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Zingiber chengii (Zingiberaceae), a new species from Taiwan

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Abstract

In this article, we describe a new species, *Zingiber chengii* Y.H. Tseng, C.M. Wang & Y.C. Lin, discovered on a rock cliff of Youluo riverside in northern Taiwan. This species is easily distinguished from other known congeners by its grass-like leaves, spikes composed of a few sterile bracts, and seeds one-third enveloped by the aril. Color illustrations, line drawings, and a key to species of *Zingiber* in Taiwan are provided as well as comparative morphology in relation to its allied species, geographical distribution, and conservation status.

Keywords

northern Taiwan, riverside, rock cliff, *Zingiber*

Introduction

Zingiber Mill (Zingiberaceae) comprises approximately 100–150 species, with its center of diversity in Southeast Asia (Wang 2000, Wu and Larsen 2000, Theerakulpisut et al. 2012). *Zingiber* spp. are mostly perennial herbs, characterized by a pulvinus leaf base (a swollen part of the petiole) and a horn-shaped anther crest embracing the up-

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per part of the style (Bai et al. 2015a). Several species in this genus are known to be widely cultivated in tropical Asia, such as *Z. officinale* Roscoe and *Z. zerumbet* (L.) Sm., and carry great economic value (Wang 2000). The genus *Zingiber* is divided into *Z.* sect. *Zingiber*, sect. *Dymczewiczia* (Horan.) Benth., sect. *Pleuranthesis* Benth., and sect. *Cryptanthium* Horan. based on the position of the inflorescence (Schumann 1904). Additionally, species of the sections *Zingiber* and *Dymczewiczia* have spherical pollen grains with cerebroid sculpturing, while those belonging to the sect. *Cryptanthium* have ellipsoidal pollen grains with spiro-striate sculpturing (Theilade et al. 1993).

Three native species of *Zingiber* have been recognized by Wang (2000) in Taiwan, i.e. *Z. kawagoii* Hayata, *Z. oligophyllum* K.Schum and the insufficiently studied *Z. pleiostachyum* K. Schum. Subsequently, *Z. shuanglongense* C.L.Yeh & S.W.Chung were described from central to southern Taiwan (Yeh et al. 2012). All four Taiwanese species belong to sect. *Cryptanthium*.

Recently, we discovered an unknown *Zingiber* in northern Taiwan belonging to the *Z.* sect. *Cryptanthium*, as indicated by the radical inflorescences with a procumbent peduncle. Here, we describe this new species of *Zingiber* and evaluate its conservation rank.

Materials and methods

An unknown species of *Zingiber* was found abundant on a rock cliff of Youluo riverside, where more than 100 individuals were observed in an area of ca. 400 m^2 (24.694, 121.184). In addition, more than 50 individuals were discovered in similar habitat along the same riverside (24.695, 121.220). Morphological measurements were made from both herbarium and spirit samples by a ruler and digital calipers. For morphological descriptions, the terminology used by Beentje (2012) and Leong-Škorničková et al. (2014) was followed.

Protologues of *Zingiber* spp. and herbarium specimens were examined, including type specimens deposited in HAST, IBSC, NTNU, TAI, TAIF, TCF, TI, TNM, and PPI, in addition to specimens at K, UPS, and US, which were available as images. Considering the similarity of the newly collected species and *Z. tenuifolium* L. Bai, Škorniček. & N.H. Xia, we also compared the Taiwanese species with *Z. tenuifolium,* as described by Bai et al. (2015b).

The conservation rank for the new species was evaluated according to IUCN (2017). Pollen grains for scanning microscope examination (voucher: *Z. chengii* Hsinchu County, Jianshih Township, *Y.C.Lin 1116* & *1148*, TCF) were prepared following Halbritter (1998): anthers were treated with DMP (2, 2-Dimethoxypropane) for 30 minutes and transferred to acetone for 30 minutes and critical-point dried. The material was mounted on a stub and sputter coated with gold (Quorum SC7620) and examined using a Hitachi S-3400N microscope.

