* and related species, note diagnostic differences in bract arrangement and length. *Palicourea longinvolucrata*, inflorescence (**A** Berger 1418) and infructescence (**B** Berger 1633); *Palicourea hoffmannseggiana*, infructescence (**C** unvouchered); *Palicourea gracilentia*, infructescence (**D** Berger 2055); *Palicourea winkleri*, infructescence (**E** Berger 1737). All photos by the author.

1.5–5 mm) and *Palicourea winkleri* Borhidi (both 1–9 mm), belong to the same species group (e.g., Taylor 2004, 2014), but have less-congested inflorescences (Figure 1).

Distribution. *Palicourea longinvolucrata* is known from Belize to Bolivia, from Venezuela and from Brazil (Taylor 2014).

Acknowledgements

Special thanks are due to Charlotte M. Taylor (MO) who generously helped answering many questions in the course of the project. She pointed me to the earlier name *Rudgea horquetensis* and also curates the Rubiaceae in the invaluable TROPICOS database (<http://www.tropicos.org>). Further thanks goes to J. McNeill (E) for some help with nomenclature. Also, many thanks go to the curators and staff of the herbaria that helped me by checking their collections for type specimens and digitized them on request. In addition, I wish to thank the Andrew W. Mellon Foundation which funded the digitization of most type specimens currently available online. I wish to thank Rhys Gardner for reviewing the paper and providing some valuable suggestions on how to improve the manuscript. Fieldwork was supported by a grant by the Society for the Promotion of the La Gamba Field Station. Publication of this article was supported by the Open Access Publishing Fund of the University of Vienna.

References

- Aublet JBCF (1775) Histoire des plantes de la Guiane Française. Pierre-François Didot jeune, Paris, 52 pp., 392 pl. <https://doi.org/10.5962/bhl.title.674>
- Berger A, Fasshuber H, Schinnerl J, Brecker L, Greger H (2012) Various types of tryptamine-iridoid alkaloids from *Palicourea acuminata* (= *Psychotria acuminata* Rubiaceae). *Phytochemistry Letters* 5(3): 558–562. <https://doi.org/10.1016/j.phytol.2012.05.013>
- Berger A, Kostyan MK, Klose SI, Gastegger M, Lorbeer E, Brecker L, Schinnerl J (2015) Loganin and secologanin derived tryptamine-iridoid alkaloids from *Palicourea crocea* and *P. padifolia* (Rubiaceae). *Phytochemistry* 116: 162–169. <https://doi.org/10.1016/j.phytochem.2015.05.013>
- Berger A, Preinfalk A, Windberger M, Fasshuber HK, Gastegger M, Klose I, Robien W, Felsing S, Brecker L, Valant-Vetschera K, Schinnerl J (2016) New reports on flavonoids, benzoic- and chlorogenic acids as rare features in the *Psychotria* alliance (Rubiaceae). *Biochemical Systematics and Ecology* 66: 145–153. <https://doi.org/10.1016/j.bse.2016.02.027>
- Berger A, Tanuhadi E, Brecker L, Schinnerl J, Valant-Vetschera K (in review) Chemodiversity of tryptamine-derived alkaloids in some Costa Rican *Palicourea* species (Rubiaceae–Palicoureeae). *Phytochemistry*.
- Borhidi AL (2011) Transfer of the Mexican species of *Psychotria* subgen. *Heteropsychotria* to *Palicourea* based on morphological and molecular evidences. *Acta Botanica Hungarica* 53(3–4): 241–250. <https://doi.org/10.1556/ABot.53.2011.3-4.4>

- Borhidi AL (2017a) El subgénero *Heteropsychotria* (Rubiaceae, Palicoureeae) en México y Mesoamérica. *Acta Botanica Hungarica* 59(1–2): 13–23. <https://doi.org/10.1556/034.59.2017.1-2.3>
- Borhidi AL (2017b) La circunscripción de *Palicourea* subgen. *Heteropsychotria* (Rubiaceae, Palicoureeae). *Acta Botanica Hungarica* 59(1–2): 25–61. <https://doi.org/10.1556/034.59.2017.1-2.4>
- Burger W, Taylor CM (1993) *Flora Costaricensis*. Family #202 Rubiaceae. Fieldiana. Botany, new series 33: 1–333. <https://doi.org/10.5962/bhl.title.2550>
- Castellanos MC, Wilson P, Thomson JD (2004) “Antibee” and “pro-bird” changes during the evolution of hummingbird pollination in *Penstemon* flowers. *Journal of Evolutionary Biology* 17(4): 876–885. <https://doi.org/10.1111/j.1420-9101.2004.00729.x>
- Correa AMD, Galdames C, Stapf M (2004) *Catálogo de las Plantas Vasculares de Panamá*. Smithsonian Tropical Research Institute, Panamá, 599 pp.
- Delprete PG, Kirkbride Jr. JH (2016) New combinations and new names in *Palicourea* (Rubiaceae) for species of *Psychotria* subgenus *Heteropsychotria* occurring in the Guianas. *Journal of the Botanical Research Institute of Texas* 10(2): 409–442.
- Dwyer JD (1980a) *Flora of Panama*. Part IX. Family 179. Rubiaceae—Part 1. *Annals of the Missouri Botanical Garden* 67(1): 1–256. <https://doi.org/10.2307/2398954>
- Dwyer JD (1980b) *Flora of Panama*. Part IX. Family 179. Rubiaceae—Part 2. *Annals of the Missouri Botanical Garden* 67(2): 257–522. <https://doi.org/10.2307/2398901>
- Dwyer JD, Hayden MV (1967) Notes on woody Rubiaceae of tropical America. *Annals of the Missouri Botanical Garden* 54(2): 138–146. <https://doi.org/10.2307/2394999>
- Fenster CB, Armbruster WS, Wilson P, Dudash MR, Thomson JD (2004) Pollination syndromes and floral specialization. *Annual Review of Ecology and Systematics* 35: 375–403. <https://doi.org/10.1146/annurev.ecolsys.34.011802.132347>
- Koebach J, Attah AF, Berger A, Hellinger R, Kutchan TM, Carpenter EJ, Rolf MM, Sonibare MA, Moody JO, Wong K-SG, Dessein S, Greger H, Gruber CW (2013) Cyclotide Discovery in Gentianales Revisited—Identification and characterization of cyclic cystine-knot peptides and their phylogenetic distribution in Rubiaceae plants. *Biopolymers Peptide Science* 100: 438–452. <https://doi.org/10.1002/bip.22328>
- Krause K (1916) Rubiaceae Americae tropicae imprimis andinae. *Botanische Jahrbücher für Systematik* 54(3, Beibl. 119): 40–46. <http://biodiversitylibrary.org/page/191197#page/833>
- Krause K (1920) Rubiaceae africanae. V. *Botanische Jahrbücher für Systematik* 57(1): 25–53. <http://biodiversitylibrary.org/item/720#page/32>
- Kuntze CEO (1891) *Revisio generum plantarum vascularium omnium atque cellularium multarum secundum leges nomenclaturae internationales cum enumeratione plantarum exoticarum in itinere mundi collectarum*. Pars 1–2. A. Felix, Leipzig, [etc.], 1011 pp. <https://doi.org/10.5962/bhl.title.327>
- Linnaeus C (1759) *Systema Naturae*. Editio decima, reformata. Vol. 2. Holmiae: Impensis Direct. Laurentii Salvii. <https://doi.org/10.5962/bhl.title.542>
- Lorence DH (1999) A nomenclator of Mexican and Central American Rubiaceae. *Monographs in Systematic Botany from the Missouri Botanical Garden* 73: 1–177. <http://biodiversitylibrary.org/item/89863>

- Lorence DH, Taylor CM (2012) Rubiaceae. In: Davidse G, Sousa Sánchez M, Knapp S, Chiang Cabrera F (Eds) *Flora Mesoamericana* 4. Missouri Botanical Garden Press, St. Louis, Missouri, 1–288.
- McNeill J (2014) Holotype specimens and type citations: General issues. *Taxon* 63(5): 1112–1113. <https://doi.org/10.12705/635.7>
- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, Prud'homme Van Reine WF, Smith GF, Wiersema JH, Turland NJ (Eds.) (2012) *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*: Adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. *Regnum Vegetabile* 154. Koeltz Scientific Books, Königstein, 208 pp.
- Nepokroeff M, Bremer B, Sytsma KJ (1999) Reorganization of the genus *Psychotria* and tribe Psychotrieae (Rubiaceae) inferred from ITS and rbcL sequence data. *Systematic Botany* 24(1): 5–27. <https://doi.org/10.2307/2419383>
- Pirie MD, Oliver EGH, de Kuppler AM, Gehrke B, Le Maitre NC, Kandziora M, Bellstedt DU (2016) The biodiversity hotspot as evolutionary hot-bed: spectacular radiation of *Erica* in the Cape Floristic Region. *BMC Evolutionary Biology* 16(1): 190. <https://doi.org/10.1186/s12862-016-0764-3>
- Polakowski H (1877) Plantas Costaricensis anno 1875 lectas enumerat. *Linnaea* 41(5–6): 545–598. <http://biodiversitylibrary.org/page/124200#page/546>
- Razafimandimbison SG, Taylor CM, Wikström N, Pailler T, Khodabandeh A, Bremer B (2014) Phylogeny and generic limits in the sister tribes Psychotrieae and Palicoureeae (Rubiaceae): Evolution of schizocarps in *Psychotria* and origins of bacterial leaf nodules of the Malagasy species. *American Journal of Botany* 101(7): 1102–1126. <https://doi.org/10.3732/ajb.1400076>
- Robbrecht E, Manen JF (2006) The major evolutionary lineages of the coffee family (Rubiaceae, Angiosperms). Combined analysis (nDNA and cpDNA) to infer the position of *Coptosapelta* and *Luculia*, and supertree construction based on rbcL, rps16, trnL-trnF and atpB-rbcL data. A new classification in two subfamilies, Cinchonoideae and Rubioideae. *Systematics and Geography of Plants* 76(1): 85–145. <http://jstor.org/stable/20649700>
- Rolfe RA (1893) *Flora of St. Vincent and adjacent islets*. Bulletin of Miscellaneous Information, Royal Gardens, Kew 1893: 231–296. <http://biodiversitylibrary.org/item/127511#page/236>
- Staffeu FA, Cowan RS (1976–1988) *Taxonomic literature: A selective guide to botanical publications and collections with dates, commentaries and types*. 2nd ed., vols. 1–7. *Regnum vegetabile* 94, 98, 105, 110, 112, 115, 116, Bohn, Scheltema & Holkema, Utrecht/Antwerpen; dr. W. Junk b.v., Publishers, The Hague/Boston. <http://www.sil.si.edu/DigitalCollections/tl-2>
- Standley PC (1925a) New plants from Central America.—II. *Journal of the Washington Academy of Sciences* 15(5): 101–107. <http://biodiversitylibrary.org/part/147266>
- Standley PC (1925b) New plants from Central America.—III. *Journal of the Washington Academy of Sciences* 15(13): 285–289. <http://biodiversitylibrary.org/part/147267>
- Standley PC (1927) New plants from Central America.—VII. *Journal of the Washington Academy of Sciences* 17(7): 159–171. <http://biodiversitylibrary.org/item/123316#page/191>
- Standley PC (1928) Five new trees and shrubs from Nicaragua. *Tropical Woods* 16: 43–46.

- Standley PC (1929) Studies of American plants—I. Publications of the Field Museum of Natural History. Botanical Series 4(8): 197–299. <https://doi.org/10.5962/bhl.title.2243>
- Standley PC (1938) Flora of Costa Rica. Rubiaceae. Coffee Family. Publications of the Field Museum of Natural History. Botanical Series 18(4): 1264–1380. <https://doi.org/10.5962/bhl.title.2251>
- Standley PC, Record SJ (1936) The forests and flora of British Honduras. Publications of the Field Museum of Natural History. Botanical Series 12: 1–432. <https://doi.org/10.5962/bhl.title.2289>
- Steyermark JA (1964) Novedades en las Rubiaceas colombianas de Cuatrecasas. Acta Biologica Venezuelica 4(1): 1–117.
- Steyermark JA (1972) The botany of the Guayana Highlands—Part IX. Rubiaceae. Memoirs of the New York Botanical Garden 23: 227–832.
- Taylor CM (1995) New species and combinations in Rubiaceae from Costa Rica and Panama. Novon 5(2): 201–207. <https://doi.org/10.2307/3392247>
- Taylor CM (1996) Overview of the Psychotrieae (Rubiaceae) in the Neotropics. Opera Botanica Belgica 7: 261–270.
- Taylor CM (1997) Conspectus of the genus *Palicourea* (Rubiaceae: Psychotrieae) with the description of some new species from Ecuador and Colombia. Annals of the Missouri Botanical Garden 84(2): 224–262. <https://doi.org/10.2307/2400003>
- Taylor CM (2004) Rubiacearum Americanarum Magna Hama Pars XVI. New species, a new subspecies, and an overlooked species of *Psychotria* subg. *Heteropsychotria* from Mexico, Central America, and western South America. Novon 14(4): 493–508. <http://www.jstor.org/stable/3393551>
- Taylor CM (2014) Rubiaceae. In: Hammel BE, Grayum MH, Herrera C, Zamora N (Eds) Manual de Plantas de Costa Rica. Vol. VII. Monographs in Systematic Botany from the Missouri Botanical Garden 129: 464–779.
- Taylor CM (2015a) Rubiacearum americanarum magna hama XXXIII: The new group *Palicourea* sect. *Didymocarpae* with four new species and two new subspecies (Palicoureeae). Novon 23(4): 452–478. <https://doi.org/10.3417/2012003>
- Taylor CM (2015b) Rubiacearum americanarum magna hama pars XXXIV: The new group *Palicourea* sect. *Tricephalium* with six new species and a new subspecies (Palicoureeae). Novon 24(1): 55–95. <https://doi.org/10.3417/2015001>
- Taylor CM, Hammel BE, Burger WC (1991) New species, combinations, and records in Rubiaceae from the La Selva Biological Station, Costa Rica. Selbyana 12: 134–140. <http://jstor.org/stable/41759780>
- Taylor CM, Hollowell VC (2016) Rubiacearum Americanarum Magna Hama Pars XXXV: The new group *Palicourea* sect. *Nonatelia*, with five new species (Palicoureeae). Novon 25(1): 69–110. <https://doi.org/10.3417/2015012>
- Taylor CM, Lorence DH, Gereau RE (2010) Rubiacearum Magna Hama Pars XXV: The nocturnally flowering *Psychotria domingensis*–*Coussarea hondensis* group plus three other Mesoamerican *Psychotria* transferred to *Palicourea*. Novon 20(4): 481–492. <https://doi.org/10.3417/2009124>

Typification of binomials in *Xyris* section *Nematopus* (Xyridaceae) published by L.A. Nilsson

Maria das Graças Lapa Wanderley¹

¹ Instituto de Botânica, São Paulo, Brazil

Corresponding author: Maria das Graças Lapa Wanderley (gracaw@me.com)

Academic editor: Peter Boyce | Received 21 February 2017 | Accepted 2 May 2017 | Published 5 June 2017

Citation: Wanderley MGL (2017) Typification of binomials in *Xyris* section *Nematopus* (Xyridaceae) published by L.A. Nilsson. *PhytoKeys* 80: 65–86. <https://doi.org/10.3897/phytokeys.80.12348>

Abstract

A nomenclatural revision of fifteen taxa of *Xyris* (Xyridaceae) described by L.A. Nilsson (1892) is presented as part of a taxonomic revision of the genus in Brazil. All the protologues and type collections of these taxa were studied. The type collections were examined in the respective herbarium collections where they are preserved and complemented by images available on herbarium websites and from JSTOR Global Plants. Lectotypes were selected for *Xyris cristata* L.A.Nilsson, *X. glaziovii* L.A.Nilsson and *X. insignis* L.A.Nilsson. The holotypes, of *X. glandacea* L.A.Nilsson and *X. stenophylla* L.A.Nilsson, were discovered at the herbaria of Uppsala (UPS) and Berlin (B) respectively, and provided with their correct determinations.

Resumo

É apresentada a revisão nomenclatural de quinze taxa do gênero *Xyris* (Xyridaceae) descritos por L.A. Nilsson (1892), como parte da revisão taxonômica do gênero no Brasil. Foram analisados os protólogos destes taxa e as coleções-tipo nos acervos dos respectivos herbários onde os mesmos estão preservados e complementarmente por imagens disponíveis nos websites dos herbários e por meio do JSTOR Global Plants. Foram designados os lectótipos para *Xyris cristata* L.A.Nilsson; *X. glaziovii* L.A.Nilsson and *X. insignis* L.A.Nilsson. Dois holótipos com indicações equivocadas foram aqui encontrados e corretamente determinados: *Xyris glandacea* L.A.Nilsson, no Herbário UPS e *X. stenophylla* L.A.Nilsson, em B.

Keywords

Xyris, Xyridaceae, lectotype, holotype, nomenclature

Introduction

The family Xyridaceae comprises about 400 species (Wanderley 2011, Silva and Wanderley 2013, Mota and Wanderley 2014, Santos-Guedes and Wanderley 2015), of which approximately 92% occur in Brazil (Flora do Brasil 2016). The most recent monograph of Xyridaceae in Brazil (Smith and Downs 1968) recognized 115 species of *Xyris*. However, a large number of Brazilian species have been described since (Kral and Smith 1980, 1982, Wanderley 1983, 1986, Wanderley and Cerati 1987, Kral and Wanderley 1988a, 1988b, 1993, Wanderley 2003, 2010, Mota and Wanderley 2013, Mota and Wanderley 2014, Wanderley and Mota 2015, Lozano et al. 2016), increasing the number of taxa by approximately 44% over the last three decades.

While undertaking taxonomic studies of Brazilian Xyridaceae, it was discovered that a number of species of the genus *Xyris* needed nomenclatural revision. Although Smith and Downs (1968), proposed typifications of many taxa of *Xyris* as part of their treatment, many others still do not have any indication of typification, or there are problems to be solved. In some cases, unrecognized type material was found in the general collections of herbaria with the consequence that these types are also not available on herbaria websites or by JSTOR Global Plants (Ithaka 2015).

In this paper, we revised the typification of fifteen Brazilian taxa described by L.A. Nilsson (1892), most of whose type collections are housed at the herbaria of two research institutions, the Swedish Museum of Natural History (S) and Uppsala University Museum of Evolution, Botany Section (UPS). Both herbaria were the institutions where the author worked during the 19th century. In his treatment, “Studien über die Xyrideen”, Nilsson (1892) studied 109 taxa of *Xyris*, of which 53 belong to section *Nematopus*. Two were placed in a “dubia” section by the author, i.e. without sectional affiliation, but these two taxa are assigned here to *Xyris* section *Nematopus*. Following a recent visit to the two Swedish herbaria, fifteen names were reviewed and typified, of which twelve are accepted names and three are synonyms, all included in *Xyris* section *Nematopus*. Lectotypes are proposed here for three names, chosen in accordance with the original descriptions of the taxon, so as to enhance nomenclatural stability and following the author’s original intentions. In the case of a previous intention of indication by another author, the priority of designation was accepted, according to the International Code of Nomenclature for Algae, Fungi and Plants (McNeill et al. 2012), unless the designation was incorrect, and bearing in mind if the indicated material is representative of the species (Prado et al. 2015). Based on the review of all the protologues and type collections of the studied taxa, lectotypes are designated for *Xyris cristata* L.A. Nilsson, *X. glaziovii* L.A. Nilsson and *X. insignis* L.A. Nilsson. Two holotypes with equivocal determinations are reported and corrected here: *Xyris glandacea* L.A. Nilsson, housed at the Uppsala herbarium (UPS) and *X. stenophylla* L.A. Nilsson, at Berlin (B), both designated equivocally as lectotypes earlier by Smith and Downs (1968). Some types cited by Smith and Downs (1968) simply as “type”, were updated to lectotype status, and isotypes and isolectotypes are also reported here.

Material and methods

In this study, we analysed the protologues and morphological features from specimens of the following herbaria (* visited herbaria): B*, BR, K*, M*, NY*, P*, S*, US* and UPS* (see Thiers 2016 for acronyms). Typifications were carried out according to the current edition of the International Code of Nomenclature for Algae, Fungi and Plants (McNeill et al. 2012), as well as recommendations by Prado et al. (2015). The accepted names of the taxa are shown in bold italics, and the non-accepted ones only in italics. Images were studied using a source from the herbaria B, BR and M or by using digital images available on the JSTOR Global Plants website (Ithaka 2015). All the original protologues were reviewed. Citations of type specimens are given as follows; when labelled by barcode, this is cited immediately after the herbarium acronym; if there is no barcode the herbarium registration number is cited, as in the case of the S herbarium; when the exsiccatae have no registration numbers, as in the case of the UPS herbarium, just the respective herbarium acronym is cited.

Typifications

1. *Xyris cristata* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 56. 1892.

Type. “Brasilien”. Bahia “in paludosis ad Itahype flum. Com. Dos Ilheos”, *Martius s.n.* (lectotype, **designated here:** M! *pro parte*: plant marked as M0241131). Other: “Brasilien”. Minas Gerais, Vila do Príncipe, “in editis camporum humidis prope V. do Príncipe”, *Martius s.n.* (syntype: M! *pro parte*: plant marked as M0241116).

=*Xyris minarum* Seub. in Martius, Fl. Bras. 3(1): 215. 1855.

This species is a synonym of *X. minarum* Seub. Nilsson (1892) cited two syntypes for *Xyris cristata* in the protologue, both collected by Martius: 1) *Martius s.n.*, from Minas Gerais, Vila do Príncipe, (“in editis camporum humidis prope V. do Príncipe”), and 2) *Martius s.n.* from Bahia, “in paludosis ad Itahype flum. Com. Dos Ilheos”. However, both collections contain a mixture of species. The sheet from Bahia presents a mixture of *Xyris cristata* and *X. rupicola* Kunth, presumably due to their similarity in habit, a common problem in identification of *Xyris* species. On this sheet, the plants of the two species are marked with different barcodes, *X. rupicola* (M0241130) and *X. cristata* (M0241131). The specimen of *X. cristata* is positioned in the center of the sheet marked with the number “2”, whereas the two specimens positioned laterally and marked “1” correspond to *X. rupicola*. The material (M0241131) agrees with the description of the species provided in the protologue.

The collection from Minas Gerais includes the other syntype of *Xyris cristata*, but also plants of a third species, *X. subsetigera* Malme. The specimens of each species mixed together in this Martius collection agree with their respective protologues and both names are validly published. The mixed collection has been separated into three

exsiccatae; the plants of *X. subsetigera* are now registered as M0241136 and M0241137, whereas that of *X. cristata* is registered as M0241116. This latter plant is a poor sample of *X. cristata*, represented only by three peduncles and three spikes.

After studying the two syntypes (M0241131, M0241116), the Bahian collection was selected as the lectotype of *Xyris cristata*, because it is a more complete specimen.

2. *Xyris filifolia* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 43-44. 1892.

Type. “Brasilien”. Minas Gerais, Caldas, *Regnell III 2051*, “in palude inter gramineas altas” (lectotype, designated by Smith & Downs, 1968: S! [S-R-6569]; isoelectotypes: UPS!, US! [US00088150]).

In the protologue of the species, two collections were cited: *Regnell III 2051* and *Lindberg s.n.* The choice of lectotype was previously made by Smith and Downs (1968), who indicated the sheet *Regnell III 2051*, 30[?]-II-1880 as the “type”, deposited in S (S-R-6569), which by this indication became the lectotype. It is likely that during the distribution of the duplicates between the S (30-II-1880) and UPS (20-II-1880) herbaria, a change in the date was made in the transcription of the label. A second sheet is deposited in UPS (*Regnell III 2051*), although under a different date (13-II-1880), but there is no doubt that this material is part of the same collection (*Regnell III 2051*). This sheet from UPS (*Regnell III 2051*, 13-II-1880) contains a short description of the species (in handwriting similar to that of Nilsson) and the observation “in palude inter gramineas altas”, which occurs in the protologue. The Lindberg collection 556 (XII-1854), deposited in S (S-R-6570) and also cited in the protologue, is a syntype. This material comes from Minas Gerais, Caldas, and has the same location as the lectotype.

3. *Xyris fusca* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 57-58. 1892.

Type. “Brasilien”. *Glaziov 6747* (lectotype, designated as type by Smith & Downs, 1968: B! [B10 0243260]; isoelectotypes: P! [P01679919], K! [K000587085]).

The Glaziov 6747 specimen from Brazil has three duplicates, of which B10 0243260 is the lectotype, designated as “type” by Smith and Downs (1968). The isoelectotypes deposited in P and K are: P01679919, K000587085. The label of the sheet at P gives the origin of the collection as Brazil, Rio de Janeiro, Itatiaia, January 22, 1873. In the K isoelectotype, there is no information on locality or date. The information given is the collector and the respective collection number, the origin as Rio de Janeiro, and the date as February 1874. The later date of the Kew specimen might signify when the specimen was received at K as a duplicate from P. However, there is no doubt that the three exsiccates are from the Glaziov 6747 collection.

4. *Xyris glandacea* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 50. 1892.

Type. “Brasilien”. Minas Gerais, Caldas, *Regnell III 2065* (in herb. UPS) (holotype: UPS!; isotype: S! [S-R-6575]).

In his *Xyris glandacea* protologue, Nilsson (1892) cited the *Regnell III 2065* collection, and indicated UPS as the herbarium where it was deposited. However, Smith and Downs (1968), apparently ignoring the holotype, made an improper designation, and chose the isotype at S as the lectotype. The present study confirmed the presence of the holotype at UPS (*Regnell III 2065*), and that the duplicate housed at S is indeed the isotype. The holotype contains a short manuscript description that agrees with the species diagnosis. There is an attached envelope containing fragments of the inflorescence, confirming that it was used to describe the species. Both the holotype and isotype are compatible with the diagnosis and provide decisive confirmation of the rediscovery in the field of *X. glandacea* after a century, previously reported by Wanderley (2011). Due to earlier poor understanding of its identity, the name has been applied to various different species of *Xyris* in herbarium collections.

5. *Xyris glaziowii* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 61-62. 1892.

Type. “Brasilien”, *Glaziou 8004* (B†; lectotype, **designated here:** P! [P00753734]; isolectotypes: NY! [NY00246945], BR [BR000000694356, scan!], P! [P00753735]).

= *Xyris augusto-coburgii* Szyzyl. ex G.Beck., Itin. Princ. S. Coburgii 2: 94. 1888.

This name is a synonym of *Xyris augusto-coburgii* Szyzyl. ex G.Beck. Although cited in the protologue as deposited in B, the type material of *X. glaziowii* is no longer to be found there. Dr. Robert Vogt, curator of B, has confirmed that the type material of *Xyris glaziowii* probably disappeared as a result of World War II damage to the B herbarium. Duplicates of *Glaziou 8004* at P, BR, NY, and a photograph at F were therefore examined with a view to selection of a lectotype. Smith and Downs (1968) indicated material deposited at P as the type. However, there are two sheets of *Glaziou 8004* in this herbarium, and the sheet numbered P00753734 was chosen and designated here as the lectotype, because of its more complete label data, stating that the material is from São Paulo, Fazenda da Bocaina, near Cascatinha do rio Mambucabo, collected on February 11, 1876. The isolectotypes are: P00753735, NY00246945 and BR000000694356, which although from the same collection (*Glaziou 8004*), have incomplete label information. The BR sheet indicates that it originated from Rio de Janeiro, while the label data of the NY sheet indicates its origin as São Paulo, Bocaina, as in the lectotype.

6. *Xyris insignis* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 44. 1892.

Type. “Brasilien”. Minas Gerais, “in campis alpestribus ad Serro Frio”, *Martius s.n.* (in herb. Monac.) (lectotype, **designated here:** M! [M0241098]; isolectotype: M! [M0241097]).

According to the protologue, the Martius’s type collection is from Serro, Minas Gerais state, Brazil, but with no information of the collector number and date. It is deposited at the Munich herbarium (M) where there are two sheets of the same collection (M0241097 and M0241098). According to Smith and Downs (1968), the *Martius* collection was cited as a type, but without choosing one of the two *Maritus* sheets deposited in M. The lectotype is therefore designated here as the sheet M0241098. This choice was made because the material is more complete, corresponds to the original description of the species, and has annotations in pencil indicating that it is the holotype. Another indication of having been used by Nilsson (1892) to describe the species is the fact that there is an envelope with fragments of the dried floral spike. The duplicate sheet (M0241097) thus becomes an isolectotype.

7. *Xyris laevigata* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 50. 1892.

Type. “Brasilien”. Rio de Janeiro, *Glaziou 1327* (lectotype, designated by Smith and Downs, 1968: B! [B100242250]; isolectotype: K! [K000587092]).

According to the protologue, the *Glaziou 13277* collection was used to describe the species, but without indication of the depository herbarium where it was deposited. Considering the intention of Smith and Downs (1968) in indicating the Berlin sheet (B100242250) as a “type”, their choice has priority and this sheet is therefore considered the lectotype. An isolectotype is deposited at K (K000587092).

8. *Xyris longiscapa* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 59-60. 1892.

Type. “Brasilien”. Minas Gerais, “in palustribus Serra do Caraca”, *Martius s.n.* (holotype: M! [M0241109]).

In the protologue Nilsson (1892) indicated only the *Martius* collection without collector number, collected in Brazil, Minas Gerais state, in the Serra do Caraça, and deposited at the Munich herbarium (M). Since this collection consists of a unique sheet, it is consequently the holotype. The material is made up of three leaf rosettes, representative of the species and compatible with the protologue.

9. *Xyris nigricans* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 60. 1892.

Type. “Brasilien”. Rio de Janeiro, *Glaziou 15513* (lectotype, designated by Smith & Downs, 1968: P! [P00752388]); isoelectotypes: P! [P00752436]), K! [K000587098]), BR [BR000000694390, scan!]. Other: *Sellow s.n.* (syntype: B! [B 10 0242237]).

We examined two syntype collections of *X. nigricans*. Both are of good quality: 1) *Glaziou 15513*, has two sheets at P (P00752388; P00752436), one at K (K000587098) and one at BR (BR000000694390); 2) *Sellow s.n.* has a single sheet at B (B 10 0242237). The lectotype is confirmed as sheet P00752388 of the *Glaziou 15513* collection, previously indicated by Smith and Downs (1968) as the “type”. The label data of the lectotype states that it was collected in the state of Minas Gerais, at Alto de Itacolomy (“Haut Itacolomy”). The other three sheets at P (P 00752436), BR (BR000000694390) and K (K000587098) are thus isoelectotypes. Although the species is endemic to Minas Gerais, equivocal information is given on the labels of the isoelectotypes at K and BR, referring to the surroundings from Rio de Janeiro and Ouro Preto. However, there is no doubt that all of them are duplicates and part of the same collection *Glaziou 15513*, and each sheet was probably labelled by Glaziou. The exsiccate *Sellow s.n.*, deposited at B (B 10 0242237), is a syntype of *Xyris nigricans* and is compatible with the protologue.

10. *Xyris obtusiuscula* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 47. 1892.

Type. “Brasilien”, *Sellow s.n.* (“in herb. Berol.”) (holotype: B! [B10 0242234]).

Nilsson (1892) cited the *Sellow s.n.* collection in the protologue as at the Berlin herbarium (B). Smith and Downs (1968) indicated the B sheet as the type, but without specifying the type’s category. Considering that only this sheet of this collection is known at B (B10 0242234) and Nilsson’s citation of B in the protologue, we can confirm that it is the holotype. Although no mention was made in the protologue of Sellow’s collecting number, the label states that it is *Sellow 1087*. The holotype is a poor specimen, consisting of only one plant with two incomplete spikes, together with added fragments of the inflorescence, but nevertheless corresponds to the characteristics of the species.

11. *Xyris regnellii* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 43. 1892.

Type. “Brasilien”, Minas Gerais, Caldas, *Regnell III 2050* (lectotype, designated by Smith & Downs, 1968: S! [S-R-6609]; isoelectotype: UPS!, *pro parte* P! [P01676114]). Other: “Brasilien”, Minas Gerais, Caldas, *Regnell III 2050* “loco paludoso in consortione graminearum excelsiorum” (syntype: UPS!).

In the protologue of the species, Nilsson (1892) cited two different collections from the same location (Brazil, Minas Gerais, Caldas) under the same number *Regnell III 2050*. The two collections can be recognized by the annotations referred to in the protologue: 1) “In palude inter gramineas alta”, and 2) “loco paludoso in consortione graminearum excelsiorum”. The sheets examined in the present study at P, S and UPS have different dates on their labels for this same collection - no dates are mentioned in the protologue. This variation of dates and other label information on the duplicate sheets of the type collection led to a more detailed analysis of the typification of this name, involving visits to both Swedish herbaria (UPS and S) and P, where the duplicates of the *Regnell III 2050* are deposited. Smith and Downs (1968) previously indicated as lectotype the sheet deposited in S (S-R-6609), and since this is representative of the species and protologue, it is confirmed here as the lectotype. It can also be recognized by the citation in the protologue (“Brasilien”, Minas Gerais, Caldas, *Regnell III 2050*); its label includes the date 10-01-1880. The isolectotype is deposited in UPS (*Regnell III 2050*) and has the same date as the lectotype (10-I-1880), includes a short description of the species (in pencil with similar handwriting to that of Nilsson), and the ecological description “in palude inter gramineas alta”, as cited in the protologue. Although the latter information does not appear on the lectotype sheet at S, there is no doubt that they are duplicates and that they complement each other in relation to the protologue. The syntype at UPS corresponds to the second material mentioned in the *Regnell III 2050* protologue (“loco paludoso in consortione graminearum excelsiorum”), and this sheet includes two dates: 20-I-1880 and 17-2-1880. It also has a brief description of the species and fragments of material in envelopes, indicating that they were examined by Nilsson when he prepared his original description. This material is thus very informative and complementary for interpreting this species name.

The P01676114 collection at Paris (P) is part of the type collection of *Xyris regnellii* (*Regnell III 2050*), and can be considered as a syntype, but only in part (*pro parte*), as it consists of a mixture of specimens of *Xyris regnellii* and *X. filifolia*. This sheet does not have a date of collection or any of the other information mentioned above, showing only the collector's name and number. It is, however, the only reference to *X. regnellii* currently available on the JSTOR Global Plants (Ithaka 2015) website for type materials. Another specimen at P (P01727365), is possibly part of the type collection of *Xyris regnellii*, but as the number of the *Regnell* collection has not been recorded, it has not been included here in the above citation of duplicates of the type collection. Yet another P specimen, P01676128, which is of *X. regnellii*, was not considered for typification of the name, because it is labelled as *X. filifolia* and is a different collection (*Regnell III 2051*). The interpretation of *Xyris regnellii* and *X. filifolia* type material, described by Nilsson (1892) in the same work, was made more difficult as they were collected by Regnell in the same location (Minas Gerais, Caldas), and received consecutive numbers: *Regnell III 2050* for *Xyris regnellii*, and *Regnell III 2051* for *X. filifolia*. The mixture of material of these two species in the duplicates at P and the exchange of labels between them must have occurred during the original distribution of duplicates.

12. *Xyris seubertii* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 51. 1892.

Type. Guyana: “British Guiana”, *Rich. Schomburgk* 897 (in herb. Berol.) (holotype: B! [B10 0242218]; isotype: K! [K000308887]).

In his species description, Nilsson (1892) cited the collection *Schomburgk* 897, originating from British Guiana, undated, and deposited in the B herbarium. The unicate of this collection in B (B10 0242218) was examined, and is compatible with the protologue. Smith and Downs (1968) cited this sheet (B10 0242218) as “type”, thus identifying it as the holotype, which has two plants with the typical characteristics of *Xyris seubertii*, and the label indicates the location and the date (October 1842), as quoted in the protologue. Illustrations attached to the holotype sheet show characteristic features of the species, with a drawing of the central placenta and sepals with a thickly pilose carina and acute apex. However, in addition to these illustrations, there is an annotation signed by Seubert that indicates the species as *Xyris fontanesiana* Kunth, now considered as a synonym of *Xyris anceps* Lam. (*Xyris* section *Xyris*), which has a marginal placenta and is very different from *X. seubertii* (*Xyris* section *Nematopus*). An isotype is deposited at K (K000308887), with an annotation giving its origin from Guiana, and with indications of having previously been separated from another specimen. Another sheet at K (K000308888), also of *Xyris seubertii*, has the locality information “Roraima Expedition, British Guiana, Monte Roraima”. The collector is not mentioned, but the number 257 given on the label makes clear that it does not belong to the type collection.

13. *Xyris simulans* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 47. 1892.

Type. “Brasilien”, Minas Gerais, Caldas. *Regnell III* 1276 (lectotype, designated by Smith & Downs, 1968: S! [S 05-5679]; isolectotypes: UPS!; US [US00433375, image!]).

= *Xyris tortula* Mart. Flora 24(Beibl. 2): 55. 1841.

The lectotype of the *Regnell III* 1276 (S 05-5679) material, designated as “type” by Smith and Downs (1968), is confirmed. Isolectotypes are deposited at US (US00433375) and UPS.

14. *Xyris stenophylla* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 46. 1892.

Type. Brasil. *Glaziou* 7999 (in herb. Berol.) (holotype: B! [B100242212]; isotypes: S! [S-R-6620], K! [K00494720]; P! [P00753728, P00753729]).

The holotype (B100242212) is the single sheet of *Glaziou* 7999 at the B herbarium. It is from Brazil, undated, lacks a more precise location, and was indicated in the

protologue as deposited at the B herbarium. The holotype consists of several plants and dried material that was used by Nilsson (1892) to describe the species. Smith and Downs (1968) cited the collection *Glaziou 7999* at the Stockholm herbarium (S R-6620) as “type”, but because Nilsson (1892) cited the B collection, the only sheet of this collection there, the S sheet must be considered as an isotype. Other isotypes were examined for the present study at K (K00494720) and P (P00753728, P00753729), all of *Glaziou 7999*, despite having annotations which give differing locations. The exsiccate K00494720 indicates that it is from Rio de Janeiro and P00753728 has a different indication to São Paulo, Campos Bocaina. However, the sheet P00753729 and the holotype (B100242212) were labeled only to Brazil, without mention of locality.

These disagreements in location attribution are thought to have occurred when Glaziou’s duplicates were distributed to the different herbaria.

15. *Xyris teres* L.A.Nilsson, Kongl. Svenska Vetenskap.-Akad. Handl. 24(14): 44-45. 1892.

Type. “Brasilien”. *Glaziou 4286* (lectotype, designated by Smith & Downs, 1968: P! [P00753726]; isolectotypes: K! [K00587113], US! [US00088220]). Other: *Glaziou 8003* (Itatiaia) (syntype: K! [K000587112]; isosyntype: P! [P01677114]); GH *n.v.*

[GH00028828]; *Sellow s.n.* (syntype: B! [B10 0242206]; isosyntypes: K! [K000837563, K000837566, K000837567]).

In the protologue, Nilsson cited three collections he had examined: *Glaziou 4286*, *Glaziou 8003* and *Sellow s.n.*, indicating the B herbarium as depository, however only the Sellow collection was found at B. Smith and Downs (1968) cited as “type” the material of *Glaziou 4286* deposited at P (P00753726), which is thus the lectotype, since there is no reason to disagree with the intention of these authors, the specimen being representative of the species and in agreement with the protologue. The lectotype consists of only a single plant, although a line drawn on the sheet shows that other, presumably mixed material has been removed; the label states that it is from the Serra dos Órgãos in Brazil, dated April 4, 1870. The duplicates at K (K000587113) and US (US00088220) are isolectotypes. The Kew isolectotype (K000587113) sheet, comprising young plants, also bears traces of previous mixtures, while the US isolectotype (US00088220) is mixed with *X. macrocephala* Vahl.

Duplicates of the syntype *Glaziou 8003* are deposited at K (K000587112) and P (P01677114), with annotations giving different origins. The P duplicate (P0167114), states its origin as Brazil, São Paulo, Fazenda Bocaina, near Cascatinha Manbucabo, collected on February 11, 1876. The K duplicate (K000587112) label annotation states the collection is from Rio de Janeiro, while another duplicate at GH (GH00028828) has data identical to the P specimen (Fazenda Bocaina, São Paulo). Despite this divergent locality information, there is no doubt that they all belong to the same Glaziou 8003 collection.

The duplicates of the syntype *Sellow* s.n. (B100242206, K000837563, K000837563, K000837566, K7000837567) indicate their origin only as from Brazil, with all bearing the number 204 on the label, confirming that all belong to the same *Sellow* collection. The collections examined revealed leaves with dark edges that can vary from bright to opaque, smooth to rugulose, variations observed in recent specimens of this species. The globular or ovoid spikes with brown bracts having a conspicuous macula are also very variable, sometimes making it difficult to identify this species, which overlaps in some characters with other similar species such as *Xyris rigida* Kunth.

Acknowledgments

I would like to thank the curators and staff at the following herbaria for allowing me to access their collections and/or for providing images complementary to the study: B, BR*, F*, K, M, S, UPS, US and P (* not visited). Visits to K, P, S and UPS were supported by CNPq, FAPESP and Refflora Project (CNPq). And special thanks to Dr. Simon Mayo and Dr. Jefferson Prado for the valuable comments and suggestions and the careful review of the editorial committee and reviewers.

References

- Flora do Brasil 2020 em construção (2016) Jardim Botânico do Rio de Janeiro. Available in: <http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB252> [accessed 20.02.2017]
- Ithaka (2015) JSTOR Global Plants. <http://plants.jstor.org/> [accessed: 21.II.2015]
- Kral R, Smith LB (1980) Xyridaceae Brasiliae – I. Bradea 3: 57–64.
- Kral R, Smith LB (1982) Xyridaceae Brasiliae – II. Bradea 3: 273–298.
- Kral R, Wanderley MGL (1988a) Ten novelties in *Xyris* (Xyridaceae) from the planalto of Brazil. Ann. of Missouri Botanical Garden 75: 352–372. <https://doi.org/10.2307/2399478>
- Kral R, Wanderley MGL (1988b) Two New *Xyris* from the Amazon Basin of Brasil. Ann. Missouri Botanical Garden 74(4): 912–916. <https://doi.org/10.2307/2399459>
- Kral R, Wanderley MGL (1993) Five new taxa of *Xyris* L. (Xyridaceae). Kew Bulletin 48(3): 577–588. <https://doi.org/10.2307/4118722>
- Lozano ED, Smidt EC, Wanderley MGL (2016) A new species of *Xyris* (Xyridaceae) from Brazil. Phytotaxa 245(1): 084–088. <http://dx.doi.org/10.11646/phytotaxa.245.1.11>
- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, Prud'Homme Van Reine WF, Smith GF, Wiersema JH, Turland NJ (2012) International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. [Regnum Vegetabile 154]. Gantner, Ruggell, 240 pp.
- Mota NFO, Wanderley MGL (2013) *Xyris riopretensis* (Xyridaceae): uma nova espécie para Minas Gerais, Brasil. Rodriguésia 64(3): 555–560. <https://doi.org/10.1590/S2175-78602013000300007>

- Mota NFO, Wanderley MGL (2014) Three new species of *Xyris* (Xyridaceae) from Diamantina Plateau in Brazil, Minas Gerais. *Brittonia* 66(1): 42–50. <https://doi.org/10.1007/s12228-013-9306-0>
- Nilsson LA (1892) Studien über die Xyrideen. Kongl. Svenska Vetenskapsakad. Handl. 24(14): 1–75.
- Prado J, Hirai RY, Moran RC (2015) (046–048) Proposals concerning inadvertent lectotypifications (and neotypifications). *Taxon* 64: 651–651. <https://doi.org/10.12705/643.29>
- Santos-Guedes JS, Wanderley MGL (2015) Xyridaceae na Serra do Cabral, Estado de Minas Gerais, Brasil. *Hoehnea* 42(2): 367–397. <https://doi.org/10.1590/2236-8906-71/2014>
- Silva GO, Wanderley MGL (2013) A família Xyridaceae no município de Mucugê, BA, Brasil. *Hoehnea* 40: 51–76.
- Smith LB, Downs RJ (1968) Xyridaceae. In: Hoehne FC, Teixeira AR (Eds) *Flora Brasileira*. São Paulo, fasc. 12, v. 9, n. 2, 1–214.
- Thiers B (2016) Continuously updated. Index Herbariorum: A global directory of public herbaria and associated staff. <https://doi.org/10.1590/S2236-89062013000100002>
- Wanderley MGL (1983) *Xyris* da Serra do Cipó, MG, Brasil: duas novas espécies. *Revista Brasileira de Botânica* 6(1): 11–14.
- Wanderley MGL (1986) Estudos em Xyridaceae, 3: *Xyris paradisiaca* Wanderley, uma nova espécie para o Brasil. *Hoehnea* 13: 31–33.
- Wanderley MGL (2003) Nova espécie de *Xyris* L. (Xyridaceae) para o Estado de Minas Gerais, Brasil. *Pabstia* 14(4): 1–4.
- Wanderley MGL (2010) Cinco novas espécies de *Xyris* (Xyridaceae) da Serra do Cipó, Minas Gerais, Brasil. *Rodriguésia* 61(1): 083–094.
- Wanderley MGL (2011) Flora da Serra do Cipó, Minas Gerais: Xyridaceae. *Boletim de Botânica da Universidade São Paulo* 29: 69–134. <https://doi.org/10.11606/issn.2316-9052.v29i1p69-134>
- Wanderley MGL, Cerati TM (1987) Studies in Xyridaceae II. Two new species of *Xyris* from Brazil. *Brittonia* 39: 298–301. <https://doi.org/10.2307/2807399>
- Wanderley MGL, Mota NFO (2015) Three new species of *Xyris* (Xyridaceae) from the Espinhaço Range, Brazil. *Phytotaxa* 204: 213–222. <https://doi.org/10.11646/phytotaxa.204.3.4>

Epitypification with an emended description of *Tropidia connata* (Orchidaceae, Epidendroideae, Tropidieae)

Izai Alberto Bruno Sabino Kikuchi^{1,2}, Hirokazu Tsukaya^{3,4}

1 Institute of Biology Leiden, Faculty of Science, Leiden University, Sylviusweg 72, 2333 BE, Leiden, Netherlands **2** Botanical Gardens, Graduate School of Science, The University of Tokyo, 3-7-1 Hakusan, Bunkyo-ku, Tokyo 112-0001, Japan **3** Department of Biological Sciences, Faculty of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan **4** Bio-Next Project, Okazaki Institute for Integrative Bioscience, National Institutes of Natural Sciences, Yamate Build. #3, 5-1, Higashiyama, Myodaiji, Okazaki, Aichi 444-8787, Japan

Corresponding author: Hirokazu Tsukaya (tsukaya@bs.s.u-tokyo.ac.jp)

Academic editor: M. Simo-Droissart | Received 16 February 2017 | Accepted 3 May 2017 | Published 5 June 2017

Citation: Kikuchi IABS, Tsukaya H (2017) Epitypification with an emended description of *Tropidia connata* (Orchidaceae, Epidendroideae, Tropidieae). PhytoKeys 80: 77–85. <https://doi.org/10.3897/phytokeys.80.12304>

Abstract

We found several specimens of *Tropidia connata*, a mycoheterotrophic orchid from Borneo, with features which have never been described in any of the existing literature, namely subterranean tubers. We mainly focus on the importance of the subterranean structures in comparison with the mycoheterotrophic genus *Kalimantanorchis* from the tribe Tropidieae. This finding of the tuberous structure gives a new insight into the classification of mycoheterotrophic species of Tropidieae and might affect the generic placement of *Kalimantanorchis*. We made a detailed study on the newly discovered specimens as well as the type, and found more diagnostic characters of *T. connata* than the previous description. Considering that the type specimen lacks the whole tuberous character, we consequently designate an epitype with a drawing and emend the description.