A distribution map was generated by using QGIS ver. 3.4 from package of Lin (2018).

Taxonomic treatment

***Zingiber chengii* Y.H.Tseng, C.M.Wang, & Y.C.Lin, sp. nov.**
urn:lsid:ipni.org:names:77204420-1
Figs 1–5

Diagnosis. *Zingiber chengii* sp. nov. is morphologically similar to its Taiwanese congeners. However, the new species can be distinguished from them by its deciduous leafy shoots while those of *Z. kawagoii*, *Z. oligophyllum* and *Z. shuanglongense* are evergreen; *Z. chengii* has narrow lanceolate to linear leaves, whereas *Z. kawagoi* and *Z. shuanglongense* have ovate to lanceolate ones; except *Z. oligophyllum*, which has yellow flowers, all native species of Taiwan have reddish-purple flowers; each spike of *Z. chengii* bears 1–3 flowers, whereas spikes of *Z. kawagoi* and *Z. shuanglongense* bear 8–11 and 4–10 flowers, respectively; *Zingiber chengii* rarely has sterile bracts, whereas *Z. kawagoii* and *Z. shuanglongense* have apparent sterile bracts; *Zingiber chengii* has ovoid fruit, whereas *Z. kawagoii* and *Z. shuanglongense* has ellipsoidal one. Both *Z. kawagoii* and *Z. shuanglongense* are almost enveloped by the aril, whereas *Z. chengii* is one-third enveloped by the aril (Table 1).

Compared with the images of the syntype of *Z. pleiostachyum*, *Z. chengii* has much narrower lamina, with a length: width ratio of ca. 6 (vs. ca. 3.8 in *Z. pleiostachyum*) and rarely has sterile bracts. *Zingiber chengii* is similar to *Z. tenuifolium* L. Bai endemic to Yunnan (Bai et al. 2015b), but the number of blades per leafy shoot of *Z. chengii* is about 11–15 vs. 13–23 in *Z. tenuifolium*. The two species can also be distinguished by the length to width ratio of the lamina, which is ca. 6 in *Z. chengii* vs. ca. 10 in *Z. tenuifolium*. *Zingiber tenuifolium* also has apparent sterile bracts while these are rare in *Z. chengii*. These comparisons indicate that *Z. chengii* is clearly different from other known similar congeners, therefore we treat *Z. chengii* as a new species in Taiwan. Also, *Z. chengii* has ellipsoidal pollen grains with spiro-striate sculpturing (Fig. 5), and the inflorescence borne on a radical, procumbent peduncle (Fig. 1A, 2E, 3F). These characters indicate that this new species belongs to sect. *Cryptanthium*.

Type. TAIWAN. Hsinchu County, Jianshih township, elevation ca. 320 m, 23 May 2014. *Yen Hsueh Tseng 5614* (Holotype: TCF).

Description. Perennial rhizomatous herbs, 40–70 cm tall. Rhizomes fleshy, compacted, sympodial, densely branched, 0.8–1.4 cm in diameter, surface brown, center light yellow; root tubers terete, distantly from the rhizomes, ca. 3.8 × 1.2 cm, surface brownish green. Leafy shoots erect, 1–16 per plant, forming dense clumps, spreading, each shoot comprising 11–15 well-developed leaves at anthesis. Leaves deciduous, simple, distichous; ligules ca. 2 mm long, bilobed, membranaceous, pale green, auriculate; petiole 2.0–3.0 mm long, adnate to lamina by a pulvinus; lamina linear-lanceolate to lanceolate, 9–15 × 1.5–2.5 cm, length:width ratio 5.1–6.6, adaxial surface green, glabrous, abaxial surface pale green, pubescent along the midrib, base cuneate obtuse, apex acuminate, margin entire, conspicuously undulate, chartaceous.

Table 1. Morphological characters of *Zingiber chengii, Z. kawagoii, Z. shuanglongense,* and *Z. tenuifolium.*

Character	*Z. chengii*	*Z. kawagoii*	*Z. shuanglongense*	*Z. tenuifolium*
Rhizome	yellowish	yellow to greenish yellow	dark violet internally	yellow to greenish yellow
Leafy shoots	spreading to weakly arching, 11–15 leaves	erect, 6–21 leaves	erect, or slightly inclined, 7–21 leaves	spreading to weakly arching, 13–23 leaves
Lamina shape	linear-lanceolate to lanceolate, 9–15 × 1.5–2.5 cm	narrowly oblong to lanceolate, 12–29 × 3–8.5 cm	narrowly oblong to lanceolate, 12–23 × 2–7 cm	linear to narrowly ovate, 18–23 × 1.5–3.0 cm
Lamina length: width ratio	ca. 6	ca. 3.8	ca. 3.7	ca. 10
Flower number of each spike	1–3	8–11	4–10	unknown
Floral tube	extending at least 15 mm beyond the bract	extending at least 10 mm beyond the bract	extending at least 10 mm beyond the bract	extending only 2 mm beyond the bract
Color of corolla tube	cream-white	yellowish	cream-white	white with slight pink
Labellum	widely obovate, 21–33 × 29–19 mm, margin crisped, apex retuse or entire	obovate to oblong, 15–20 × 5–10 mm, apex retuse or entire or acuminate	broadly ovate or obovate, 24–34 × 15–16 mm, apex retuse or cleft	subrhombic to ovate, 24–28 × 13–17 mm, margin crisped, apex acuminate obtuse or shortly incised
Lateral staminodes	narrowly oblong, 18–24 × 4–7 mm, basal 1/3 to 1/4 connate to labellum, apex acute or obtuse	oblong, 14–18 × 5–6 mm, basal 1/2 to 2/3 connate to labellum, apex acute or obtuse	narrowly oblong, 15–29 × 3–6 mm, basal 1/3 to 1/4 connate to labellum, apex acute or obtuse	narrowly ovate, 13–18 × 3–5.5 mm, basal 1/3 to 1/2 connate to labellum, apex acute or obtuse
Color of labellum and lateral staminodes	violet, scattered with cream-white patches at base	red or deep violet, yellowish at base	violet, scattered with cream-white patches at base	deep violet with cream-white patch at base
Fruit shape	ovate	elliptic	elliptic	unknown
Seed enveloped by the aril	1/3	3/4	3/4	unknown