Keywords

Borneo, emendation, epitypification, *Kalimantanorchis*, mycoheterotroph, Orchidaceae, *Tropidia*, Tropidieae

Introduction

The genus *Tropidia* Lindl. (Orchidaceae, Epidendroideae, Tropidieae) currently contains about 30 species mainly distributed from Far East Asia, India, Sri Lanka, Indochina, Malaysia, Indonesia, the Philippines and New Guinea to northern Australia, spreading across the South Pacific Islands. There is one exception to this distribution: *Tropidia polystachya* (Sw.) Ames is native to Florida, the West Indies, Central America and northern South America including the Galapagos Islands (Chun-Kuei et al. 2013). *Tropidia* is often characterized by its woody stems with plicate leaves. However, two mycoheterotrophic species without any green leaves have been reported from this genus: *T. saprophytica* J.J.Sm. and *T. connata* J.J.Wood & A.L.Lamb.

Due to the rare occurrence of the mycoheterotrophic species in general and to the difficulty in extracting a complete root system, the subterranean parts of most mycoheterotrophic plants are less known than their aerial parts (Imhof et al. 2013). This is also the case for *Tropidia connata*, with no description provided for its subterranean parts (Wood and Cribb 1994). However, in 2011 and 2012, multiple specimens of *T. connata* with underground tuberous structure were collected by the last author from the heart of Borneo, inside the Betung-Kerihun National Park, (West Kalimantan, Indonesia), where many new mycoheterotrophic taxa were discovered (Tsukaya and Okada 2005, 2012a, b, c, 2013a, b, Tsukaya et al. 2011). In addition to the subterranean structures, we also found some remarkable floral features, which were also not described in the original description (Wood and Cribb 1994). As the type specimen lacks the tuber structure, we therefore chose one of the newly collected specimens to designate as an epitype with a drawing. We consequently provide an emended description of this enigmatic species, *T. connata*.

Materials and methods

We collected three specimens from three localities of Indonesia under permission of Secretariat of Permission for Foreign Research, The Ministry of Research and Technology, Republic of Indonesia (RISTEK). The specimens (two of which are with tubers) were examined in this study. We also examined the type specimen, A.Lamb, A.Surat & H.Lim 1512 (K000942868). The newly collected specimens were dried or kept in 50% (v/v) ethanol and deposited in both BO and TI (herbarium codes are according to the Index Herbariorum <http://sweetgum.nybg.org/science/ih/>). The type specimen is deposited in K. Morphological observation was carried out using a stereomicroscope (MZ16a; Leica Microsystems). All measurements were taken from dried and spirit herbarium collections and field notes. The measurements are presented as length × width, followed by units of measurements (mm or cm). The terminology used here is according to Tsukaya et al. (2011).

Results

In the original description, the diagnostic characters of *Tropidia connata* are the fractiflex rachis, connate lateral sepals forming a synsepalum, and shortly spurred lip (Wood and Cribb 1994). We confirmed each of these features in both the type specimen and the newly collected specimens. However, we discovered three features other than these characters.

The most distinct feature that had not been described in the previous description is the subterranean tuberous structure (Figures 1M, 2A, E). The type specimen totally lacks this structure. The inflorescences occurred at the flanking region of the tuber, which was 2-7 cm long and 0.5-1 cm in diameter and covered with dense hairs (Figure 2E) (N = 4). One of the specimens (#1040) lacks a full length rhizome, but retains about 8 mm. Filamentous roots were poorly elongated in the specimen HT245 at the basal nodes of inflorescence (Figure 1M, Figure 2E), while most of the fibrous roots lack apices showing necrosis, suggesting the original length of the roots might be longer. On the other hand, we could not find any fibrous roots for the other specimens, suggesting that development of fibrous roots does not continue long, even if occurred.

The second distinct feature observed for the first time here is the two fiber-like protrusions attached to the adaxial side of the stigma (Figure 1D, H) (N = 2). Examination of the type specimen at the Kew Herbarium confirmed this structure as well. However, the color of this structure observed in the type was whitish and almost transparent, whereas the other floral specimens examined were black.

Another distinct feature recognized is the difference between the scale-like leaves and the flower bracts. While 5-10 scale-like leaves are seen on the stem and are ovate, acute, adpressed to the stem (N = 7) (Figure 1A, 2A), the bracts showed a distinct feature from scale-like leaves, the presence of an abscission layer 1-2 mm from the apex (N = 7) (Figure 2B-D). After maturation, the apical part falls away at this abscission layer.

We did not find any specimens with fully matured fruits, so we could not make an observation of the fruits or the seeds, which are also undescribed in the original description.

Discussion

The tribe Tropidieae contains the genera *Tropidia*, *Corymborkis* Thouars, and the monotypic and mycoheterotrophic *Kalimantanorchis* Tsukaya, M.Nakaj. & H.Okada. *Corymborkis* does not contain any mycoheterotrophic species.

The presence of underground tubers has never been described in the genus *Tropidia*, although it was described for *Kalimantanorchis nagamasui* Tsukaya, M.Nakaj. & H.Okada (Tsukaya et al. 2011). Moreover, other leafy *Tropidia* species have fibrous roots and bear short and cylindrical tuber-like nodules at the distal end (Yeh et al. 2009, Chun-Kuei et al. 2013). Therefore, we hypothesize the tuber of *T. connata* may be equivalent to the tuber-like nodules of other leafy *Tropidia*. To confirm this hypothesis, we need comparative studies of the subterranean parts of both leafy and mycoheterotrophic *Tropidia*.

This discovery of the tuberous structure of *T. connata* clearly indicates that this is a shared feature of two of the mycoheterotrophic species in the tribe Tropidieae. However, the presence of a tuber has also never been reported for the other mycoheterotrophic species of Tropidieae, *T. saprophytica*. We consider that it is of great importance to discover new samples of *T. saprophytica* with well-preserved subterranean parts as well.

The main morphological feature of *Kalimantanorchis*, which made it distinct from other *Tropidia* mycoheterotrophic species at the time it was discovered, is the presence of the tubers. This result therefore raises the possibility that the genus *Kalimantanorchis* is not distinct from the genus *Tropidia* or that the tuber structure separately evolved in the tribe Tropidieae more than twice. The previous phylogenetic analyses of *Kalimantanorchis* (Tsukaya et al. 2011) did not include any samples of other mycoheterotrophic species of *Tropidia*, so we intend to perform further molecular phylogenetic analyses on both the samples of *T. connata* and *T. saprophytica*, as well as other leafy species of the tribe Tropidieae to obtain phylogenetic trees with better sampling, higher resolution, and higher support values than the previous work.

In addition to the tuberous structure, we found an abscission layer on bracts and two fibrous protrusions attached to the adaxial side of the stigma, both of which have never been described for other mycoheterotrophic Tropidieae species. The presence of such protrusions implies that there may have been some change in the pollination systems for *T. connata* due to the fully mycoheterotrophic habitat. Further research is needed to examine the function of these fibers in the pollination system to understand the possible pollination change in this species.

Conclusions

The subterranean part of the type specimen was badly preserved as it lacks whole tuberous parts. Judging from the importance of this new finding of the tuberous structure, which provides possible changes in the classification of the tribe Tropidieae, we therefore consider it is necessary to choose one of the newly collected specimens (HT245) as an epitype. We designate the epitype, provide a drawing of the epitype, and emend the description of *Tropidia connata* at the end of this section as a taxonomic treatment.

Following this research, we conclude that the tribe Tropidieae is not thoroughly understood and little work has been done through either morphological or molecular methods. In particular, no comprehensive research of the whole genus *Tropidia* has been done, though this genus has a morphologically unique subterranean tuberous structure, and it seems that there still remain a lot of complications in this genus. It is also important to mention that several species have been discovered recently (Lin et al. 2006, Yeh et al. 2009, Chun-Kuei et al. 2013). We would like to continue and expand this study about the tribe Tropidieae focusing on *Tropidia* to contribute to a better understanding of this tribe.

Taxonomic treatment

***Tropidia connata* J.J.Wood & A.L.Lamb (1994: 47) emend. I.Kikuchi & Tsukaya**
Figure 1

Type. MALAYSIA. Borneo: Sabah, Sipitang District, Gunung Lumaku, 27 June 1992, A.Lamb, A.Surat, & H.Lim 1512 (holotype: K!, K000942868).

Epitype. INDONESIA. West Kalimantan: Kabupaten Kapuas Hulu, Betung Kerihun National Park, en route from stream to ridge, a branch of Sungai (River) Sibau, 01°13.32'N; 113°06.2433'E, 240 m alt., 31 December 2011, H. Tsukaya, H. Okadada and A. Soejima HT245 (BO, TI), here designated.

Emended description. Erect, mycoheterotrophic herb. Tubers 2–7×0.5–1 cm, dark brown, pubescent. Roots 2–5 mm long, short, occurring at the basal 1–3 nodes of stem. Stem 10–22 cm high, ivory white to creamy colored, wiry, simple or branched, perennial, 1 mm thick, internodes 0.8–2.5 cm long, sparsely ramentaceous, bearing 5–10 ovate, acute, sheath-like leaves appressed to the stem, 3–5 mm long. Inflorescence 5–15 flowered, 1–2 flowers open at a time; rachis 2–9 cm long, creamy white, internodes 4–10 mm, slightly zigzag, sparsely ramentaceous; floral bracts 3–5 mm long, off white tipped brown, triangular, acute to acuminate, with a abscission zone at 1–2 mm from the apex, apex detached at the abscission zone after maturation, base of the bracts forming a sheath enclosing the stem. Flowers 1 cm across, non-resupinate, partially open, white, apex of the lip pale orange to yellow. Pedicel with ovary 3–7 mm long, white, sparsely ramentaceous. Dorsal sepal 5–5.9×1.5–1.8 mm, narrowly elliptic, acute, sparsely ramentaceous on the abaxial sides. Lateral sepals connate into a 4–7.4×2.5–2.7 mm ovate-elliptic, cymbiform synsepalum, apex minutely bifid. Petals 4.8–6×1.5 mm narrowly elliptic, acute and asymmetric with two keels at the adaxial surface. Lip 5–7.6×2–2.2 mm with 3 nerves, elliptic, acute, concave, margin minutely erose, curving back to a horizontal position, spur saccate, obtuse, bifid, enclosed by synsepalum, 1.1–4×1 mm. Column 3–3.9×1.6–1.9 mm, ovate-trullate rostellum margin minutely erose 1.4–1.5 mm long, anther cap rostrate 2.5 mm long, stigma with calli-like protrusions and two fiber-like protrusions on the adaxial side of the column, the fibers 1.1–1.4 mm long. Pollinia 2, granular. Vicidium ellipsoid.

Additional specimens examined. INDONESIA. West Kalimantan: Kabupaten Kapuas Hulu, Betung Kerihun National Park, Sungai (River) Menyakan, upstream of Sg. Sibau, 01°13.825'N; 113°03.963'E, 331 m alt. to 01°13.82167'N; 113°03.9367'E, 331 m alt., 5 January 2011, H. Tsukaya, H. Okada and H. Nagamasu #1040 (BO, TI); Kabupaten Kapuas Hulu, Betung Kerihun National Park, on a ridge the junction of Sungai (River) Sibau and Sungai Minyak, from 01°12.5567'N; 113°04.35'E, 298 m alt. to 01°12.325'N; 113°04.433'E, 341 m alt., 1 January 2012, H. Tsukaya, H. Okadada and A. Soejima HT250 (BO, TI).

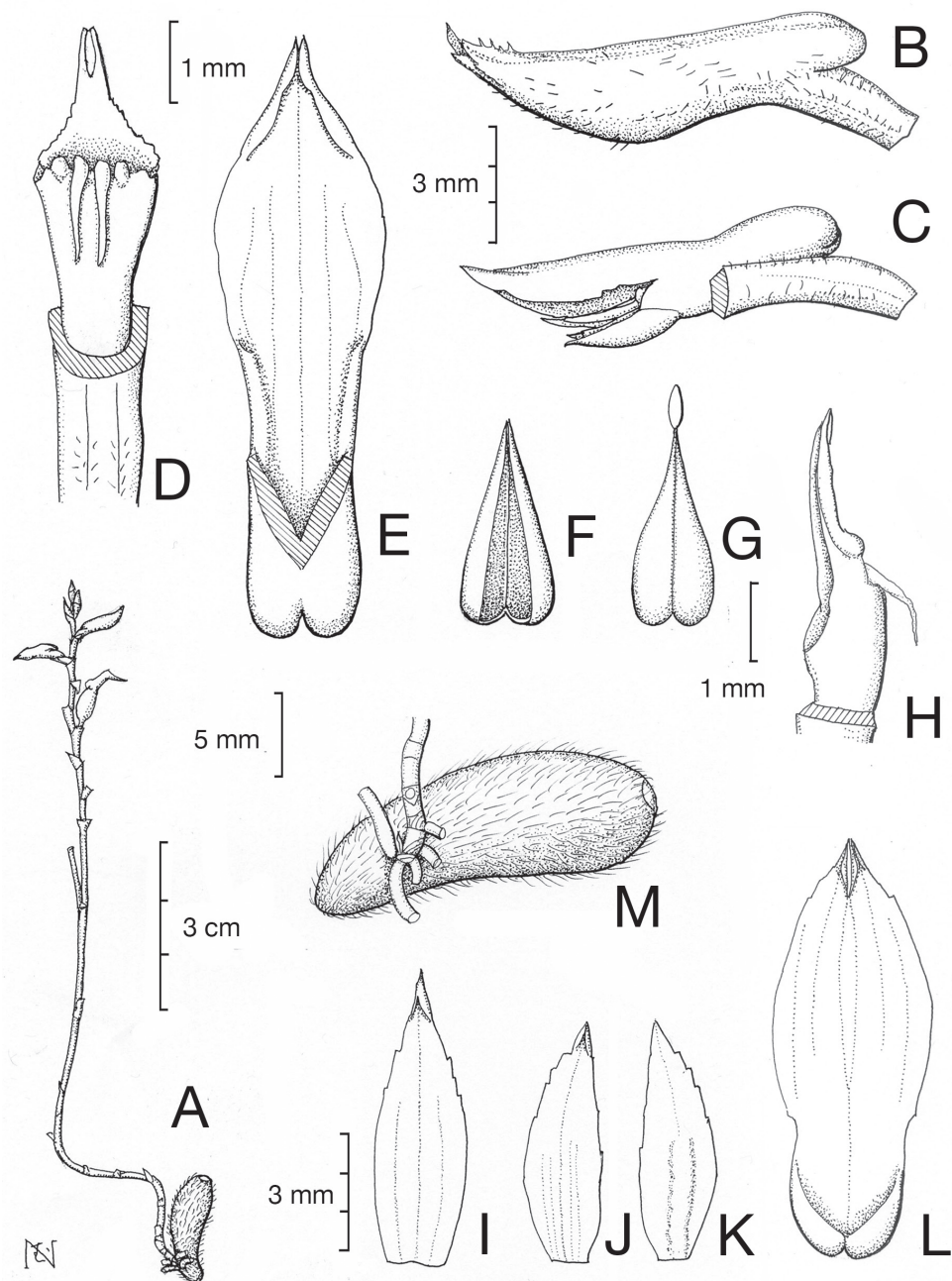


Figure 1. Drawing of *Tropidia connata* J.J.Wood & A.L.Lamb. **A** Gross morphology **B** Lateral view of unopened flower **C** Lateral view of the column with lip **D** Dorsal view of the column **E** Lip **F** Anther cap **G** Pollinia **H** Lateral view of the column **I** Dorsal sepal **J, K** Lateral petal of abaxial (**J**) and adaxial (**K**) side. **L** Lateral sepal **M** Tuber with basal part of inflorescence with short filamentous roots. Scales 3 cm (**A**), 3 mm (**B, C, I–K**), 1 mm (**D–H**), 5 mm (**M**). Drawing by Ms. Mutsuko Nakajima based on the specimen HT245.

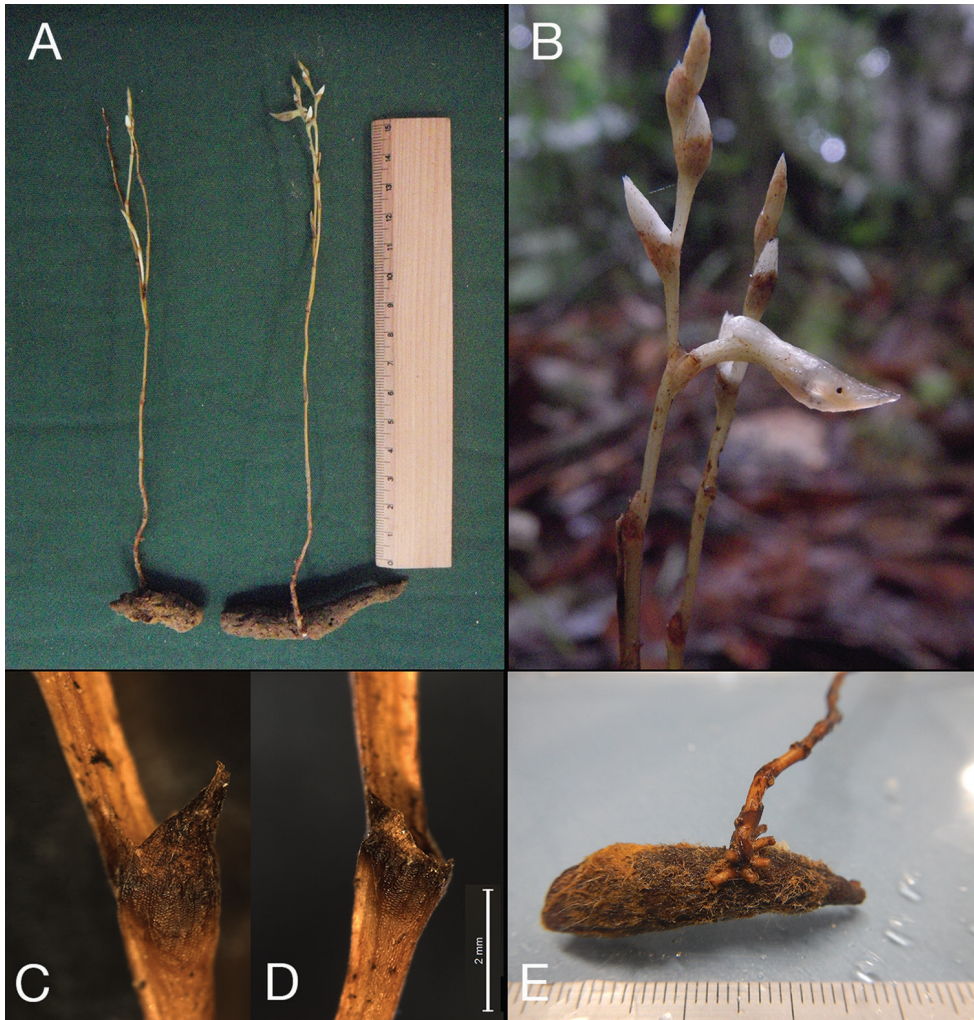


Figure 2. *Tropidia connata* J.J.Wood & A.L.Lamb. **A** Gross morphology of two individuals (specimen number 1040, collected in January 5, 2011). Scale in cm **B** Close-up of the inflorescence **C, D** Part of inflorescent stem with bracts showing before (**C**) and after (**D**) the detachment of the apical part at the abscission zone **E** Subterrestrial part of the flowering individual. Divisions of scale in mm.

Acknowledgements

The authors wish to thank the Secretariat of Permission for Foreign Research, The Ministry of Research and Technology, Republic of Indonesia (RISTEK) for kindly giving us the permission to conduct the expeditions in West Kalimantan. We would like to thank the curators and collaborators at the Indonesian Institute of Science (LIPI) for kindly supporting the study in the Betung Kerihun National Park, West Kalimantan. We also thank Dr Hiroshi Okada of Osaka City University, Dr Hidetoshi Nagamasu of Kyoto University, Dr Akiko Soejima of Kumamoto University, Dr Dedy Daernadi of

LIPI, Mr Ujang Hapid of Herbarium Bogoriense (BO), Mr Mustarr Udin, Suherman, Jon, Anong, Mazid, and Eddy for helping to conduct the botanical surveys during the expedition. Mr Arief Hidayat of Herbarium Bogoriense kindly guided us through the complex procedure of obtaining research permission. We are grateful to Mutsuko Nakajima for making the beautiful and very helpful illustration of *Tropidia connata*. Prof. Jin Murata, Dr Tetsuo Ohi-toma at the Botanical Gardens of the Univ. Tokyo, Dr Jorinde Nuytinck at Naturalis Biodiversity Center and Ben Gable at Leiden University are also appreciated for reviewing the first draft of this manuscript. The last author was financially supported by Grants-in-Aid from the Asahi Glass Foundation.

References

- Chun-Kuei L, Tsan-Piao L, Mo-Shih T (2013) *Tropidia namasiae*, a new species of Orchidaceae (Epidendroideae, Tropidieae) from southwestern Taiwan. *Novon: A Journal for Botanical Nomenclature* 22.4 : 424–427. <http://dx.doi.org/10.3417/2011003>
- Imhof S, Massicotte HB, Melville LH, Peterson RL (2013) Subterranean Morphology and Mycorrhizal Structures. *Mycoheterotrophy: The Biology of Plants Living on Fungi*. Springer Publishing, New York, 157–214. https://doi.org/10.1007/978-1-4614-5209-6_4
- Lin W, Huang L, Lin T (2006) Newly discovered native orchids of Taiwan. *Taiwania* 51(3): 162–169. [https://doi.org/10.6165/tai.2006.51\(3\).162](https://doi.org/10.6165/tai.2006.51(3).162)
- Thiers B (continuously updated) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/science/ih/>
- Tsukaya H, Okada H (2005) *Thismia mullerensis* (Burmanniaceae), a new species from Muller Range, central Kalimantan. *Acta Phytotaxonomica et Geobotanica* 56.2: 129–133. <http://ci.nii.ac.jp/naid/110006318630/>
- Tsukaya H, Okada H (2012a) A new species of *Thismia* (Thismiaceae) from West Kalimantan, Borneo. *Systematic Botany* 37: 1–5. <https://doi.org/10.1600/036364412X616639>
- Tsukaya H, Okada H (2012b) A new variety of *Didymoplexis cornuta* (Orchidaceae) from West Kalimantan, Borneo. *Acta Phytotaxonomica et Geobotanica* 62: 89–93. <http://ci.nii.ac.jp/naid/110009470708/>
- Tsukaya H, Okada H (2012c) A color variation of *Epirixanthes* species (Polygalaceae) found in West Kalimantan, Borneo, Indonesia. *Acta Phytotaxonomica et Geobotanica* 62: 95–97. <http://ci.nii.ac.jp/naid/10031083316/>
- Tsukaya H, Okada H (2013a) A new species of *Sciaphila* Blume (Triuridaceae) from Kalimantan, Borneo, with a new record from Borneo. *Systematic Botany* 38: 600–605. <https://doi.org/10.1600/036364413X670476>
- Tsukaya H, Okada H (2013b) A new species of *Lecanorchis* Blume (subfamily Vanilloideae, Orchidaceae) from Kalimantan, Borneo. *Systematic Botany* 38: 69–74. <https://doi.org/10.1600/036364413X662079>

- Tsukaya H, Nakajima M, Okada H (2011) *Kalimantanorchis*: a new genus of mycotrophic orchid from West Kalimantan, Borneo. Systematic Botany 36: 49–52. <http://dx.doi.org/10.1600/036364411X553117>
- Wood JJ, Cribb PJ (1994) Checklist Orchids Borneo. Royal Botanic Gardens Kew, London, 47–49.
- Yeh C, Leou C, Yeh C (2009) A new species of *Tropidia* (Orchidaceae) from Southern Taiwan. Taiwaniana, 54(2): 140–144. [https://doi.org/10.6165/tai.2009.54\(2\).140](https://doi.org/10.6165/tai.2009.54(2).140)

Taxonomic study on Japanese *Salvia* (Lamiaceae): Phylogenetic position of *S. akiensis*, and polyphyletic nature of *S. lutescens* var. *intermedia*

Atsuko Takano¹

¹ Division of Natural History, Museum of Nature and Human Activities, Hyogo. Yayoigaoka 6, Sanda, Hyogo 669-1546, Japan

Corresponding author: Atsuko Takano (takano@hitohaku.jp)

Academic editor: E. Fischer | Received 7 February 2017 | Accepted 8 May 2017 | Published 5 June 2017

Citation: Takano A (2017) Taxonomic study on Japanese *Salvia* (Lamiaceae): Phylogenetic position of *S. akiensis*, and polyphyletic nature of *S. lutescens* var. *intermedia*. *PhytoKeys* 80: 87–104. <https://doi.org/10.3897/phytokeys.80.11611>

Abstract

Both *Salvia akiensis* and *S. lutescens* (Lamiaceae) are endemic to Japan. *Salvia akiensis* was recently described in 2014 in the Chugoku (= SW Honshu) region, and each four varieties of *S. lutescens* distributed allopatrically. Among varieties in *S. lutescens*, var. *intermedia* show a disjunctive distribution in the Kanto (=E Honshu) and Kinki (= W Honshu) regions. Recent field studies of *S. lutescens* var. *intermedia* revealed several morphological differences between the Kanto and Kinki populations. Here, I evaluated these differences among *Salvia lutescens* var. *intermedia* and its allies with morphological analysis and molecular phylogenetic analyses of nuclear ribosomal DNA (internal and external transcribed spacer regions) and plastid DNA (*ycf1-rps15* spacer, *rbcL*, and *trnL-F*) sequences. Both morphological analysis and molecular phylogenetic analyses showed that *S. lutescens* var. *intermedia* from the Kinki region and var. *lutescens* were closely related to each other. However, var. *intermedia* from the Kanto region exhibited an association with *S. lutescens* var. *crenata* and var. *stolonifera*, which also grew in eastern Japan, rather than var. *intermedia* in the Kinki region. These results indicated that *S. lutescens* var. *intermedia* is not a taxon with a disjunctive distribution, but a combination of two or more allopatric taxa. Present study also suggested that *S. akiensis* was most closely related to *S. omerocalyx*.

Keywords

cpDNA, Lamiaceae, nrDNA, Phylogenetics, *Salvia akiensis*, *Salvia lutescens*

Introduction

The genus *Salvia* L. (tribe Mentheae) is the largest genus in Lamiaceae; it comprises nearly 1,000 species. *Salvia* has radiated extensively into three regions of the world: Central and South America (500 spp.), West Asia (200 spp.), and East Asia (100 spp.) (Alziar, 1988–1993). In Japan, twelve species, eight varieties, and one putative hybrid have been described since Thunberg's (1784) first account. The genus was classified into three subgenera (subg.), including *Allagospadonopsis* Briq., *Salvia*, and *Sclarea* (Moench) Benth. (Hihara et al. 2001, Inoue 1997, Murata and Yamazaki 1993, Takano et al. 2014). Most of the taxa are endemic to Japan, with the exception of *S. japonica* Thunb., *S. nipponica* Miq. and *S. plebeia* R. Br. (Murata and Yamazaki 1993).

There are four varieties known in *S. lutescens* (Koidz.) Koidz.: var. *crenata*, var. *intermedia*, var. *lutescens*, and var. *stolonifera* (Murata 1952, Yonekura and Kajita 2003 onwards). Fukuoka and Kurosaki (1982) noticed distribution of each taxon does not overlap and clarified that the distribution of var. *crenata* on the Japan Sea side of Central to Northern Honshu, var. *stolonifera* on the Pacific side of Central Honshu, var. *lutescens* around the Suzuka Mountain range (Mie Pref., W Honshu), and the disjunctive distribution of var. *intermedia* in the Kanto (E Honshu) and Kinki regions (W Honshu) based on herbarium works.

Takano and Okada (2011) conducted molecular phylogenetic analyses of Japanese *Salvia* and found that the species were distributed among three subclades: (1) *S. plebeia* (subg. *Sclarea*), (2) subg. *Salvia*, and (3) subg. *Allagospadonopsis*. They also found four varieties of *S. lutescens* that did not form a monophyletic group; instead, they were dispersed among several clades in phylogenetic trees, based on both plastid DNA (cpDNA) and nuclear ribosomal DNA (nrDNA) data, and their topologies were not concordant with each other. In addition, they became paraphyletic in the phylogenetic trees based on combined cpDNA and nrDNA data (Takano and Okada 2011). Furthermore, during a recent field survey, I noticed that *S. lutescens* var. *intermedia* in the Kanto and Kinki regions had different morphological characteristics. The basal part of the anther connective was generally glabrous in the Kanto population, but it was pilose in the Kinki population. Also, in the Kanto population, the stalk of the inflorescence declinated toward the ground after flowering, and it typically became proliferous; in contrast, in the Kinki population, the inflorescence grew erect, and it was never proliferous.

Recently, a new species of Japanese *Salvia*, *S. akiensis* A. Takano, T. Sera et Kurosaki has been described from Shimane and Hiroshima Prefectures (Takano et al. 2014). At the moment, this species shows disjunctive distribution, ca. 40 km away from each, and the habitat is also very different between Hiroshima and Shimane: it grows among bamboo by roadsides and on slopes below evergreen mixed forests and plantations in Shimane (Sakoda et al. 2014), but it is found in moist, shallow soil on rock walls by streams in deciduous forests in Hiroshima (Takano et al. 2014). Therefore, it may wonder if the species be monophyletic. Takano et al. (2014) discussed relationships among *S. akiensis*, *S. isensis* Nakai ex H. Hara, *S. lutescens* and *S. omerocalyx* Hayata

based on morphological characters, but molecular phylogenetic position of *S. akiensis* remains unclear.

As a step toward taxonomic revision of variety of *S. lutescens* and to confirm monophyly and phylogenetic position of *S. akiensis*, morphological and molecular phylogenetic analyses were conducted. Takano and Okada (2011) followed the Murata and Yamazaki (1993) system in which treated var. *intermedia* as a forma f. *lobatocrenata* and var. *lutescens* as f. *lutescens*, however, here I follow the Murata (1952) system (=Y-list, Yonekura and Kajita 2003 onwards), and each infraspecific taxon of *S. lutescens* is treated as a variety.

Materials and methods

Morphological analyses on *S. lutescens* in herbaria

Murata (1952) studied morphological variations in the plants of subgen. *Allagospadonopsis* in Japan and found hairiness, number or shape of leaflets, presence /absence of glandular hairs were so variable and could not be used as diagnostic characters. Diagnostic characters separated each variety of *S. lutescens* are indumentums of the basal part of the anther connective and floral color (Nakai 1950, Murata 1952). Among varieties, var. *lutescens* shows pale yellow flowers and pilose at the base of anther connective, var. *intermedia* shows deep violet corolla and pilose at the base of anther connective, var. *crenata* does purple corolla and glabrous base of anther connective. Floral color and indumentums of var. *stolonifera* is same as var. *crenata*, however, var. *stolonifera* extends its stolon after anthesis (Nakai 1950). Since it is difficult to know exact floral color by examining dry specimens, the indumentums at the base of the anther connective were observed for glabrouisity in selected specimens, which bore at least several flowers. A total of 89 specimens of *S. lutescens* var. *intermedia*, including its syntypes, of the 34 specimens are from Kanto region and 55 from Kinki, were examined in the following herbaria: the Museum of Nature and Human Activities, Hyogo (HYO); the Kanagawa Prefectural Museum (KPM); Kyoto University (KYO); Tokyo Metropolitan University (MAK), the Osaka Museum of Natural History (OSA), and The University of Tokyo (TI) (Appendix 1). Additionally, all the specimens of *S. lutescens* var. *lutescens* including its holotype at KYO were examined on the same characters, since no information on that character is available.

DNA extraction, PCR, and DNA sequencing

The protocols for DNA extraction, polymerase chain reaction (PCR), purification, and DNA sequencing were described previously by Takano and Okada (2011). The PCR conditions and the PCR and sequencing primers for *rbcL*, the *trnL-F* intergenic spacer region of cpDNA (*trnL-F*), and the internal transcribed spacer (ITS) region of nuclear

ribosomal DNA (nrDNA) were also described previously by Takano and Okada (2011). To amplify in the *ycf1-rps15* spacer region found in cpDNA (*ycf1-rps15*), *5711f* and *rps15r* (both from Drew and Sytsma 2011) were used as PCR primers in PCR assays, and ETS-*bdfl* (Drew and Sytsma 2011) and 18S-E (Baldwin and Markos 1998) were used to amplify the external transcribed spacer (ETS) sequence from 18S-26S ribosomal DNA. The four PCR primers were also used for sequencing. The PCR conditions for amplifying the two loci were: denaturation at 95 °C for 3 min, followed by 40 cycles at 95 °C for 30 s, 54 °C for 30 s, and 72 °C for 30 s; and a final extension at 72 °C for 5 min.

Sequence alignment and phylogenetic analysis

Raw sequence data were assembled and edited manually, with BioEdit software (ver. 7.2.5 Hall 1999)

DNA sequences were aligned with the CLUSTALW 1.83 software package, with default settings and multiple alignments (Thompson et al. 1994). Alignments of the *rbcL*, *trnL-F*, and *ycf1-rps15* sequences of cpDNA, and the ITS and ETS sequences of nrDNA were combined. Gaps were deleted.

Compared to Takano and Okada (2011), the ETS (Baldwin and Markos 1998) and *ycf1-rps15* of cpDNA (Dong et al. 2015) were newly sequenced for all samples. Further, two individuals of *S. akiensis* and three of *S. lutescens* var. *intermedia*, three of *S. lutescens* var. *crenata*, and one each of *S. isensis*, *S. japonica* var. *japonica*, *S. lutescens* var. *lutescens*, and *S. plebeia* were newly added for the analysis. The sampling sites of *S. lutescens* group were shown in Fig. 1. A total of 36 individuals of *Salvia* were used, including all the *Salvia* taxa from Japan and one Taiwanese *Salvia* (*S. arisanensis* Hayata). *Salvia polystachya* M. Martens et Galeotti and *S. plebeia* were selected as outgroup; the former species belonged to clade II sensu Maria and Classen-Bockhoff (2014), which became a sister to group IV and contained the East Asian *Salvia*; the latter species became a sister to a species of the subgenus *Allagospadonopsis* and *Salvia* (Hu 2015). Materials, accession numbers for the sequences, vouchers, and references to the literature are presented in Table 1. The sampling sites for the varieties of *S. lutescens* are shown in Fig. 1.

The incongruence length difference (ILD) test (Farris et al. 1994) was used to evaluate congruence between the chloroplast and the nuclear data sets. 100 replications were performed using PAUP*4.010b (Swofford 2002). As the ILD test ($P < 0.01$) suggested incongruence between the two datasets, and the topologies also exhibited discordance, I performed separate analyses for the cpDNA and the nrDNA data. Maximum Likelihood (ML) and Bayesian inference (BI) were used. Nucleotide substitution model parameters were determined for each partition by gene was evaluated with KAKUSAN 4.0 (Tanabe 2007), and the corrected Akaike information criterion (AICc) (Sugiura 1978) was used for model selection. For the cpDNA partitions KAKUSAN suggested the HKY85 (*rbcL*) and GTR+G (*trnL-F*, *ycf1-rps15*spacer) models, and the HKY85 model for ETS and GTR+G model for ITS for the nrDNA partitions. The ML

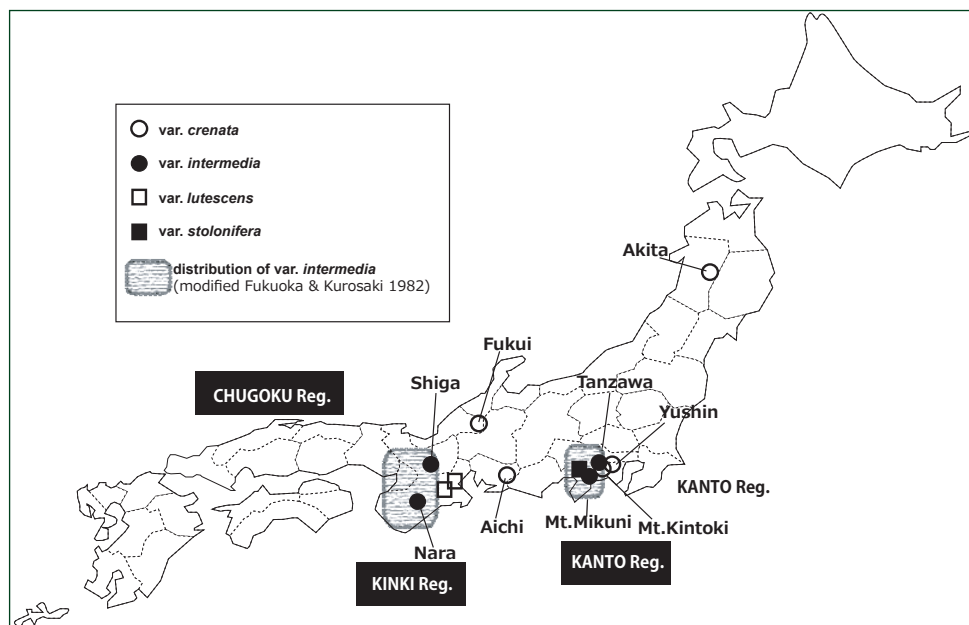


Figure 1. Map of Japan shows the sites where *Salvia lutescens* taxa were sampled. Open circle = var. *crenata*, filled circle = var. *intermedia*, open square = var. *lutescens*, filled square = var. *stolonifera*. The areas encircled with dotted lines show the Kinki and Kanto regions, as indicated.

analyses were completed using TREEFINDER version March 2011 (Jobb et al. 2004). A replicated (500 iterations) partitioned analysis was performed with bootstrap (1000 rounds) using AICc separated model for nrDNA dataset and AICc proportional model for cpDNA dataset. Bayesian evolutionary analysis using partitioned datasets were run in BEAST v.1.8.3 (Drummond et al. 2012, Heled and Drummond 2010) with 20 million Markov Chain Monte Carlo (MCMC) iterations, under an uncorrelated relaxed clock (Drummond et al. 2006), Yule process of speciation with a random starting tree for each partition. Convergence of the chains was checked using the program Tracer 1.6 (Rambaut et al. 2014). High effective sample sizes were observed for all parameters (posterior ESS values > 200 for the combined analyses). Maximum clade credibility trees with divergence times means and 95% highest probability densities (HPDs) were produced using Tree Annotator (Drummond et al. 2012).

Results

Morphological characteristics

Among the 89 specimens of *S. lutescens* var. *intermedia* examined, 52 specimens from the Kinki region were pilose at the base of the anther connective (Fig. 2), and no speci-

Table 1. Taxa, Genbank accession number, and voucher specimens/references used in this study. Newly sequenced data are shown bold.

Name	Pop. Code	<i>rbcL</i>	<i>trnL-F</i>	<i>ycf1-rps15</i>	ETS	ITS	Voucher / References
<i>S. akiensis</i> A.Takano, T.Sera et Kurosaki	HIR (Hiroshima Pref.)	LC124176	LC124188	LC060529	LC060825	LC060729	A.Takano and N.Kurosaki with T.Sera 130606-1 (HYO)
	S1 (Shimane Pref.)	LC124177	LC124189	LC060530	LC060826	LC060728	M.Sakoda et al. 1 (HYO,KYO)
<i>S. arisanensis</i> Hayata		AB295063	AB295074	LC060531	LC060827	AB295085	Sudarmono and Okada (2007)
<i>S. glabrescens</i> (Franch. et Sav.) Makino							
var. <i>glabrescens</i>	FS (Wakasa, Fukui)	AB541134	AB541148	LC060532	LC060828	AB541120	Takano and Okada (2011)
var. <i>repens</i> (Koidz.) Kurosaki	KY (Kyoto)	AB295064	AB295075	LC060533	LC060829	AB295086	Sudarmono and Okada (2007)
<i>S. izensis</i> Nakai ex Hara	MIE	AB266221	AB266231	LC060534	LC060830	AB266241	Sudarmono and Okada (2007)
	AICHI	LC124178	LC124190	LC060535	LC060831	LC060730	A-200933 (living material at Hiroshima Bot.Gard. Originally from Owariasahi city, Aichi Pref.)
<i>S. japonica</i> Thunb.							
f. <i>albiflora</i> Hiyama		AB266220	AB266230	LC060536	LC060832	AB260240	Sudarmono and Okada (2007)
f. <i>japonica</i>	Osaka	AB266219	AB266229	LC060537	LC060833	AB266239	Sudarmono and Okada (2007)
f. <i>japonica</i>	Gorenba	LC124179	LC124191	LC060538	LC060834	LC060731	A.Takano 140806-5 (HYO)
f. <i>longipes</i> (Nakai) Sugimoto		AB266218	AB266228	LC060539	LC060835	AB266238	Sudarmono and Okada (2007)
<i>S. koyamae</i> Makino		AB541128	AB541142	LC060540	LC060836	AB541114	Takano and Okada (2011)
<i>S. lutescens</i> Koidz.							
var. <i>crenata</i> (Makino) Murata	AICHI	AB266223	AB266233	LC060541	LC060837	AB266243	Sudarmono and Okada (2007)
	Yushin	AB353202	AB353198	LC060542	LC060838	AB353206	Takano and Okada (2011)
	Akita	LC124180	LC124193	LC124205	LC124201	LC124203	Y. Horihii, S. Nishida et al. 2015026 (HYO)
	Fukui	LC124181	LC124194	LC124204	LC124200	LC124202	A.Takano 150702-1a (HYO)
	Nara	LC124182	LC124195	LC060544	LC060840	AB295097	Sudarmono and Okada (2007)
var. <i>intermedia</i> (Makino) Murata	Shiga	LC124183	LC124196	LC060546	LC060842	LC060735	A.Takano 140821-1 (HYO)
	Mr.Mikuni	LC124184	LC124197	LC060547	LC060843	LC060733	A.Takano 140806-4 (HYO)
	Tanzawa	LC124185	LC124198	LC060548	LC060844	LC060734	A.Takano 140622-2 (HYO)
	MIE	AB266222	AB266232	LC060549	LC060845	AB266242	Sudarmono and Okada (2007)
var. <i>lutescens</i> Koidz.	Aoyama	LC124186	LC128192	LC060550	LC060846	LC060737	a201241 (living material at Hiroshima Bot.Gard. Originally from Aoyama Kogen, Mie Pref.)

Name	Pop. Code	<i>rbcL</i>	<i>trnL-F</i>	<i>ycf1-rps15</i>	ETS	ITS	Voucher / References
<i>var. stolonifera</i> G.Nakai		AB541139	AB541153	LC060551	LC060847	AB541125	Takano and Okada (2011)
<i>S. nipponica</i> Miq.							
<i>var. nipponica</i>	TOKU (Tokushima)	AB541132	AB541146	LC060552	LC060848	AB541118	Takano and Okada (2011)
	KUMA (Kumamoto)	AB541127	AB541141	LC060553	LC060849	AB541113	Takano and Okada (2011)
<i>var. kisoensis</i> K. Imai	NAK	AB541136	AB541150	LC060554	LC060850	AB541122	Takano and Okada (2011)
<i>S. omerocalyx</i> Hayata							
<i>var. omerocalyx</i>	HI (Hidaka, Hyogo)	AB353204	AB353196	LC060555	LC060851	AB353200	Takano and Okada (2011)
	HYO (Yabu, Hyogo)	AB353205	AB353197	LC060556	LC060852	AB353201	Takano and Okada (2011)
<i>var. prostrata</i> Satake		AB541138	AB541152	LC060557	LC060853	AB541124	Takano and Okada (2011)
<i>S. pygmaea</i> Matsum.							
<i>var. pygmaea</i>		AB295072	AB295083	LC060558	LC060854	AB295094	Sudarmono and Okada (2007)
<i>var. simplicior</i> Hatus. ex T.Yamaz.		AB541140	AB541154	LC060559	LC060855	AB541126	Takano and Okada (2011)
<i>S. nanzaniana</i> Makino		AB287373	AB287374	LC060560	LC060856	AB287375	Sudarmono and Okada (2007)
<i>S. sakuensis</i> Naruh. et Hihara		AB541129	AB541143	LC060561	LC060857	AB541116	Takano and Okada (2011)
Outgroup							
<i>S. plebeia</i> R.Br.	KIZU	AB295073	AB295084	LC060563	LC060858	AB295095	Sudarmono and Okada (2007)
	KAMI	LC124187	LC124199	LC060562	LC060859	LC060738	A. Takano and N. Kurosaki 090607-2 (HYO)
<i>S. Polystachya</i> M. Martens et Galeotti		AY570435	JF301399	JF289067	JF301334	JF301356	Drew and Systma (2011)

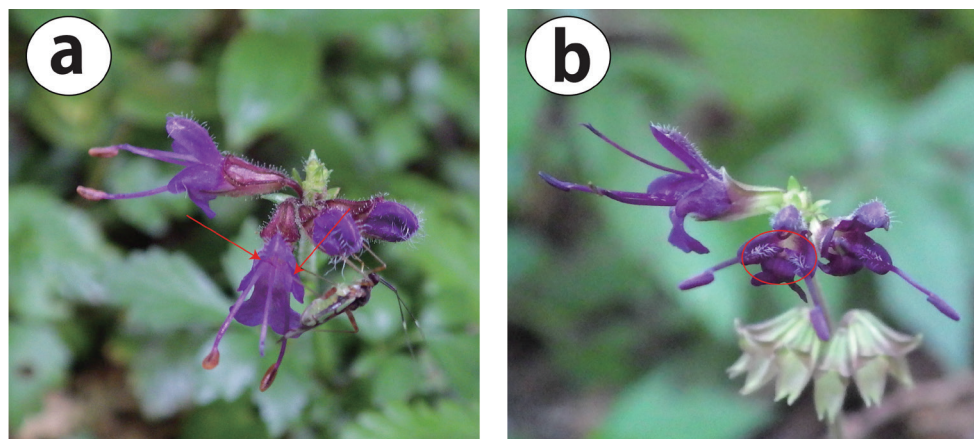


Figure 2. Photographs of *S. lutescens* var. *intermedia* flowers. **a** Flower of *A. Takano 140806-4-2* (HYO), from Mt. Mikuni, Susono-shi, Shizuoka Pref. (Kanto region). Arrows indicate the base of the anther connective. No hairs are visible. **b** Flower of *A. Takano 140813-1* (HYO), from Mt. Yamatokatsuragi, Gose-shi, Nara Pref. (Kinki region). The red open circle indicates the base of the anther connective. White hairs are visible.

mens from the Kanto region shared this characteristic (Appendix 1). Ten specimens collected from the Kanto region had at least one, but less than 10 hairs. Twenty-four specimens from the Kanto region (Fig. 2) and three specimens from the Kinki region (*Y.Kato s.n.* [KYO], *T.Kobayashi 23369* [KYO], and *A. Takano 140821-1* [HYO]) were glabrous at the base of the anther connective. However, a duplicate of *T.Kobayashi 23369* (KYO) examined at HYO was pilose at the base of the anther connective (Appendix 1).