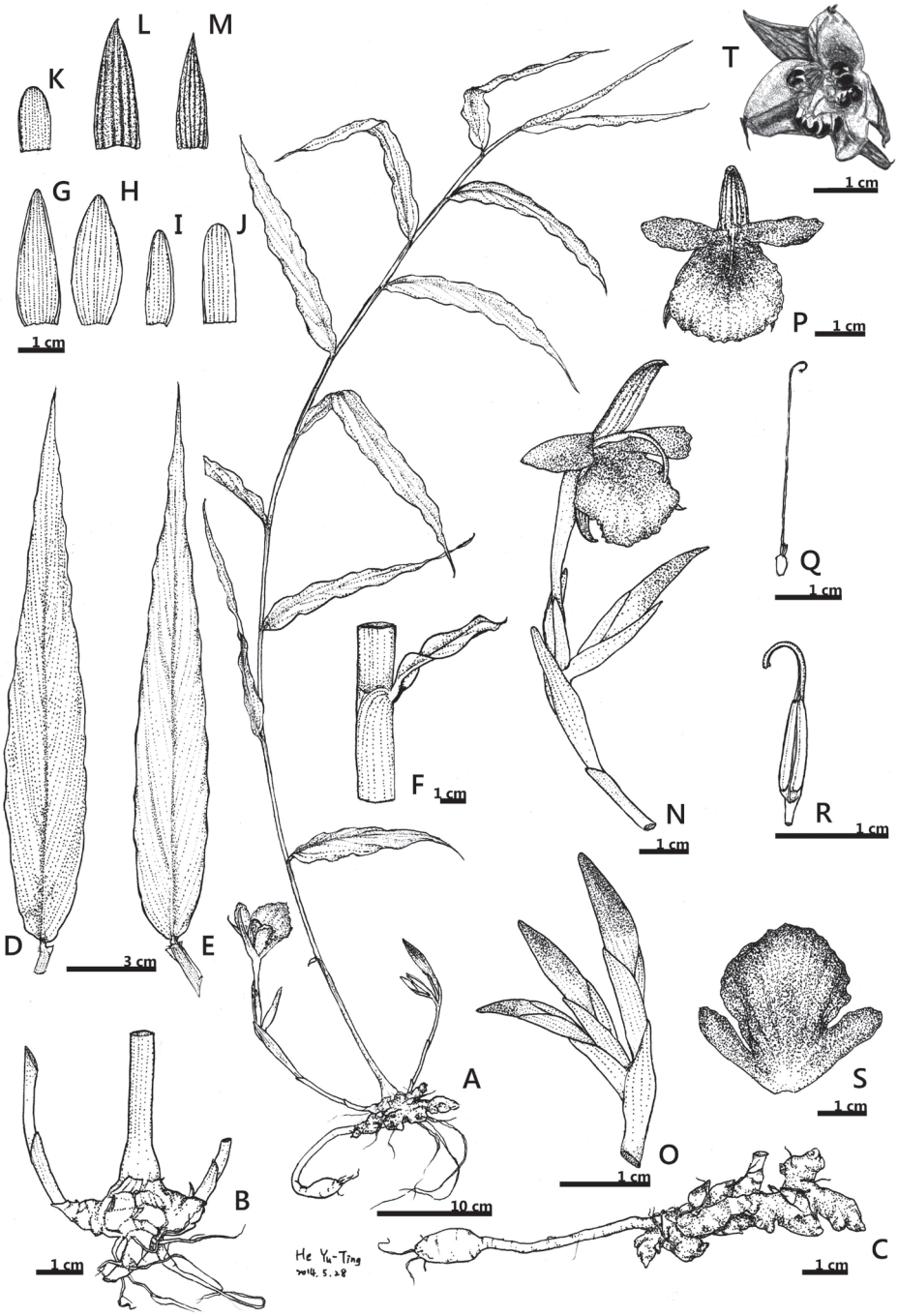

Figure 1. Line drawings of *Zingiber chengii* Y.H.Tseng, C.M.Wang & Y.C.Lin , sp. nov. **A** habit **B** base of plant **C** rhizome **D–E** leaf adaxial and abaxial surface **F** ligulate **G–K** bracts and bracteoles **L** dorsal corolla lobe **M** lateral corolla lobe **N–O** inflorescences **P** flower **Q** pistil **R** stamen and anther crest **S** labellum with basally connate lateral staminodes **T** fruit.