Totally, 18 specimens of *S. lutescens* var. *lutescens* were deposited at KYO and examined, 13 of these had pilose at the base of the anther connective (Appendix 1). Four of these had no flowers, and only one specimen, *M.Hara s.n.*, collected from Mt. Takami, Maze-Mura, Iinan-gun, Mie Pref. showed glabrousity.

Phylogenetic positions of Japanese taxa in the genus *Salvia*

A likelihood analysis using the concatenate cpDNA datasets (*rbcl*+*trnL-F*+*ycf1-rps15* spacer) for 36 individuals in 23 taxa resulted in a ML tree with $-\ln L = 5295.264$. The ML and Bayesian trees had similar topology; the Bayesian maximum clade credibility tree is shown with ML bootstrap (ML-BS) and Bayesian posterior probability (BI-PP) in Figure 4. The Japanese and Taiwanese species of subg. *Allagospadonopsis* formed a well supported clade (ML-BS/BI-PP, 100/0.97). Two subclades were found in the subg. *Allagospadonopsis* clade: (1) *S. japonica* + *S. pygmaea* + one *S. akiensis* + *S. arisanensis* + five individuals of *S. lutescens* in E Japan subclade, and (2) one *S. akiensis* (S1), two *S. isensis*, *S. lutescens* in Kinki + *S. ranzaniana* + two *S. lutescens* in the Kanto region

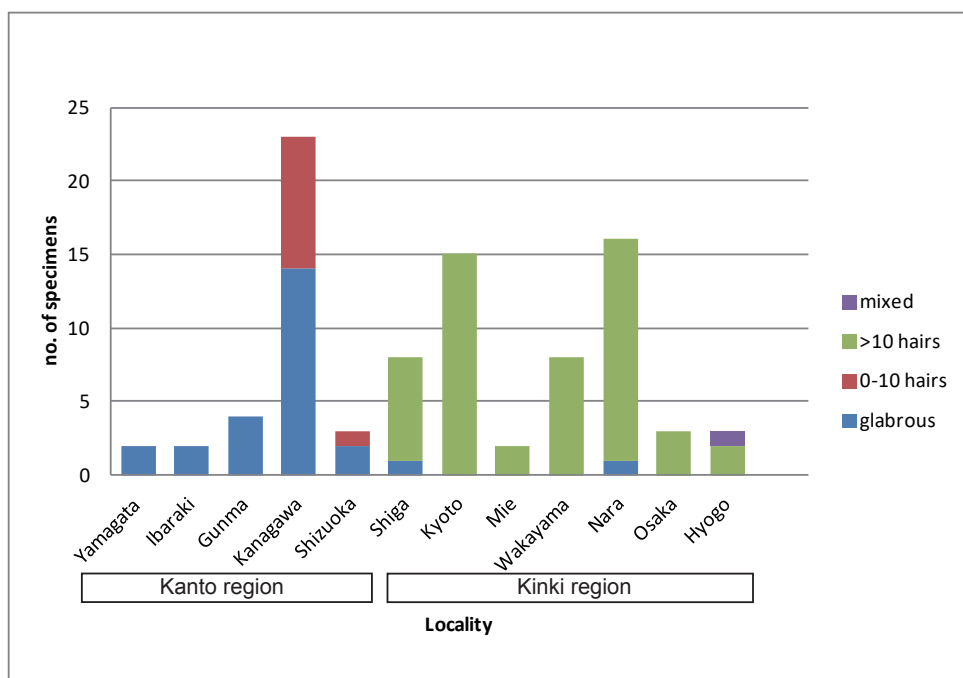


Figure 3. A graph shows the number of specimens examined indumentums at the base of anther connective.

+ *S. omerocalyx*. The latter group of taxa, minus the *S. omerocalyx* (HYO), consisted of a strongly supported subclade, with high ML-BS/BI-PP values (98/0.99). *S. lutescens* in E Japan were scattered between both subclades, but the *S. lutescens* in the Kinki region consisted a cluster with the weak support (–/0.70).

A concatenate nrDNA datasets (ETS+ITS) yielded a ML tree with $-\ln L = 3789.114$. The ML and Bayesian trees had similar topology; the Bayesian maximum clade credibility tree is shown with ML-BS and BI-PP in Figure 5. The Japanese and Taiwanese species of subg. *Allagospadonopsis* formed a well supported clade (ML-BS/BI-PP, 100/1.00). There were four subclades in the *Allagospadonopsis* clade: (1) *S. lutescens* group in E Japan + *S. isensis* (ML-BS/BI-PP, –/0.69), (2) *S. lutescens* in Kinki + *S. ranzaniana* (ML-BS/BI-PP, 61/0.57), (3) *S. arisanensis* + *S. omerocalyx* + *S. akiensis* (ML-BS/BA-PP, 76/0.99), and (4) one *S. lutescens* var. *crenata* + *S. japonica* + *S. pygmaea* (ML-BS/BA-PP, 58/0.97). Thus, *Salvia lutescens* and its allies apparently became polyphyletic. *Salvia ranzaniana* became a sister group to *S. lutescens* in the Kinki region but the ML-BS /BA-PP support was weak (61/0.57). *Salvia isensis* became a sister group to *S. lutescens* in the Kanto region with strong ML-BS/BA-PP support (86/1.00). *Salvia akiensis* formed a strongly supported subclade with *S. omerocalyx* group (89/1.00).

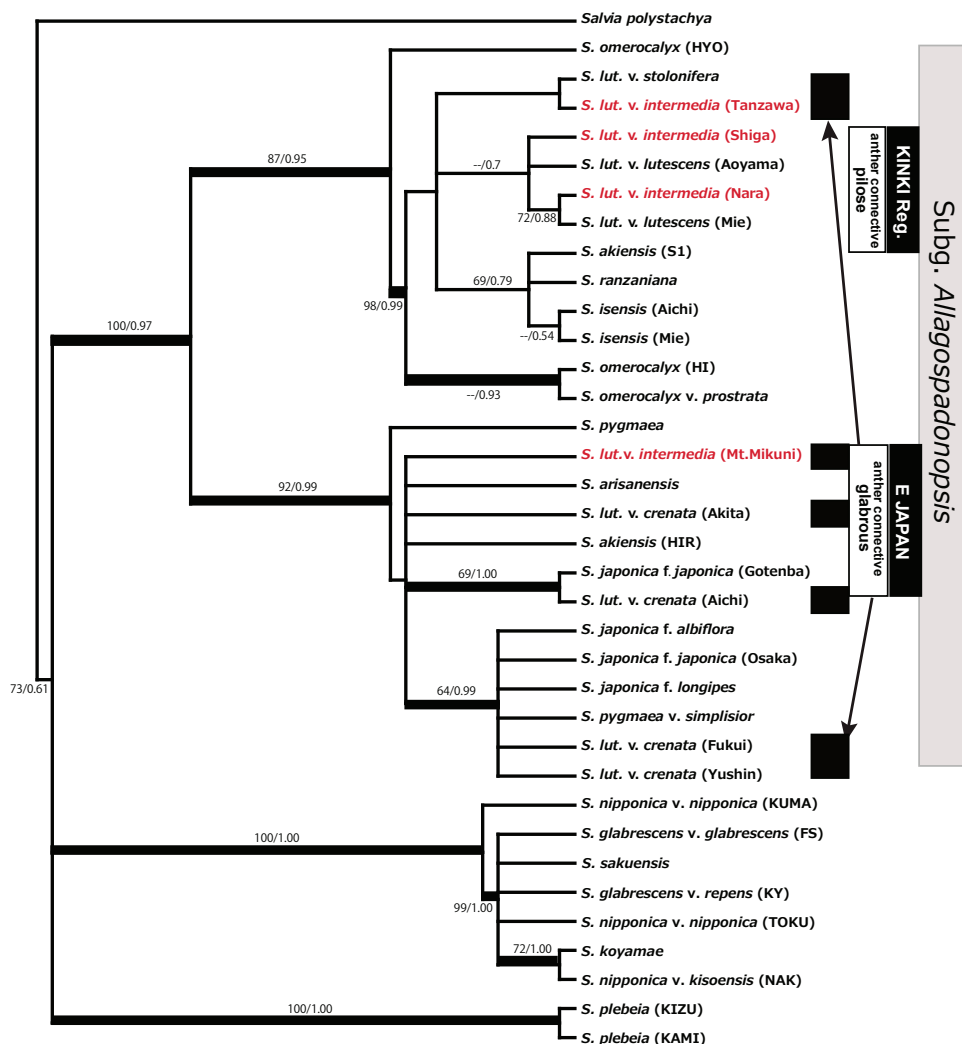


Figure 4. The Bayesian maximum cladocredibility tree derived from plastid DNA (concatenate dataset of *rbcL*, *trnL-F*, *ycf1-rps15*). ML-bootstrap/Bayesian PP numbers are shown near the corresponding branch. Thick lines denote a clade that was strongly supported, with ML-bootstrap and/or Bayesian-PP greater than 95 %. ML: maximum likelihood; PP: posterior probability.

Discussion

This study suggests that *S. lutescens* var. *intermedia* is polyphyletic. Four individuals of var. *intermedia*, two from the Kanto and two from the Kinki region fell into different subclades in both molecular phylogenetic trees using cpDNA and nrDNA datasets, although the two from the Kinki region were always in the same subclade (Figs 4, 5). The plants of var. *intermedia* from the Kanto region (Tanzawa and Mt. Mikuni) fell into the same subclade in the nrDNA tree together with var. *crenata*, var. *stolonifera*,

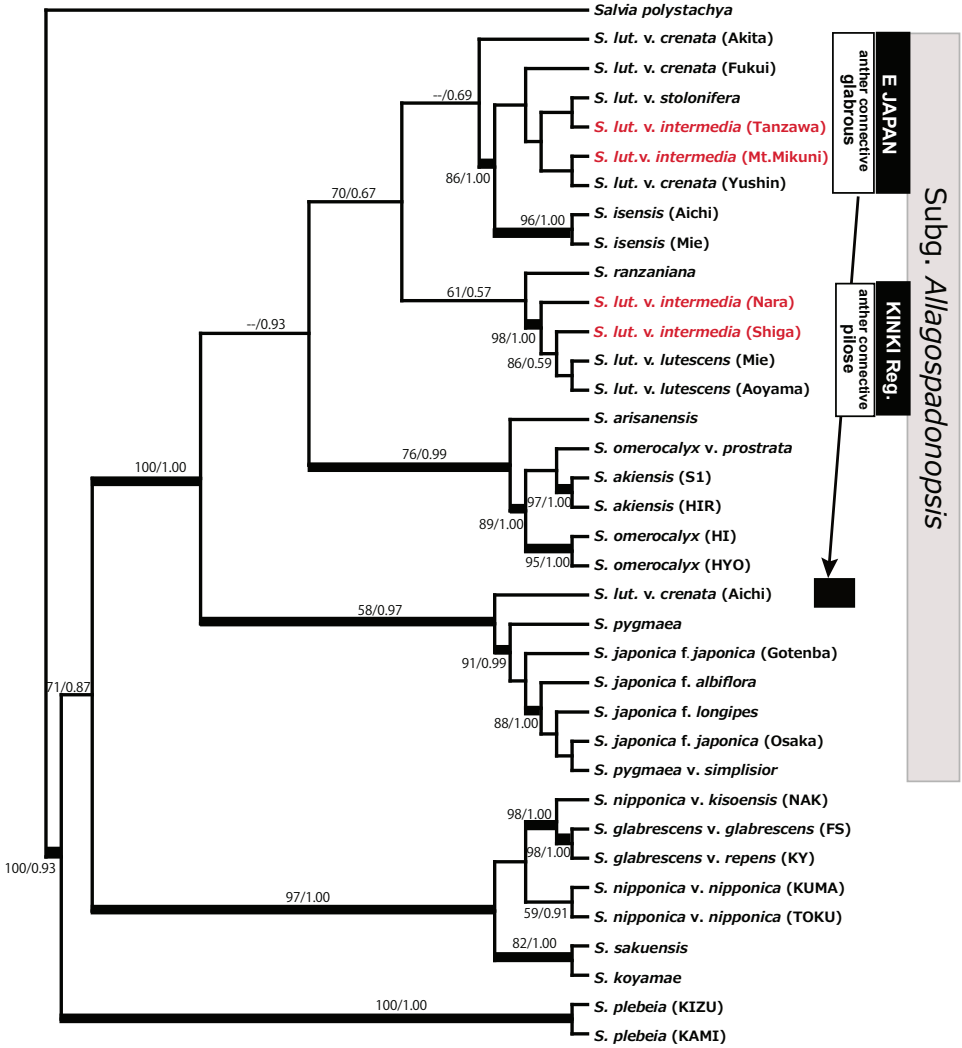


Figure 5. The Bayesian maximum clade credibility tree derived from nuclear ribosomal DNA (concatenate dataset of ETS and ITS). ML-bootstrap/Bayesian-PP numbers are shown above or below the corresponding branch. Thick lines denote a clade that was strongly supported with ML-bootstrap and/or Bayesian-PP values greater than 95 %. ML: maximum likelihood; PP: posterior probability.

and *S. isensis* whereas they fell into different subclades in the cpDNA tree. Such a contradiction might indicate that var. *intermedia* from the Kanto region have multiple origins, or might have originated via hybridization or introgressive gene flow between neighbouring taxa (e.g., Sudarmono and Okada 2007). The discordance between nr DNA and cpDNA data is common in the mint family (Trusty et al. 2004, Moon et al. 2010, Drew and Sytsma 2013, Deng et al. 2015), and chloroplast-based phylogeny often does not reflect their morphological relationships, which can be explained by

chloroplast capture (Rieseberg and Soltis 1991). Morphological analysis also supports the contention that var. *intermedia* is polyphyletic, as the specimens of var. *intermedia* studied showed in the indumentums at the base of the anther connective: pilose in the plants from the Kinki region, and glabrous in the plants from the Kanto region (Fig. 3). Therefore it is clear that var. *intermedia* from the Kinki region and the taxon from the Kanto region are different entities, suggesting that var. *intermedia* is not a taxon that shows disjunctive distribution, but is instead admixture of two or more biological entities. Additionally, as mentioned in introduction, after flowering the stalk of the inflorescence becomes declinate to ground and usually proliferous in case of the plants from the Kanto region, but never become declinate in the plants from the Kinki region. The indumentums at the base of anther connective is effective to select pollinators to avoid intrusion of insects which could not be effective pollinators (R. Classen-Bockhoff pers. Comm.) However, pollinators of var. *intermedia* in the Kinki and the Kanto region are not different (= *Bombus* (*Diversobombus*) *diversus diversus*, some Halictidae, and Syrphidae. Takano 2017). Habitat is also similar: half-shaded, on mesic soils along streamlet on the forest floor of deciduous forests. They might have begun to be diverged from each other after long geographical isolation.

On the contrary, present morphological and molecular phylogenetic analyses indicated that *S. lutescens* var. *lutescens* and var. *intermedia* from the Kinki region are closely related to each other. In molecular phylogenetic analysis, they formed a cluster in both cpDNA- and nrDNA trees, though ML-BP/BI-PP support was not strong in cpDNA tree. The morphological study revealed var. *lutescens* is pilose at the base of the anther connective: therefore, *S. lutescens* var. *intermedia* in the Kinki region share the same morphological status with var. *lutescens*. The distribution of var. *lutescens* is very near to that of var. *intermedia* in the Kinki region (Mie, Shiga, Nara Prefs.), although var. *lutescens* and populations of the Kinki regions of var. *intermedia* have never been found to grow together.

Salvia lutescens var. *intermedia* in the Kanto region may be more closely related to var. *crenata* and var. *stolonifera*. Murata (1952) mentioned that the base of anther connective is glabrous in var. *stolonifera* and var. *crenata*. The present study revealed that var. *intermedia* in the Kanto region shares this character with those two taxa. *Salvia lutescens* var. *intermedia* in the Kanto region formed a strongly supported subclade with var. *crenata*, var. *stolonifera* and *S. isensis* in nrDNA phylogenetic tree. In the cpDNA phylogenetic tree, *S. lutescens* var. *intermedia* from the Kanto region (Mt. Mikuni) was included in the subclade containing *S. akiensis*, *S. japonica*, *S. lutescens* var. *crenata*, and *S. pygmaea* whereas *S. lutescens* var. *intermedia* (Tanzawa) formed a subclade with var. *stolonifera* and was included in the subclade containing *S. akiensis*, *S. omerocalyx*, *S. ranzaniana*, and *S. lutescens* var. *intermedia* from the Kinki + *S. isensis*. These findings suggest a close relationship among var. *crenata*, var. *stolonifera*, and var. *intermedia* from the Kanto region. Var. *intermedia* from the Kanto region may belong to var. *stolonifera* and var. *crenata*. The identity of var. *intermedia* and other varieties of *S. lutescens* are needed to be re-evaluated, and further study is necessary towards revision of varieties of *S. lutescens*.

The phylogenetic analyses also suggest that *S. akiensis* comprises a monophyletic group, as indicated by nrDNA tree, and that most of the species allied to *S. akiensis* was the *S. omerocalyx* group. *Salvia akiensis* and *S. omerocalyx* group comprised a subclade in nrDNA (ML-BS/BI-PP: 89/1.00). These two taxa did not form a subclade in cpDNA, but it may be of introgression/chloroplast capture /hybridization as mentioned above. In contrast, *S. akiensis* and *S. omerocalyx* share following characters: bearing the largest flowers among species in the subg. *Allagospadonopsis*, flower from May to June, and exhibit gynodioecy (Takano 2013; Takano et al. 2014). These characters are assumed to be synapomorph.

Acknowledgements

I am grateful to Teruo Katsuyama (KPM), Nobuhira Kurosaki (Hyogo Museum/ University of Hyogo), Masahiro Sakoda (Chugai Technos Co.), Tetsuya Sera (Hiroshima City Agricultural Committee Secretariat), and Sachiko Nishida (Nagoya Univ.) for providing plant materials, references, and information. Dr. Hiroshi Okada (University of Hyogo), and anonymous reviewers provided constructive comments on an early draft of the manuscript. I also thank the curators of KPM, KYO, MAK, OSA, and TI, for allowing me to use their collections and facilities. This study was supported, in part, by the New Technology Development Foundation and by a Grant-in-Aid for Scientific Research (C) (no. 26440227) from the Japan Society for the Promotion of Science (JSPS).

References

- Alziar G (1988-1993) Catalogue synonymique des *Salvia* L. du monde (Lamiaceae). I.-VI. Bioscosme Mesogéen 5(3-4): 87–136; 6(1-2, 4): 79–115, 163–204; 7(1-2): 59–109; 9(2-3): 413–497; 10(3-4): 33–117.
- Baldwin B, Markos S (1998) Phylogenetic utility of the external transcribed spacers (ETS) of 18S-26S rDNA: congruence of ETS and ITS trees of *Calycadenia* (Compositae). Molecular Phylogeny and Evolution 10: 449–463. <https://doi.org/10.1006/mpev.1998.0545>
- Deng T, Nie Z-L, Drew BT, Volis S, Kim C, Xiang C-L, Zhang J-W, Wang Y-H, Sun H (2015) Does the Arcto-Tertiary biogeographic hypothesis explain the disjunct distribution of northern hemisphere herbaceous plants? The case of *Meehania* (Lamiaceae). Plos One. <https://doi.org/10.1371/journal.pone.0117171>
- Dong W, Xu C, Li C, Sun J, Zuo Y, Shi S, Cheng T, Guo J, Zhou, S (2015) *yefl*, the most promising plastid DNA barcode of land plants. Scientific Reports 5: 8348. <https://doi.org/10.1038/srep08348>
- Doyle JJ, Doyle D (1987) A rapid DNA isolation procedure for small quantities of fresh leaf tissue. Phytochemical Bulletin 19: 11–15.

- Drew BT, Sytsma KJ (2011) Testing the monophyly and placement of *Lepechinia* in the tribe Mentheae (Lamiaceae). *Systematic Botany* 36: 1038–1049. <https://doi.org/10.1600/036364411X605047>
- Drew BT, Sytsma KJ (2013) The South American radiation of *Lepechinia* (Lamiaceae): phylogenetics, divergence times and evolution of dioecy. *Botanical Journal of the Linnean Society* 171(1): 171–190. <https://doi.org/10.1111/j.1095-8339.2012.01325.x>
- Drummond AJ, Ho SY, Phillips MJ, Rambaut A (2006) Relaxed phylogenetics and dating with confidence. *PLoS Biology* 4: e88. <https://doi.org/10.1371/journal.pbio.0040088>
- Drummond AJ, Suchard MA, Xie D, Rambaut A (2012) Bayesian phylogenetics with BEAUti and the BEAST 1.7 *Molecular Biology and Evolution* 29: 1969–1973. <https://doi.org/10.1093/molbev/mss075>
- Farris JS, Källersjö M, Kluge AG, Bult C (1994) Testing significance of incongruence. *Cladistics* 10: 315–319. <https://doi.org/10.1111/j.1096-0031.1994.tb00181.x>
- Fukuoka N, Kurosaki N (1982) Phytogeographical notes on some species of Western Honshu, Japan 3. Shoei Junior College Annual Report of Studies 14: 29–34. [In Japanese]
- Hall TA (1999) BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series* 41: 95–98. <http://brownlab.mbio.ncsu.edu/JWB/papers/1999Hall1.pdf>
- Heled J, Drummond AD (2010) Bayesian inference of species trees from multilocus data. *Molecular Biology and Evolution* 27: 570–580. <https://doi.org/10.1093/molbev/msp274>
- Hihara S, Iwatsubo Y, Naruhashi N (2001) A new natural hybrid of *Salvia* (Lamiaceae) from Japan, *Salvia* × *sakuensis*. *Journal of Phytogeography and Taxonomy* 49: 163–170.
- Hu, G (2015) Phylogeny of *Salvia* (Lamiaceae) in East Asia. A Doctoral Dissertation, Kunming Institute of Botany, Chinese Academy of Sciences.
- Inoue K (1997) *Salvia* L. In: Shimizu T (Ed.) *Flora of Nagano Prefecture*, 939–941. [In Japanese]
- Jobb G, von Haeseier A, Strimmer K (2004) TREEFINDER: a powerful graphical analysis environment for molecular phylogenetics. *BMC Evolutionary Biology* 4: 18. <https://doi.org/10.1186/1471-2148-4-18>
- Moon HK, Smets E, Huysmans S (2010) Phylogeny of tribe Mentheae (Lamiaceae): The story of molecules and micromorphological characters. *Taxon* 56(1): 74–88.
- Murata G (1952) *Salvia* subgen. *Allagospadonopsis* of Japan and Formosa. *Acta Phytotaxonomica et Geobotanica* 16: 184–190. [In Japanese]
- Murata G, Yamazaki T (1993) *Salvia* L. In: Iwatsuki K, Yamazaki T, Boufford DE, Ohba H (Eds) *Flora of Japan IIIa*, Kodansha, 302–307.
- Nakai G (1950) On *Salvia japonica* and *S. lutescens*. *Acta Phytotaxonomica et Geobotanica* 14: 63–66. [In Japanese]
- Rambaut A, Suchard MA, Xie D, Drummond AJ (2014) Tracer v1.6, Available from <http://beast.bio.ed.ac.uk/Tracer>
- Rieseberg LH, Soltis DE (1991) Phylogenetic consequences of cytoplasmic gene flow in plants. *Evolutionary Trends in Plants* 5: 65–84.
- Sakoda M, Noriyuki M, Sato K (2014) Notes on the species of subgenus *Allagospadonopsis* Briq. (Lamiaceae) and the habitat in Shimane Prefecture. *Bunrui* 14(1): 65–68. [In Japanese]

- Sudarmono, Okada H (2007) Speciation process of *Salvia isensis* (Lamiaceae), a species endemic to serpentine areas in the Ise-Tokai district, Japan, from the viewpoint of the contradictory phylogenetic trees generated from chloroplast and nuclear DNA. *Journal of Plant Research* 120: 483–490. <https://doi.org/10.1007/s10265-007-0075-2>
- Sugiura N (1978) Further analysis of the data by Akaike's information criterion and the finite corrections, *Communications in Statistics: Theory and Methods*, A7: 13–26. <https://doi.org/10.1080/03610927808827599>
- Swofford DL (2002) PAUP*. Phylogenetic analysis using parsimony (*and other methods), version 4.0b10. Sunderland, Massachusetts: Sinauer Associates. <http://www.paup.sc.fsu.edu/>
- Takano A, Okada H (2011) Phylogenetic relationships among subgenera, species, and varieties of Japanese *Salvia* L. (Lamiaceae). *Journal of Plant Research* 124: 245–252. <https://doi.org/10.1007/s10265-010-0367-9>
- Takano A (2013) Gynodioecy in *Salvia omerocalyx* Hayata (Lamiaceae). *Acta Phytotaxonomica et Geobotanica* 63: 149–153.
- Takano A, Sera T, Kurosaki N (2014) A new species of *Salvia* (Lamiaceae) from Chugoku district, Japan, *Salvia akiensis* sp. nov.. *Acta Phytotaxonomica et Geobotanica* 65: 99–104.
- Takano A (2017) Flower visitors on Japanese *Salvia*. In: *Proceedings of the 16th annual meeting of the Japanese Society for Plant Systematics*. Kyoto, Japan, 80 pp. [In Japanese]
- Tanabe AS (2007) Kakusan: a computer program to automate the selection of a nucleotide substitution model and the configuration of a mixed model on multilocus data. *Molecular Ecology Notes* 7: 962–964. <https://doi.org/10.1111/j.1471-8286.2007.01807.x>
- Thompson JD, Higgins DG, Gibson TJ (1994) CLUSTALW: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research* 22: 4673–4680. PMID: PMC308517
- Thunberg C P (1784) *Salvia japonica*. In: Murray JA (ed) *Caroli a Linné equitis Systema vegetabilium: secundum classes ordines genera species cum characteribus et differentiis*. 14: 72.
- Trusty JL, Olmstead RG, Bogler DJ, Santos-Guerra A, Francisco-Ortega J (2004) Using molecular data to test a biogeographic connection of the macaronesian genus *Bystropogon* (Lamiaceae) to the New World: A case of conflicting phylogenies. *Systematic Botany* 29: 702–715. <https://doi.org/10.1600/0363644041744347>
- Will M, Classen-Bockhoff R (2014) Why Africa matters: evolution of Old world *Salvia* (Lamiaceae) in Africa. *Annals of Botany* 114: 61–83. <https://doi.org/10.1093/aob/mcu081>
- Yonekura K, Kajita T (2003) BG plants Y-list. <http://ylist.info>

Appendix I

Specimens examined *Salvia lutescens* var. *intermedia*. And var. *lutescens*.

Salvia lutescens var. *intermedia*

Specimens glabrous at base of anther connective (27 sheets)

KANTO Region. Yamagata Pref.: Mt. Kushigata, *S.Kigawa s.n.*, July 10, 2001 (KPM NA0151444, NA015445). **Ibaragi Pref.:** Tsukuba, *C.Owatari s.n.*, July 8, 1895 (**syntype**, TI); Ibidem, *C.Owatari s.n.*, July 25, 1895 (**syntype**, TI). **Gunma Pref.:** Mt. Akagi, *H.Hara s.n.*, July 12, 1928 (TI); Akagi, Shikisimadori, Chubu, *H.Hara s.n.*, 11 July 1928 (TI), Kouzuke, Tone, Yunogoya-daira, *H.Hara s.n.*, 13 July, 1928(TI); Joshu, Tone-gun, Tokura, *S.Saito 145* (TI). **Kanagawa Pref.:** Hakone, *S.Ohkubo s.n.*, July 26, 1881 (**syntype** TI); Ibidem, *unknown collector*, July 26, 1881 (**syntype**, TI); ibidem, *S.Tamaki s.n.*, July 14, 1914 (TI); Minami pass, Hakone, *T.Makino 62582* (KYO); Yoduku, Yamakita-cho, *T.Katsuyama et al.*, July 23, 2005 (KPM NA0124794); Mikuniyama-rindo, Hakone, *Inoue et al.*, June 18, 1998 (KPM NA0112995); Tanzawa-Ohya, *T.Nishio 1489* (KPM); Summit of Mt. Kintoki, Hakone, *S.Kigawa s.n.*, July 3, 1980 (KPM NA1020531); Ishigoya-Ochiai, Kiyokawa-mura, *H.Takahashi 20563* (KPM); Ishigoya-Ochiai, Kiyokawa-mura, *H.Takahashi 20565* (KPM); Minesaka Pass to Myojin Pass, Yamakita-cho, *S.Mori 20536* (KPM); Kaminokawa, Tsukui-machi, *S.Kigawa 20559* (KPM); Kurokura, Yamakita-machi, *M.Furuse 45371* (KPM); Ogawadani, Yamakita-cho, *A.Takano 140622-2* (HYO). **Shizuoka Pref.:** Mt.Mikuni, Fukayoshi, Susono-shi, *A.Takano 140806-4-1* (HYO); ibidem, *A.Takano 140806-4-2* (HYO).

KINKI Region. Nara Pref.; Yoshino, Yamato, *Y.Kato s.n.*, Aug. 8. 1936 (KYO). **Hyogo Pref.:**Taki-gun, Nishiki-cho, *T.Kobayashi 23369* (KYO). **Shiga Pref.:** Ikadachitochu, *A.Takano 140821-1* (HYO).

Specimens showed one to several hairs at base of anther connective (10 sheets)

KANTO Region. Pref.Sizuoka: Mt. Higane, Prov. Izu, *S. Shimazu s.n.*, July 18, 1920(KPM);

Pref.Kanagawa: Sirogane rindo, Yugawara-cho, *Y.Hasegawa 14263* (KPM); Oga-wadani-rindo, Yamakita-cho, *T.Katsuyama s.n.*, Aug. 22, 1995 (KPM NA0100397); Marudake, Hakone, *M.Tashiro s.n.*, July 18, 1956 (KPM NA0157166); Tounomine, Hakone, *T.Deguchi 80495* (KPM); Tougadake, Yamakita-cho, *S.Kigawa s.n.*, July 3, 1980 (KPM NA1020531); Ishigoya-Ochiai, Kiyokawa-mura, *H.Takahashi 20564* (KPM), Mt.Ohmuro, Tsukui-machi, *S.Kigawa s.n.*, June 10, 1979 (KPM NA1020566); Hayatogawa Rindo, Tsukui-machi, *S.Kigawa 20541* (KPM), Youkizawa, Yamakita-machi, *S.Kigawa 20567* (KPM).

Specimens which showed long pilose at base of anther connective (52 sheets)

KINKI Region. Kyoto Pref.: Rakuhoku, Ohara, Otonashi W.F., *S. Hajacava* s.n., Aug. 1896 (TI), Kyoto, Ohara, *T. Tsuyama* s.n., Sep. 7, 1934 (TI); Kiyotaki-Takao, Ukyo-ku, Kyoto, *S. Tsugaru* & *T. Takahashi* 26448 (KYO); Mt. Hyotankuzure-yama, near Ohara, *G. Nakai* 5401 (KYO); ibidem, *G. Nakai* s.n., July 25, 1951 (KYO); Kadono-gun, Nakagawa-mura, *M. Tagawa* 887 (KYO, two sheets); Maesaka Takanomine to Shimosugisaka, *S. Okamoto* s.n., July 14, 1932 (KYO), Bodai W.F., Nakagawa, *G. Nakai* 6305 (KYO); Mt. Kibune, *unknown collector*, June 28, 1921 (KYO); Kyoto-shi, Nakagawa to Bodai no Taki, *M. Hutoh* 10515 (OSA); ibidem, *M. Hutoh* 9264 (OSA); ibidem, *M. Hutoh* 10528 (OSA); ibidem, *M. Hutoh* 3465 (OSA); Mt. Hiei-san, *S. Tanaka* s.n., June 30, 1932 (OSA). **Hyogo Pref.:** Taki-gun, Nishiki-cho, *T. Kobayashi* 23369 (HYO); Youtakuji, Sanda, *T. Makino* 62583 (KYO); Moshi, Sanda, *A. Takano* 140813-1 (HYO). **Nara Pref.:** Yamato, Sanjo-ga-dake to Gyojagaeri, *Y. Momiyama* s.n., July 16, 1955 (TI) (three sheets), Ibidem, *H. Hara* s.n., July 16, 1955 (TI); ibidem, *T. Kobayashi* 30611 (OSA); near the temple Kongo, Kashiwagi, Yamato, *K. Kondo* s.n., June 8, 1928 (TI); Kosei River, Tenkawa Village, *K. Seto* 44248 (OSA); Mt. Omine to Mt. Sanjogadake, *H. Hara* 4683 (TI); en route from Wasamata hut to Mt. Nihon-dake, Kamikitayama-mura, *M. Okamoto* 1966 (OSA); Mt. Daifugendake, *T. Kodama* 10833 (OSA); Shonoiwaya-Mt. Wasamata Kamikitayama-mura, *K. Kodama* 14356 (OSA); Irinami, Yamato, *S. Sakaguchi* s.n., June, 1930 (KYO); Mt. Ohmine, *S. Sakaguchi* s.n., Aug. 4, 1931 (KYO); enroute from Mt. Sanjo to Mt. Daihugen, *T. Kodama* s.n., Aug. 6, 1959 (KYO); Mt. Sanjo, *G. Koizumi* s.n., July 13, 1922 (KYO); Mt. Yamatokatsuragi, Gose, *A. Takano* 140819-1 (HYO). **Osaka Pref.:** Mt. Izumi-katsuragi, *S. Nakanishi* s.n., July 30, 1968 (OSA); Ibidem, *T. Nakajima* s.n., Aug. 21, 1952 (OSA); Ibidem, *C. Satonaka* s.n., July 12, 1981 (OSA). **Wakayama Pref.:** Ryujin-Mura, Koya, *T. Nakajima* s.n., July 31, 1931 (two sheets, TI); Doro Hacho, *G. Nakai* 5213 (KYO); Ibidem, *T. Kodama* s.n., May 30, 1951 (OSA); ibidem, *M. Hori* s.n., May 30, 1951 (OSA); Hidaga-gun, Ooze, *S. Sakaguchi* s.n., July 27, 1932 (KYO); Mt. Sukuyama, Katsuragi-cho, Ito-gun, *K. Seto* 29839 (KYO, OSA); Mt. Kurosawa, Sayiki-mura, *Y. Ogawa* s.n., Aug. 30, 1950 (KYO). **Shiga Pref.:** Otsu, *N. Takemura* s.n., June 1901 (**Lectotype** MAK); Omi, Tochu, *M. Togashi* 1205 (TI); Tochu to Ikadachi, *M. Umebayashi* 737 (KYO); Mt. Hiei, *G. Murata* 11415 (KYO); Ukawa, Shiga-cho, *M. Tanimoto* s.n., June 9, 1973 (KYO); Benzaiten to Sakamoto, Mt. Hiei, *S. Tanaka* s.n., June 30, 1932 (KYO). **Mie Pref.:** Wada, Kiwa-cho, Minami-murogun, *H. Takahashi* 21040 (KYO); Taki-gun, Miyagawa-mura, Shimomate (cult.), *K. Seto* 17303 (OSA).

Salvia lutescens var. *lutescens*

Specimens which showed long pilose at base of anther connective (13 sheets)

Mie Pref.: Itaya, Kata, Kameyama, *S. Tsugaru* & *T. Sawada* 34155 (KYO); Notoyama, Suzuka-gun, *T. Hattori* s.n., Aug. 5, 1928 (KYO); Kozu-mura, Naga-gun, *G. Nakai*

4772 (KYO); Shinzan kokuyu-rin, Iinan-gun, *Z. Tashiro s.n.*, 4. Aug., 1934 (KYO), Mt. Gozaisyo, *G. Koizumi s.n.*, 11 Jun. 1922 (KYO); Kozu-mura, Myouga-gun, (cult. at KYO) *G. Nakai 5402* (KYO); Ibidem, *G. Nakai 4773* (KYO); Nagaishi-dani, Mt. Kamagadake, Komono-cho, Mie-gun, *N. Fukuoka 4948* (KYO); Onsen-do, Mt. Gozaisho, *G.K. & S.F. s.n.*, June 1922 (KYO, holotype).

Shiga Pref.: Nasugahara, Ohara-Mura, Kouga gun, *G. Koizumi s.n.*, 2 July, 1939 (KYO), Kurotaki, Tsuchiyama-cho, Koga-gun, *T. Murase 47897* (KYO); Koga-gun, Suzuka-Pass, *H. Koyama & N. Fukuoka 55* (KYO); **Nara Pref.:** Kamide, Momomata, Mitsue-mura, Uda-gun, *K. Kawabata 9994* (KYO)

***Hoya* of the Philippines part I. *Hoya migueldavidii* (Apocynaceae, Asclepiadoideae), a new species from Northern Mindanao, Philippines**

Derek D. Cabactulan¹, Michele Rodda², Reynold Pimentel³

1 48 Corrales and 1st Street, Nazareth, Cagayan de Oro City, Philippines **2** Herbarium, Singapore Botanic Gardens, National Parks Board, 1 Cluny Road, Singapore 259569 **3** Camp Phillips, Manolo Fortich, Bukidnon, Philippines

Corresponding author: Michele Rodda (rodma.michele@gmail.com)

Academic editor: P. Stoev | Received 23 March 2017 | Accepted 9 May 2017 | Published 5 June 2017

Citation: Cabactulan DD, Rodda M, Pimentel R (2017) *Hoya* of the Philippines part I. *Hoya migueldavidii* (Apocynaceae, Asclepiadoideae), a new species from Northern Mindanao, Philippines. *PhytoKeys* 80: 105–112. <https://doi.org/10.3897/phytokeys.80.12872>

Abstract

A new species of *Hoya* R.Br. from Mindanao (Philippines), *Hoya migueldavidii* Cabactulan, Rodda & Pimentel, is described and illustrated. It is a member of *Hoya* section *Acanthostemma* (Blume) Kloppenb. that is particularly speciose in the Philippines.

It is compared with the similar *Hoya loheri* Kloppenb, also endemic of the Philippines, from which it differs in indumentum of the vegetative parts (pubescent vs. glabrous), the shape of the corolla (almost spherical vs. partly flattened) and the type of gynostegium (not stipitate vs. stipitate)

Keywords

Acanthostemma, *Marsdenieae*, waxflower

Introduction

Hoya R.Br., with an estimated 350–450 species (Rodda 2015) is the largest genus of Apocynaceae. The Philippines are, together with Borneo and New Guinea one of the centres of diversity of the genus. The number of taxon descriptions in the Philippines

have been steadily increased since 2012. Kloppenburg et al. (2012) recorded more than 80 species of *Hoya* occurring in the Philippines, number that jumped to 104 species according to Aurigue et al. (2013). At present the Co's Digital Flora of the Philippines website (Pelser et al. continuously updated, accessed on 17 March 2017) lists 121 taxa including species and subspecies. The steep increase in species number is almost entirely due to the establishment of the e-journal *Hoya New*, where Dale Kloppenburg started publishing new taxa since 2013 either as sole author or in collaboration with numerous Philippine botanists and growers.

In comparison to the two other centres of diversity of *Hoya*, Borneo and New Guinea, the pattern of species discovery and description in the Philippines is very different. Borneo, with 72 recorded species (Lamb and Rodda 2016) saw a peak of species descriptions in the early 2000s mostly due to the work of Dale Kloppenburg and Ted Green, and more recently a second peak in 2014 and 2015, mostly due to the work of Lamb et al. (2014) and Rodda, in preparation for the book 'A Guide to Hoyas of Borneo' by Lamb and Rodda (2016). New Guinea has 85 species and one subspecies (Forster 1996, Simonsson Juhonewe and Rodda 2017), mostly described in the first half of the last century, the majority of which described by Schlechter (1913) based on his own collections. Ten species and one subspecies were instead named following recent intensive fieldwork in New Guinea (Simonsson Juhonewe and Rodda 2017).

The majority of the recent publications of new Philippine *Hoya* species are based on collections from Luzon and several parts and islands in Visayas and fewer from Mindanao. The first and last authors recently made extensive collections in the island including several unidentified species. Sterile plants were also collected and brought to cultivation in the private plant nursery of last author in Bukidnon and are awaiting to bloom so that they can be studied and identified.

The new species here published is among the first cultivated collections that flowered. It belongs to *Hoya* section *Acanthostemma*, that is particularly species-rich in the Philippines and is characterised by corolla lobes revolute, outer corona lobes bilobed and pollinaria with broad, spatulate caudicles.

Materials and methods

The description of the new species is based on the observation of the living specimens collected from the wild and cultivated at the nursery of the last author at Del Monte, Camp Phillips, Manolo Fortich, Bukidnon. Flowers were dissected and examined under the stereomicroscope and pictures were taken before pressing. Specimens of *Hoya* at A, BK, BKF, BISH, BM, BRUN, CMUH, FI, G, K, KEP, KUN, HBG, IBSC, L, M, MO, P, SAN, SAR, SNP, SING, TO, UC, US, W, WRSL and WU herbaria as well as type images at <https://plants.jstor.org/> were also studied.

Species treatment

Hoya migueldavidii Cabactulan, Rodda & Pimentel, sp. nov.

urn:lsid:ipni.org:names:77163235-1

Fig 1, 2

Diagnosis. Among Philippine *Hoya* species similar to *Hoya loheri* in inflorescence type (positively geotropic, convex) but separated because *Hoya loheri* has a flattened, turban-shaped corolla (vs. almost round in *Hoya migueldavidii*) and leaves and stems are entirely glabrous (vs. pubescent in *Hoya migueldavidii*)

Type. Philippines, Mindanao, Bukidnon, Mount Kitanglad, 11 Aug 2016, R. Pimentel s.n. (CMUH, holotype, sheet number CMUH 827; SING, isotype).

Description. Epiphytic scandent vine rooting along the stems, *roots* adventitious on internodes and just below the nodes; *stems* slender, terete, 3.0–5.0 mm diameter, green or maroon, densely strigose, *internodes* 2.5–9 cm long. *Leaf blades* fleshy, stiff, slightly concave, variable in shape, from lanceolate, elliptic-lanceolate to ovate-elliptic, 2–7.5 × 1.80–2.50 cm base rounded, apex obtuse, dark green or maroon, reddish pigmentation often occurs on the underside of the leaves, margins thickened, venation pinnate, secondary veins not visible on dry specimens, adaxially and abaxially papillate-strigose, basal *colleters* 1–3 at each lamina base, ovoid, 0.15–0.20 mm long × c. 0.15 mm in diameter, dark brown; *petiole* thickened, terete, 1–2.3 × 0.28–0.30 mm diameter, flattened approaching the lamina base, usually curved, dark green or maroon, densely strigose. *Inflorescences* extra-axillary, umbelliform, slightly concave, up to 25 flowered. *Peduncles* terete, positively geotropic, 2–8 cm long, strigose, rachis up to 3 cm long. *Pedicels*, terete, 2.50–3.80 cm × 0.70–0.72 mm in diameter, sparsely strigose, the outer pedicels strongly curved. *Calyx* lobe triangular, oblong, 0.80–1.3 mm long × 0.80–1.00 mm wide, red, outer surface strigose, inner surface glabrous. *Corolla* revolute, 5–5.3 mm diameter, 8.5–9 mm diameter when flattened, red to pink; *corolla lobes* reflexed, triangular ovate, 2.6 × 4.6 mm long, apex acute-acuminate, inside silky-pubescent, tip glabrous, outside glabrous. *Gynostegium* stipitate; *column* cylindrical, 0.04 × 0.03 mm diameter; *corona* staminal, 2.3–3.0 mm high, 4–5 mm in diameter; *lobes* ovoid-spathulate, 3.0–3.3 × 0.30–0.35 mm wide, inner processes erect above the anthers, almost linear, red, outer process long bilobed, with basal revolute margins. *Pollinia* erect, oblong, 300–320 µm long and 115–130 µm wide with a sterile edge along the outer margin; *translator arms* c. 60 µm long, each with a rounded projections c. 60 µm diam.; *corpusculum* oblong 90–110 × 35–50 µm. *Ovary* conical with an acute tip, c. 1.5 × 0.6 mm at the base, ventricose, glabrous. *Fruit* and *seed* not seen.

Etymology. *Hoya migueldavidii* is named after Dr. Miguel David de Leon, vitreoretina surgeon and plant and wildlife conservationist.

Distribution and ecology. This new species was only once collected in Mindanao Island, Philippines but the full distribution is still unknown. It is an epiphytic climber, growing at about 1000 m in disturbed primary broad leaf forest in full sun to part shade.