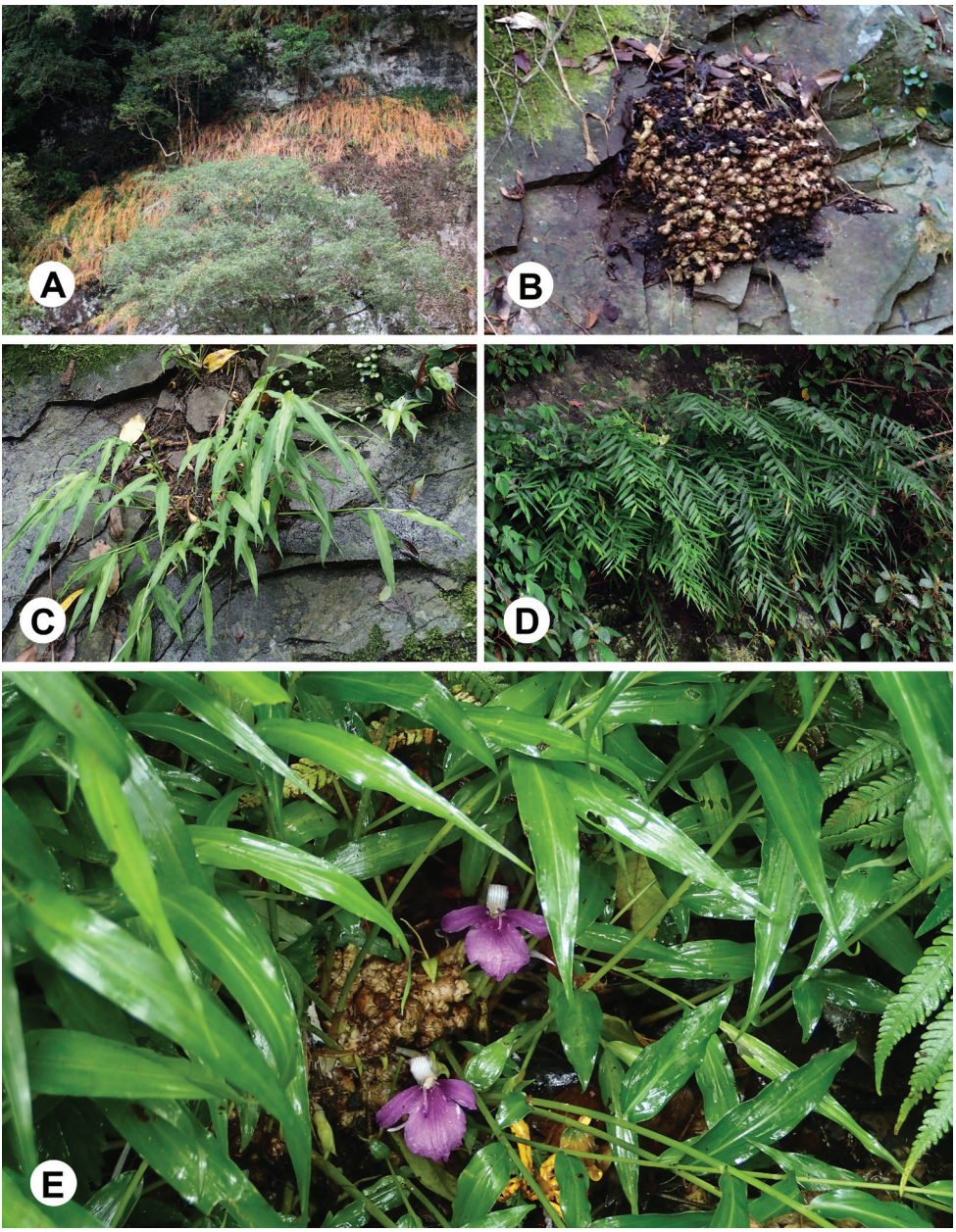

Figure 2. Phenologic phases of *Zingiber chengii* Y.H.Tseng, C.M.Wang & Y.C.Lin, sp. nov. **A** withering period **B** dormant period (rhizome) **C** growth period **D** mature period **E** flowering period.

Spike 1–2 per plant, arising from rhizomes; peduncles 2.5–6.2 cm long, ascending, glabrous; spike narrowly oblong, ca. 10.5–12.5 × 2.0–3.0 cm, each with 1–3 flowers; fertile bracts yellowish green, one-flowered, lanceolate, 2.5–3.0 × 0.6–0.8 cm,