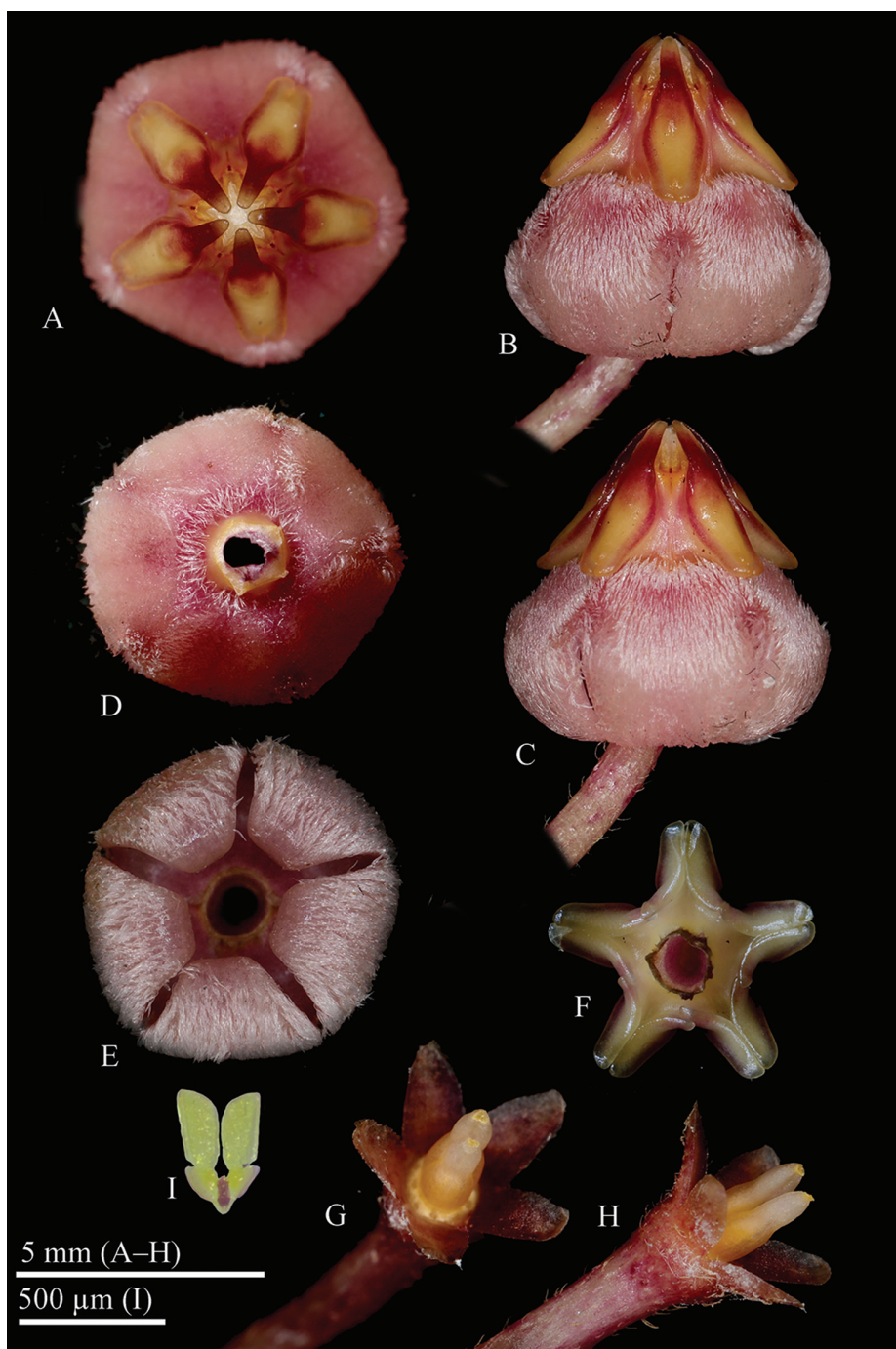


Figure 1. *Hoya migueldavidii* photographed from *R. Pimentel s.n.* (CMUH) prior to pressing **A** A single flower, front view **B, C** Corolla, side view **D** Corolla, with removed corona **E** Revolute margins of the corolla lobes **F** Corona, from underneath **G, H** Pedicel, calyx and ovary **I** Pollinarium (Photographs by M.D de Leon)

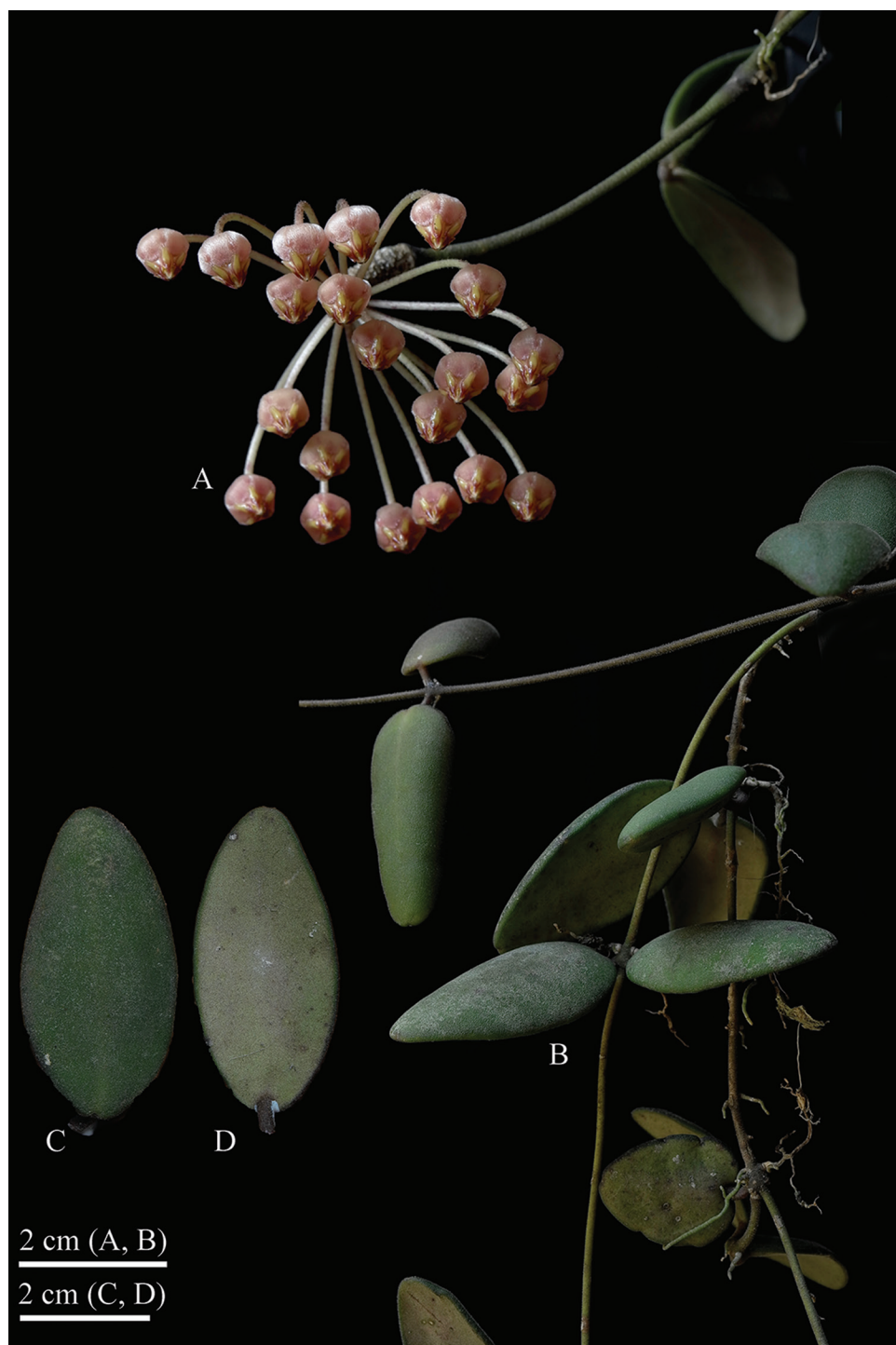


Figure 2. *Hoya migueli* photographed from R. Pimentel s.n. (CMUH) prior to pressing **A** Inflorescence **B** Branch **C, D** leaf (**C** adaxial surface **D** abaxial surface). (Photographs by M.D de Leon).



Figure 3. *Hoya loberi* photographed from Rodda M MR748 (SING) prior to pressing **A** Leafy branch and inflorescence **B** Inflorescence. (Photographs by M. Rodda)

Conservation status. The forested area where *Hoya migueli* was collected is threatened by habitat destruction due to extensive farming, charcoal production, land conversion and illegal logging. However, the species is only known from a single collection and therefore the conservation status is proposed as Data Deficient (DD, IUCN 2016) until more information is known about its area of occurrence.

Notes. The long peduncles, shape of the inflorescences and the slender pedicels of *Hoya migueli* are similar to those of *Hoya loheri* (Fig. 3). The two species can be separated because of the indumentum of the vegetative parts that are pubescent throughout in *H. migueli* vs. glabrous in *H. loheri*; the shape of the corolla that is revolute and almost spherical in *H. migueli* and instead revolute yet flattened in *H. loheri*; the gynostegium is sessile in *H. migueli* whereas it is stipitate in *H. loheri*. Additionally the leaves of *H. migueli* are similar to those of *Hoya isabelchaniae* Rodda & Simonsson from Sulawesi (Indonesia) both in shape, convex ovate-elliptic (to round in *H. isabelchaniae*) and in indumentum (pubescent). However, *H. migueli* has smaller flowers of c. 7 mm vs. 8–10 mm in diameter in *H. isabelchaniae* and different pubescence of the corolla (finely pubescent vs. setose in *H. isabelchaniae*).

Specimens of *Hoya loheri* examined. *Hoya loheri*. Philippines, unknown locality, cultivated in Thailand, Chonburi, Nong Nooch Tropical Garden vouchered on 22 September 2014, M. Rodda MR748 (SING). Luzon, Rizal Province, Paningtingan. 15 March 1915 A. Loher s.n. (UC [UC229373])

Acknowledgements

We thank the curators of the A, BK, BKF, BISH, BM, BRUN, CMUH, FI, G, K, KEP, KUN, HBG, IBSC, L, M, MO, P, SAN, SAR, SNP, SING, TO, UC, US, W, WRSL and WU herbaria for allowing access and/or for providing high quality images of herbarium specimens. We would also like to thank for the DENR 10 OIC - Regional Director Engr Edwin B. Andot and Roel G. Dahonog - OIC, Chief, Licenses, Patents & Deeds, for granting us the collection permit and allow us to collect specimens and conduct ethno-botanical research within Region 10 - Northern Mindanao, and also Central Mindanao University as our repository of the holotype specimens.

Ulrich Meve and Pavel Stoev are thanked for suggesting improvements to the manuscript.

References

- Aurigie FB, Sahagun JR, Suarez WM (2013) *Hoya cutis-porcelana* (Apocynaceae): A New Species from Samar and Biliran Islands, Philippines. *Journal of Nature Studies* 12(1): 12–17.
- Forster PI (1996) A checklist of the Asclepiadaceae of Papuaia. *Science in New Guinea* 22(1): 15–22.

- IUCN Standards and Petitions Subcommittee (2016) Guidelines for Using the IUCN Red List Categories and Criteria. Version 12. <http://www.iucnredlist.org/documents/RedList-Guidelines.pdf> [accessed on 16 Feb. 2017]
- Kloppenburger RD, Guevarra MLD, Carandang JM, Maranan FS (2012) New Species of *Hoya* R. Br. (Apocynaceae) from the Philippines. *Journal of Nature Studies* 11(1&2): 34–48.
- Lamb A, Gavrus A, Emoi B, Gokusing L (2014) The Hoyas of Sabah, a commentary with seven new species and a new subspecies. *Sandakanian* 19: 1–89.
- Lamb A, Rodda M (2016) A Guide to Hoyas of Borneo. Natural History Publications Borneo, Kota Kinabalu, 204 pp.
- Pelser PB, Barcelona JF, Nickrent DL (continuously updated) (Eds) Co's Digital Flora of the Philippines. www.philippineplants.org [accessed 17 March 2017]
- Rodda M (2015) Two new species of *Hoya* R.Br. (Apocynaceae, Asclepiadoideae) from Borneo. *PhytoKeys* 53: 83–93. <https://doi.org/10.3897/phytokeys.53.5079>
- Schlechter R (1913) Die Asclepiadaceen von Deutsch-Neu-Guinea. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 50: 81–164.
- Simonsson Juhonewe N, Rodda M (2017) Contribution to a revision of *Hoya* (Apocynaceae, Asclepiadoideae) of Papuaia. Part I: ten new species, one new subspecies and one new combination. *Gardens' Bulletin Singapore* 69(1): 97–147.

Macrosolen bidoupensis (Loranthaceae), a new species from Bidoup Nui Ba National Park, southern Vietnam

Shuichiro Tagane¹, Van Son Dang², Nguyen Van Ngoc^{1,3}, Hoang Thi Binh^{1,3},
Natsuki Komada⁴, Jarearnsak Sae Wai^{5,6}, Akiyo Naiki⁷, Hidetoshi Nagamasu⁸,
Hironori Toyama¹, Tetsukazu Yahara¹

1 Center for Asian Conservation Ecology, Kyushu University, 744 Motoooka, Fukuoka, 819-0395, Japan **2** The VNM Herbarium, Institute of Tropical Biology, Vast, 85 Tran Quoc Toan Street, District 3, Ho Chi Minh City, Vietnam **3** Department of Biology, Dalat University, 01 – Phu Dong Thien Vuong, Dalat, Vietnam **4** Laboratory of Forest Resources and Society, Graduate School of Agriculture Kyoto University, Kitashirakawa-oiwakecho, Sakyo-ku, Kyoto, 606-8502, Japan **5** Prince of Songkla University, Hat Yai, Thailand **6** Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan **7** Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi-cho, Yaeyama-gun, Okinawa, 907-1541, Japan **8** The Kyoto University Museum, Kyoto University, Yoshida Honmachi, Sakyo-ku, Kyoto, 606-8501, Japan

Corresponding author: Shuichiro Tagane (stagane29@gmail.com)

Academic editor: D. Nickrent | Received 21 April 2017 | Accepted 15 May 2017 | Published 5 June 2017

Citation: Tagane S, Dang VS, Ngoc NV, Binh HT, Komada N, Wai JS, Naiki A, Nagamasu H, Toyama H, Yahara T (2017) *Macrosolen bidoupensis* (Loranthaceae), a new species from Bidoup Nui Ba National Park, southern Vietnam. PhytoKeys 80: 113–120. <https://doi.org/10.3897/phytokeys.80.13338>

Abstract

Macrosolen bidoupensis Tagane & V.S.Dang, **sp. nov.** (Loranthaceae) is newly described from Bidoup Nui Ba National Park in Lam Dong Province, southern Vietnam. The new species is characterized by small broadly elliptic to circular leaves, sessile to short petioles, slightly cordate to rounded leaf bases, 4–5 pairs of lateral veins and a basally green corolla tube. An illustration, a summary of DNA barcoding of the plastid genes *rbcL* and *matK*, and a key to the species of *Macrosolen* in Vietnam are provided.

Keywords

Bidoup Nui Ba National Park, DNA barcoding, Loranthaceae, *Macrosolen*, new species, Vietnam

Introduction

Macrosolen (Blume) Rchb. is a small parasitic shrub in the family Lorantheae. The genus is characterized by being totally glabrous with 6-merous flowers subtended by one bract and two bracteoles (often connate), reflexed corolla lobes at anthesis, and 4-locular anthers. The genus comprises ca. 40 species widely distributed in tropical South and Southeast Asia. In Vietnam, it has been recorded by de Loureiro (1790, as *Loranthus*), Lecomte (1915, as *Elytranthe*), Danser (1938) and Hô (2003), and recently a taxonomic revision of Lorantheae in the country by Han (2014) enumerated seven species of *Macrosolen*: *M. annamicus* Danser, *M. avenis* Danser, *M. bibracteolatus* (Hance) Danser, *M. cochinchinensis* (Lour.) Tiegh., *M. dianthus* Danser, *M. robinsonii* (Gamble) Danser and *M. tricolor* (Lecomte) Danser.

During botanical surveys in Bidoup Nui Ba National Park, Lam Dong Province, southern Vietnam in 2016, we encountered an undescribed species of *Macrosolen*. We here describe this new species as *Macrosolen bidoupensis* Tagane & V.S.Dang, and provide illustrations, and a key to the species of *Macrosolen* in Vietnam.

In addition to the morphological examination, DNA sequences are extremely helpful for delimiting species (Hebert and Gregory 2005, Dick and Webb 2012). We sequenced two DNA barcode regions of *rbcL* and *matK* following the recommendation of CBOL Plant Working Group (2009).

Materials and methods

Morphological observations

To verify the validity of the new species, we undertook morphological comparisons to closely related species based on herbarium specimens (ANDA, BKF, BO, BRUN, FU, HN, KYO, SAR, TNS, VNM), specimen images on the web (e.g. JSTOR Global Plants, <http://plants.jstor.org/> and Muséum National d'Histoire Naturelle, <http://www.mnhn.fr/>), and consulting the relevant literature (e.g. Barlow 1995, 1997, 2002, Qiu and Gilbert 2003, Hô 2003, Han 2014).

DNA barcoding

DNA amplification and sequencing of portions of the chloroplast genes *rbcL* and *matK* followed established protocols (Kress et al. 2009, Dunning and Savolainen 2010) as in Toyama et al. (2015).

Taxonomy

Macrosolen bidoupensis Tagane & V.S.Dang, sp. nov.

urn:lsid:ipni.org:names:77163237-1

Figures 1, 2

Diagnosis. *Macrosolen bidoupensis* is similar to *Macrosolen tricolor* Danser of China, Laos and Vietnam in leaf shape and size and by possession of a 2-flowered umbel, but differs in having a sessile to very short petiole (up to 0.7 mm long in *M. bidoupensis* vs. 2–3 mm long in *M. tricolor*), more lateral veins (4 or 5 vs. 2 or 3 pairs), slightly cordate to rounded leaf bases (vs. cuneate) and a basally green corolla tube (vs. reddish around the basal 1/3). The leaf shape is also somewhat similar to *Macrosolen platyphyllus* Danser of Thailand, Peninsular Malaysia and Borneo, but easily distinguished in having much smaller leaves and flowers, and very short petioles.

Type. VIETNAM. Lam Dong Province, Bidoup Nui Ba National Park, in lower montane evergreen forest, 12°10'34.7"N, 108°41'08.4"E, alt. 1533 m, 21 Feb. 2016, with flowers, Tagane S., Nagamasu H., Naiki A., Dang V. Son, Ngyuen V. Ngoc, Binh T. Hoang & Wai J. V4083 (holotype-KYO!, fl. spirit collection; isotypes NTU!, the herbarium of Bidoup Nui Ba National Park!, VNM!).

Description. Hemi-parasitic shrub, 25–40 cm tall, totally glabrous. Branches terete, grayish to grayish brown, lenticellate. Leaves opposite; blade elliptic, broadly elliptic, broadly ovate-elliptic, or circular, 1.2–4.8 × 1.2–3.5 cm, coriaceous, apex broadly obtuse to rounded, base slightly cordate to rounded, margin entire, grayish green and slightly lustrous adaxially, dull olive abaxially, midrib prominent at basal 1/3 to 1/2 abaxially, secondary veins 4 or 5 pairs, obscure or visible adaxially, obscure to faintly visible abaxially; petiole to 0.7 mm long. Inflorescences axillary, sometimes at older leafless nodes, 2-flowered umbels; peduncle ca. 0.9 mm long. Pedicel 1.1–1.5 mm long; central bract suborbicular, ca. 1 mm long, bracteoles suborbicular, connate, ca. 1 mm long; mature buds 2.8–3.2 cm long; calyx limb (calyculus) annular, ca. 0.7 mm long; corolla green tinged with red at top of tube and lobes, symmetrically 6-winged at about two thirds the length, tube 2.2–2.4 cm long in anthesis, gradually dilated, inflated, slightly curved, lobes lanceolate, 6–8 mm long, reflexed in anthesis; stamens 6, anthers ca. 2.3 mm long, filaments basally adnate to corolla tube, free part 2.3–3.3 mm long; ovary 2.8–3.3 mm long; style 2.8–3.2 cm long, stigma capitate. Berry reddish orange, subglobose to slightly depressed-barrel-shaped, ca. 8 mm high, ca. 6 mm wide, ovoid when dry, apex beaked by calyx limb. Seed 1, ellipsoidal, ca. 5 mm high, ca. 3 mm wide, longitudinally 6-grooved. The measurements of the flower characters are derived from the spirit collection.

Other specimen examined in Vietnam. Bidoup Nui Ba National Park; in lower montane evergreen forest, 12°10'34.9"N, 108°41'04.4"E, alt. 1533 m, 22 Feb. 2016, with fruits, Tagane et al. V4169 (FU, NTU, the herbarium of Bidoup Nui Ba National Park, VNM).

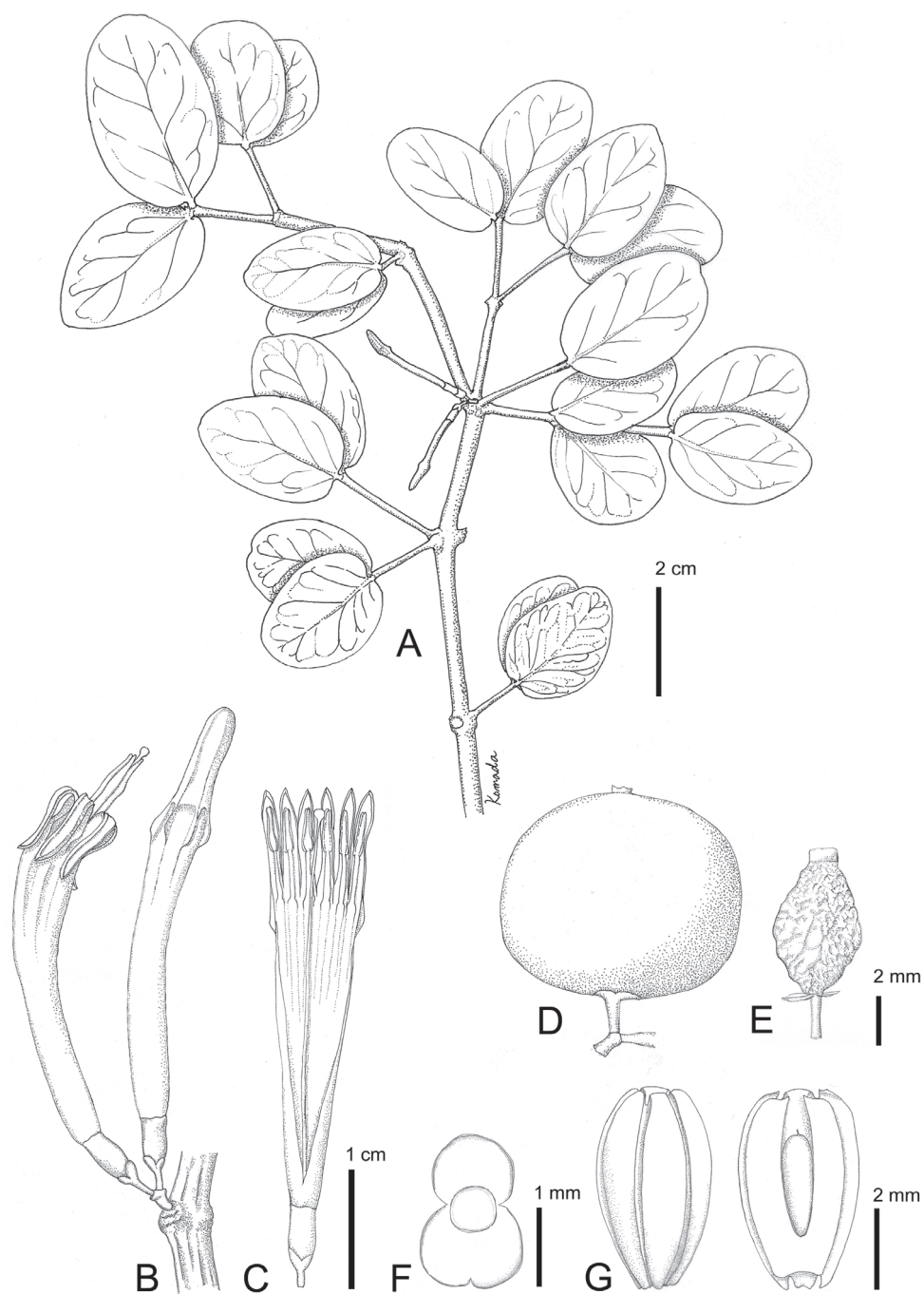


Figure 1. *Macrosolen bidoupensis* Tagane & V.S.Dang. **A** Branch with flower buds **B** 2-flowered inflorescence **C** Flower with corolla tube opened **D** Fresh fruit **E** Dried fruit **F** Seed **G** seed (left) and longitudinal section of seed (right). Materials: Tagane et al. V4083 (KYO). Drawn by N. Komada.



Figure 2. *Macrosolen bidoupensis* Tagane & V.S.Dang. **A** Branch with flower buds **B** Flower **C** Fruits. Photos by Tagane et al. V4083.

Phenology. Flowering and fruiting specimens were collected in February.

Distribution and habitat. Vietnam (so far known only from Bidoup Nui Ba National Park, Lam Dong Province). In lower montane evergreen forest, ca. 1500 m altitude.

GenBank accession no. *Tagane et al.* V4083: LC259010 (*rbcl*), LC259011 (*matK*). The partial *rbcl* sequence of *M. bidoupensis* was identical to *M. tricolor* (GenBank accession no. HQ317771) of the total 517 bp and differed at 3 bases of the 518 total from *M. cochinchinensis* (KP094775 and HQ317768). The partial *matK* sequence of *M. bidoupensis* differed at 23 bases from *M. cochinchinensis* (EU544439) of the 813 total.

Etymology. The specific epithet *bidoupensis* is derived from its type locality.

Conservation status. Least Concern (LC). Bidoup Nui Ba National Park is located on Central highland of Vietnam. It covers ca. 700.38 km² and is the core zone of the Langbiang biosphere reserve (Bidoup-Nui Ba National Park 2016). *Macrosolen bidoupensis* is commonly found in the lower montane evergreen forest in the national park. Since the forest is widely seen and well-protected, we suggest this status as LC according to IUCN (2012).

Note. A similar species, *Macrosolen tricolor* is known from lower elevations (below 100 m, Qiu and Gilbert 2003), and the two species do not occur sympatrically.

Key to the species of *Macrosolen* in Vietnam

- 1 Leaf blade 1.2–5.5 × 1.2–3.5 cm, apex rounded to broadly obtuse 2
- Leaf blade (3–)4–15 × (1.2–)1.5–7 cm, apex acute to acuminate, or obtuse 3
- 2 Petiole to 0.7 mm long; lateral veins 4 or 5 pairs *M. bidoupensis*
- Petiole 2–3 mm long; lateral veins 2 or 3 pairs *M. tricolor*
- 3 Mature flower bud 1–1.5(–2.3) cm long 4
- Mature flower bud 3–8.5 cm long 5
- 4 Petiole (1–)5–10 mm long; inflorescences racemose, (2–)4–8-flowered; peduncle (5–)15–20 mm long *M. cochinchinensis*
- Petiole 2–4 mm long; inflorescences umbellate, 2- or 3-flowered; peduncle 1–2.5 mm long *M. robinsonii*
- 5 Flowers subsessile, pedicel less than 1 mm long; bract 2–3 mm long; anther 5–8 mm long *M. dianthus*
- Flowers distinctly pedicellate, pedicel 2–6 mm long; bract 1–1.5 mm long; anther 2–5 mm long 6
- 6 Mature flower bud more than 4.5 cm long; anthers 4–6 mm long *M. annamicus*
- Mature flower bud 3–4 cm long; anthers 2–3 mm long 7
- 7 Corolla tube curved near the middle, asymmetrically winged *M. avenis*
- Corolla tube curved above the middle, symmetrically winged *M. bibracteolatus*

Acknowledgements

Authors thank the staff of Bidoup Nui Ba National Park for their kind assistance in the field survey. We are grateful to Keiko Mase for her help with DNA barcoding, and to the curators and staff of the following herbaria: ANDA, BKE, BO, BRUN, FU, HN, KYO, SAR, TNS, VNM for allowing us to examine their collections. We also thank the editors of the journal and two anonymous reviewers and for their help and advice. The present study was supported by the Ministry of the Environment, Japan (4-1601) and was partially supported by JSPS KAKENHI Grant Number 15H02640 and 24255007.

References

- Barlow BA (1995) New and noteworthy Malesian species of Loranthaceae. *Blumea* 40: 15–31.
- Barlow BA (1997) Loranthaceae. *Flora Malesiana* (ser. I) 13: 209–442.
- Barlow BA (2002) Loranthaceae. *Flora of Thailand* 7(4): 665–706.
- Bidoup Nui Ba National Park, (2016–onwards) official website, <http://bidoupnuiiba.gov.vn/en/introduction-menu.html> [Accessed 14 May, 2017]
- CBOL Plant Working Group (2009) A DNA barcode for land plants. *Proceedings of the National Academy of Sciences of the United States of America* 106: 12794–12797. <https://doi.org/10.1073/pnas.0905845106>
- Danser BH (1938) The Loranthaceae of French Indo-China and Siam. *Bulletin du Jardin Botanique de Buitenzorg*, Sér. 3, 16: 1–63.
- Dick CW, Webb CO (2012) Plant DNA barcodes, taxonomic management, and species discovery in tropical forests. In: Kress WJ, Erickson DL (Eds) *DNA Barcodes*. Springer, New York, NY. *Methods and Protocols* 858: 379–393. https://doi.org/10.1007/978-1-61779-591-6_18
- Dunning LT, Savolainen V (2010) Broad-scale amplification of *matK* for DNA barcoding plants, a technical note. *Botanical Journal of the Linnean Society* 164: 1–9. <https://doi.org/10.1111/j.1095-8339.2010.01071.x>
- Han LN (2014) Taxonomy of Loranthaceae in Vietnam. Master thesis, Published by author, Ha Noi, 161 pp. [In Vietnamese]
- Hebert PDN, Gregory TR (2005) The promise of DNA barcoding for taxonomy. *Systematic Biology* 54: 852–859. <https://doi.org/10.1080/106351505000354886>
- Hô PH (2003) *Cay Co Viet Nam: An Illustrated Flora of Vietnam* Vol. 2. Published by the author, Montreal.
- IUCN (2012) *IUCN Red List Categories and Criteria: version 3.1. second edition*. IUCN, Gland and Cambridge.
- Kress WJ, Erickson DL, Jones FA, Swenson NG, Perez R, Sanjur O, Bermingham E (2009) Plant DNA barcodes and a community phylogeny of a tropical forest dynamics plot in Panama. *Proceedings of the National Academy of Sciences of the United States of America* 106(44): 18621–18626. <https://doi.org/10.1073/pnas.0909820106>

- Lecomte H (1915) Loranaceae. In: Lecomte PH, Gagnepain F (Eds) Flore Générale de l'Indo-Chine 5, Masson, Paris, 185–210.
- de Loureiro J (1790) Flora Cochinchinensis 1. Typis et expensis Academicis, Ulyssepone.
- Qiu HX, Gilbert MG (2003) Loranaceae. In: Wu ZY, Raven PH, Hong DY (Eds) Flora of China 5. Beijing, Science Press and Missouri Botanical Garden Press, St. Louis, 220–239. <http://www.efloras.org>
- Toyama H, Kajisa T, Tagane S, Mase K, Chhang P, Samreth V, Ma V, Sokh H, Ichihashi R, Onoda Y, Mizoue N, Yahara T (2015) Effects of logging and recruitment on community phylogenetic structure in 32 permanent forest plots of Kampong Thom, Cambodia. Philosophical Transactions of the Royal Society B: Biological Sciences 370(1662): 20140008. <https://doi.org/10.1098/rstb.2014.0008>

The correct typification of *Tradescantia crassula* (Commelinaceae)

Gustavo Hassemer¹, Luís A. Funez², João Paulo R. Ferreira³, Lidyanne Y. S. Aona⁴

1 Statens Naturhistoriske Museum, Københavns Universitet, Sølvgade 83 S, 1307 Copenhagen, Denmark
2 Herbário Dr. Roberto Miguel Klein (FURB), Universidade Regional de Blumenau, Campus I, 89012-900, Blumenau, SC, Brazil
3 Laboratório de Moluscos Marinhos, Universidade Federal de Santa Catarina, Servidão Beco dos Coroaes, 503, 88061-600, Florianópolis, SC, Brazil
4 Centro de Ciências Agrárias, Ambientais e Biológicas, Universidade Federal do Recôncavo da Bahia, Rua Rui Barbosa, 710, 44380-000, Cruz das Almas, BA, Brazil

Corresponding author: Gustavo Hassemer (gustavonaha@gmail.com)

Academic editor: P. Boyce | Received 27 April 2017 | Accepted 19 May 2017 | Published 5 June 2017

Citation: Hassemer G, Funez LA, Ferreira JPR, Aona LYS (2017) The correct typification of *Tradescantia crassula* (Commelinaceae). PhytoKeys 80: 121–127. <https://doi.org/10.3897/phytokeys.80.13448>

Abstract

Here, we present evidence that the alleged correction of the typification of *Tradescantia crassula* recently proposed by Pellegrini, Forzza and Sakuragui is erroneous. Furthermore, we clarify misconceptions concerning the epitype of *T. crassula*, the specimen B-100521014, which was collected by Friedrich Sello in southern Brazil, and is not original material for *T. crassula*.

Keywords

Humboldt, Kunth, Link & Otto, Sello

Introduction

In their recently published article, Pellegrini et al. (2017) (hereafter: PFS) claim to make corrections to the typification of *Tradescantia crassula* Link & Otto (Commelinaceae) done by Funez et al. (2016) (hereafter: FHF). The objectives of this note is to present evidence that PFS's alleged “correction” is erroneous, and to clarify misconceptions concerning the epitype of *T. crassula*, the specimen B-100521014, which was collected by Friedrich Sello in southern Brazil, and is not original material for *T. crassula*.

In their nomenclatural notes on this species, PFS (pp. 7–8) start affirming that FHF “indicate that Pellegrini (2015) erroneously designated the specimen *Sellow 3033* (B100521014) as the lectotype for *T. crassula*”. This is not true, as FHF (p. 70) stated that “Pellegrini (2015) (a M.Sc. dissertation) incorrectly regarded the sheet kept in B (barcode B100521014) as the lectotype for the name *T. crassula*”. No mention of “correcting” a typification was made by FHF, and the use of the word “regarded”, instead of the more usual “designated”, had the purpose of leaving clear that FHF were aware that the M.Sc. dissertation in question (Pellegrini 2015) was not a validly published document.

Next, PFS argue that the collector of the specimen B-100521014 (see fig. 5 in Funez et al. 2016) should be considered to be Friedrich Sello (also known as Sellow, which is not his family name but is how he signed his name after 1814), and that the year written on the label, 1836, does not refer to the collection date of the specimen, but rather to the date when Karl Sigismund Kunth would have received it in Berlin (“We believe this date might correspond to the date when this specimen was acquired by Kunth, and placed into his personal herbarium”). On this basis, PFS proposed the designation of the specimen B-100521014 as the lectotype for the name *T. crassula* and, according to them, this newly designated lectotype would supersede the lectotype designated for this name in FHF (p. 71), i.e., tab. 7 in Link and Otto (1828a) (see Fig. 1)—“According to the *Code* (McNeill et al. 2012, Art. 9.2), the *Sellow 3033* (B100521014) specimen is a suitable choice for a lectotype, superseding the lectotypification of the original illustration, done by Funez et al. (2016)”.

Nevertheless, the interpretation of PFS of the type of *T. crassula* is erroneous. First of all, the authors cite the work that includes the protologue of *T. crassula* erroneously. The work cited, *Icones plantarum selectarum Horti Regii Botanici Berolinensis cum descriptionibus et colendi ratione* (Link and Otto 1828b), does not contain the description of *T. crassula*, which was in fact published in *Icones plantarum rariorum Horti Regii Botanici Berolinensis cum descriptionibus et colendi ratione*, vol. 1 (Link and Otto 1828a). The possibility that PFS have not read the protologue of *T. crassula* could perhaps explain the misunderstandings that these authors cause regarding the typification of this name.

A careful reading of the protologue of *T. crassula* (see Figs. 2 and 3) leaves clear that this species was described based on plants which grew from seeds included by chance in the soil transported along with living plants sent by Sello from Porto Alegre (southern Brazil) to Berlin (“Diese Pflanze ging aus der Erde, worin Herr Sello Pflanzen von Porto Allegro geschickt hatte, zufällig auf” [This plant grew by chance from the earth with which Mr. Sello sent plants from Porto Alegre]). Further evidence for this is that the illustration (tab. 7) provided by Link and Otto (1828a) (see Fig. 1) is in colour, and clearly shows a living specimen, and not a dried herbarium specimen. Also, there is absolutely no evidence that either Heinrich Friedrich Link or Christoph Friedrich Otto have studied any herbarium specimens to describe *T. crassula* (see more details below). Therefore, since the type of *T. crassula* was cultivated in Germany, and not collected in Brazil, it is evident that it was not collected by Sello, a fact that invalidates the entire line of discussion conducted by PFS to try to invalidate the correct lectotypification done by FHF.



Figure 1. Lectotype of *Tradescantia crassula* (tab. 7 in Link and Otto 1828a), designated in Funez et al. (2016: 71).

13

7.

TRADESCANTIA CRASSULA.

O. N. COMMELINEAE.

HEXANDRIA MONOGYNIA.

T. caule procumbente, foliis oblongis lanceolatisque nervosis basi ciliatis, pedunculis geminis umbelliferis, umbellis terminalibus sessilibus, calyce hirsutissimo.

Habitat in Brasilia australi prope Porto Allegro. 24. T.

Caulis procumbens elongatus subsimplex teres glaber. Folia superiora lanceolata 3—4 poll. longa, ultra poll. lata acuta succulenta glabra basi tantum ciliata. Pedunculi gemini ex axillis elongati divaricati, flores umbellati copiosi, bracteis 2 lanceolatis fulti, pedicellis reflexis glabris. Cal. e phyllis tribus 4 lin. longis pilis longis. Cor. tripetala, petala calyce paullulum majora breviter acuta alba. Stam. 6 basi pilis septatis stipata corolla minora. Stylus staminibus longior, stigmate acuto. Germen triloculare.

Enata est planta e terra, in qua e Brasilia australi plantas miserat clar. Sello. Affinis Tr. debili Humb. et Kunth.

Fig. a sistit florem a parte superiore, Fig. b eundem ab inferiore.

Der Stamm ist niederliegend, lang, fast einfach, rund und glatt. Die oberen Blätter sind lanzettförmig, 3—4 Zoll lang, über einen Zoll breit, nervig und dadurch liniert, spitz und saftig, glatt, an der Basis nur gefranst. Die Blüthenstiele kommen aus den Blattwinkeln zu zwei, sind lang ausgesperret, zwei solcher Blüthenstiele, ein sehr kurzer und langer, bilden das Ende des Stammes; die Blüthen sitzen in Dolden sehr zahlreich, mit zwei lanzettförmigen

Figure 2. Protologue of *Tradescantia crassula*, page 1 (Link and Otto 1828a: 13).

14

migen Bracteen gestützt; die besondern Blüthenstiele sind zurückgebogen und glatt. Der Kelch besteht aus drei, 4 Lin. langen Blättern, auf denen lange Haare sitzen. Die Blume besteht aus drei Blättern, welche etwas größer sind als der Kelch, kurz gespitzt, weiß. Die 6 Staubfäden haben an der Basis lange Haare mit Querwänden, sind kleiner als die Blume. Der Griffel ist länger als die Staubfäden. Die Narbe spitz. Fruchtknoten dreifächrig.

Diese Pflanze ging aus der Erde, worin Herr Sello Pflanzen von Porto Allegro geschickt hatte, zufällig auf. Sie liebt Feuchtigkeit und eine gewöhnliche leichte mit Sand vermischte Gartenerde. Die Blüten erscheinen in der Regel zweimal im Jahre, im März und October. Die Vermehrung geschieht entweder durch Samen, oder durch abgeschnittene Zweige, die sehr leicht wachsen. Sie wuchert sehr stark, ihre Zweige breiten sich auf der Erde aus und wurzeln dann leicht. Den Sommer über kann sie im Freien gehalten werden, im Winter bedarf sie nur einer mäßigen Temperatur von 8—10° R.

Fig. *a* stellt die Blumen von der obern Seite vor, Fig. *b* von der untern.

Figure 3. Protologue of *Tradescantia crassula*, page 2 (Link and Otto 1828a: 14).

The specimen B-100521014 (*F. Sello 3033*), which was designated epitype of *T. crassula* by FHF (p. 71), has a complex history and has been the source of much misunderstanding. This specimen was collected by Sello in the then province of São Pedro do Rio Grande do Sul (today state of Rio Grande do Sul, southern Brazil) in November–December 1825 (Urban 1893; Marchiori et al. 2016), and originates from the set of duplicates which Alexander von Humboldt received in 1836 for his herbarium from Ignaz von Olfers and which he immediately passed on to Kunth, who kept the specimen in his personal herbarium until his death in 1850 (Urban 1893; Robert Vogt, pers. comm.). The label was most probably written by Kunth (Robert Vogt, pers. comm.); the text in the lower right part of the label reads “*Humboldt ded. [dedit] 1836*” [donated by Humboldt in 1836], and not “Dec. 1836” as wrongly reported by both FHF and PFS (Robert Vogt, pers. comm.). This date, which is eight years after the description of *T. crassula*, refers to when Humboldt received this specimen, and not when it was collected. All things considered, the specimen B-100521014 clearly is not original material for *T. crassula*, and as a result the lectotypification and epitypification

of this name proposed by FHF are correct and effective, in accordance to Arts. 9.2, 9.3, 9.8, 9.11, 9.12, 9.19, 9.20, 9.21, 9.22 and 9.23 of the Melbourne Code (McNeill et al. 2012).

On a final remark, PFS (p. 28) affirm that “many recent studies of Brazilian Commelinaceae have been narrowly focused, and proposed new species and several typifications (Funez et al. 2016; Hassemer et al. 2016a, 2016b; Hassemer 2017)” and that “perhaps the most unfortunate result of such studies is the potential for incorrect typification and application of names (e.g. Funez et al. 2016; Hassemer et al. 2016b; Hassemer 2017)”. Here, we must highlight that their critiques are completely unrelated to the content of their own article, since, with the exception of Funez et al. (2016), all works criticised (Hassemer et al. 2016a, 2016b; Hassemer 2017) dealt with the genus *Commelina* L., and not *Tradescantia* L. Therefore, these critiques can be regarded as gratuitous attacks, which are certainly not an example to be followed. Taxonomy advances best and fastest when taxonomists behave ethically, and collaborate, among themselves and with scientists of other fields.

Acknowledgements

We are deeply indebted to Robert Vogt (Botanischer Garten und Botanisches Museum Berlin-Dahlem) for his important help in clarifying historical aspects of the specimen B-100521014, and to Henrique Mallmann Büneker (Universidade Federal de Santa Maria) for critically revising and greatly improving this work. Gustavo Hassemer also acknowledges *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES) for a scholarship granted through the *Ciência sem Fronteiras* programme (process BEX 13765/13-2).

References

- Funez LA, Hassemer G, Ferreira JPR (2016) Description of *Tradescantia schwirkowskiana* (Commelinaceae), a narrow endemic new species from Santa Catarina, southern Brazil, and typification of *T. crassula*. *Phytotaxa* 272(1): 63–72. <https://doi.org/10.11646/phytotaxa.272.1.3>
- Hassemer G, Ferreira JPR, Funez LA, Medeiros JDM (2016a) *Commelina catharinensis* (Comelinaceae): a narrow endemic and endangered new species from Santa Catarina, southern Brazil. *Phytotaxa* 246(1): 49–60. <https://doi.org/10.11646/phytotaxa.246.1.4>
- Hassemer G, Ferreira JPR, Funez LA, Aona LYS (2016b) Identity and typification of *Commelina vilavelhensis* (Commelinaceae), and typification of *C. robusta* and *C. scabrata*. *Phytotaxa* 260(2): 144–156. <https://doi.org/10.11646/phytotaxa.260.2.4>
- Hassemer G (2017) Taxonomic and nomenclatural notes on neotropical *Commelina* (Comelinaceae), and an identification key for Brazil, Guyana, Paraguay, Suriname and Uruguay. *Phytotaxa* 303(2): 101–117. <https://doi.org/10.11646/phytotaxa.303.2.1>

- Link JHF, Otto CF (1828a) *Icones plantarum rariorum Horti Regii Botanici Berolinensis cum descriptionibus et colendi ratione*, vol. 1. L. Oehmigke, Berlin, 96 pp, 48 tabs.
- Link JHF, Otto CF (1828b) *Icones plantarum selectarum Horti Regii Botanici Berolinensis cum descriptionibus et colendi ratione*. Decker, Berlin, 128 pp., 60 tabs. <http://dx.doi.org/10.5962/bhl.title.51952>
- Marchiori JNC, Pontes RC, Marchiori Neto DL (2016) Textos inéditos de Friedrich Sellow. 1 – Viagem às missões jesuíticas da Província de São Pedro do Rio Grande do Sul. *Balduinia* 51: 12–24. <http://dx.doi.org/10.5902/2358198021422>
- McNeill J, Barrie FR, Buck WR, Demoulin V, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Marhold K, Prado J, van Reine WFP'H, Smith GF, Wiersema JH, Turland NJ (2012) *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code)*. *Regnum Vegetabile* 154. Koeltz Botanical Books, Oberreifenberg, 240 pp.
- Pellegrini MOO (2015) *Filogenia e revisão taxonômica de Tradescantia L. sect. Austrotradescantia D.R.Hunt (Comelinaceae)*. M.Sc. dissertation, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.
- Pellegrini MOO, Forzza RC, Sakuragui CM (2017) Novelties in Brazilian *Tradescantia* L. (Comelinaceae). *PhytoKeys* 80: 1–31. <https://doi.org/10.3897/phytokeys.80.12232>
- Urban I (1893) *Biographische Skizzen. I. Friedrich Sellow (1789–1831)*. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 17: 177–198.