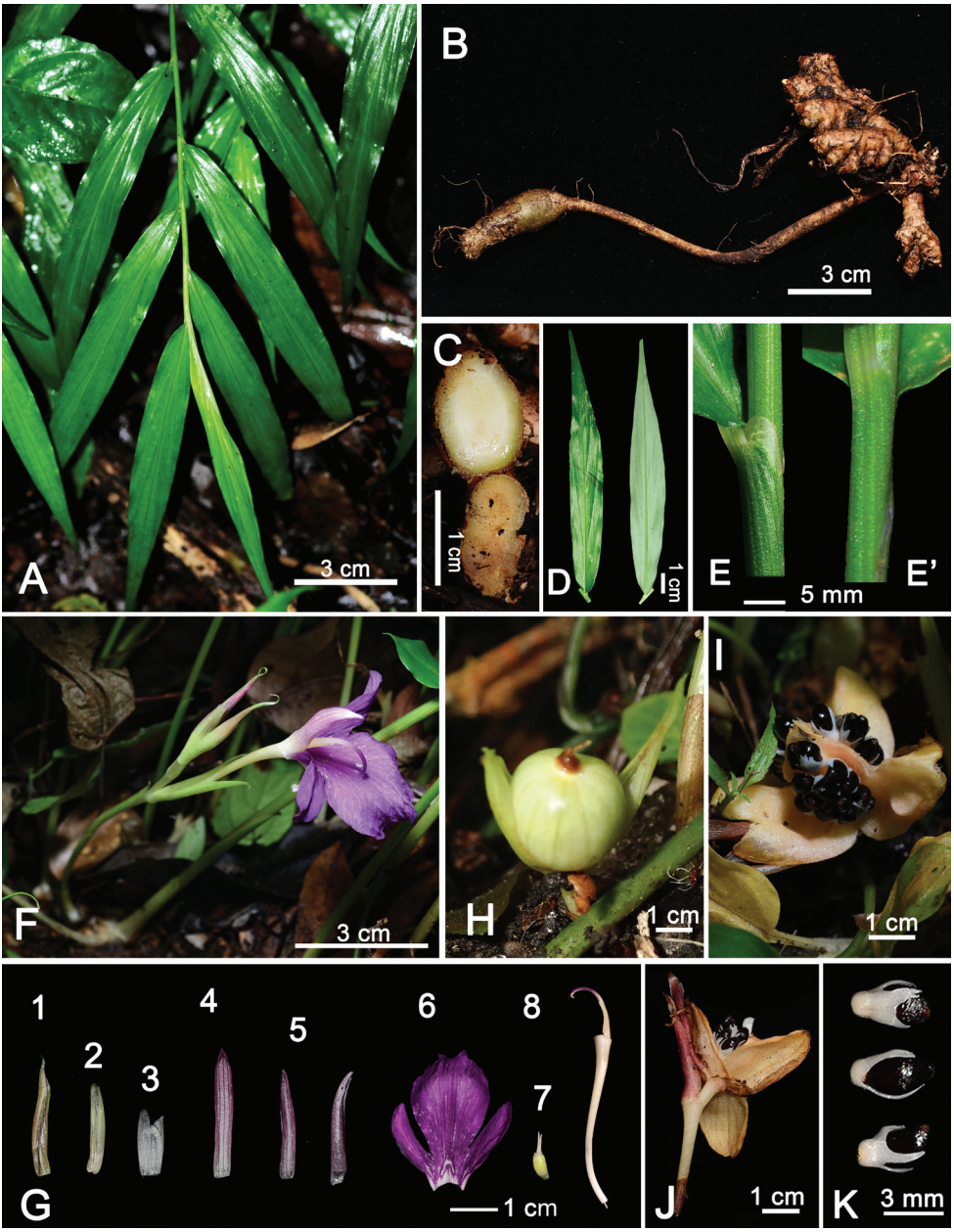

Figure 3. *Zingiber chengii* Y.H.Tseng, C.M.Wang & Y.C.Lin, sp. nov. **A** habit **B** rhizome **C** the cross-section of rhizome **D** leaf blade **E** ligule and sheath (side view) **E'** sheath (front view) **F** inflorescence **G** flower dissection **1** fertile bracts **2** Bracteole **3** calyx **4** dorsal corolla lobe **5** lateral corolla lobes **6** Labellum with basally connate lateral staminodes **7** ovary **8** floral tube with stamen and stigma (side view) **H–J** fruit **K** seeds.

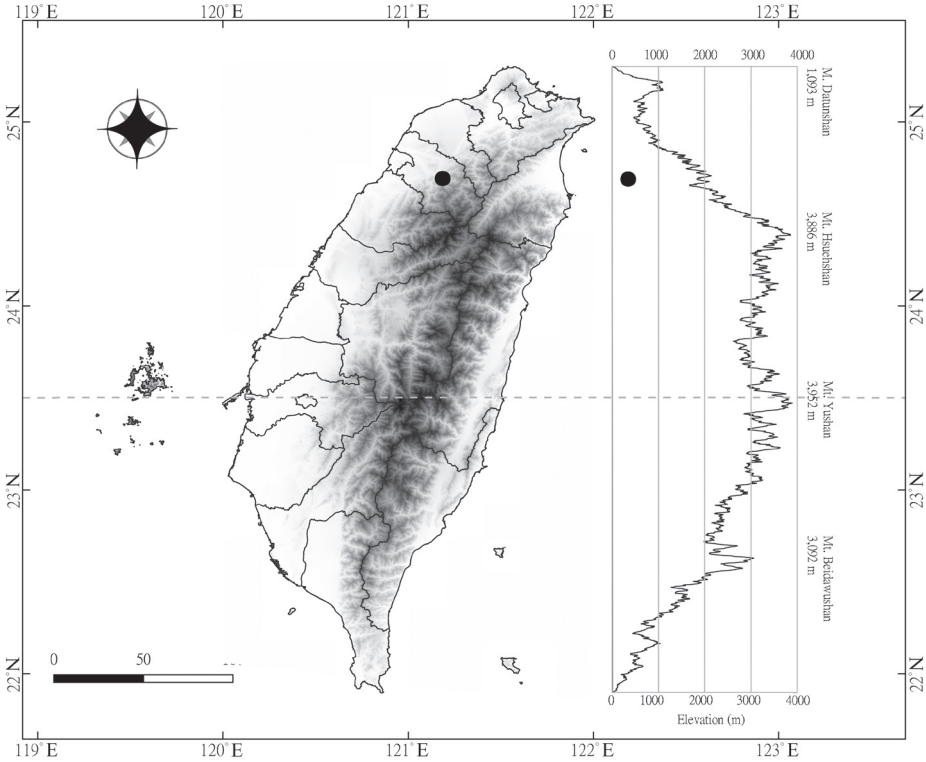

Figure 4. Distribution map of *Zingiber chengii* Y.H.Tseng, C.M.Wang & Y.C.Lin, sp. nov.

usually red tinged, usually involute on both sides, apex acute to attenuate; bracteole lanceolate, 1.8–2.8 × 0.6–0.8 cm, translucent green with slight red tinge, apex acute. Flowers ca. 7.0–9.0 cm long, exerting much beyond the bracts; calyx tubular, membranaceous, ca. 7 mm long, with unilateral incision, translucent. Corolla tube slender, ca. 3.5-cm long, cream-white, glabrous externally and internally; dorsal corolla lobe lanceolate, ca. 2.7 × 0.7 cm, purple, apex acuminate; lateral corolla lobes lanceolate, ca. 2.5 × 0.7 cm, purple, apex acuminate; labellum widely obovate, ca. 3.0 × 2.5 cm, purple, apex retuse or entire, scattered with cream-white patches at base; lateral staminodes narrowly oblong, ca. 2.0 × 0.5 cm, connate to labellum at ca. basal 1/3 to 1/4, purple. Stamen one; filament short; anther connective tissue cream-white, elongated appendage of a wrapped style; anther thecae two, ca. 1 cm long, longitudinal dehiscense, pollen light yellow; anther crest beak-shaped, ca. 1.5-cm long when stretched, purple, apex entire. Style filiform, white, ca. 5.5-cm long, extending to the end of anther crest; stigma white, ciliate. Ovary cylindrical, trilocular, ca. 6.0 × 3.0 mm, yellowish green, glabrous; epigynous glands two, narrowly conical, ca. 6-mm long, pale yellow, apices sharp. Capsule ovate, dehiscence loculicidally ca. 1.5 × 1.3 cm, usually as long as the persistent bract, pericarp yellowish cream or orange-red inside. Seed ellipsoid, ca. 4.0 mm × 2.0 mm, enveloped by the aril. Aril white, deep denticulate

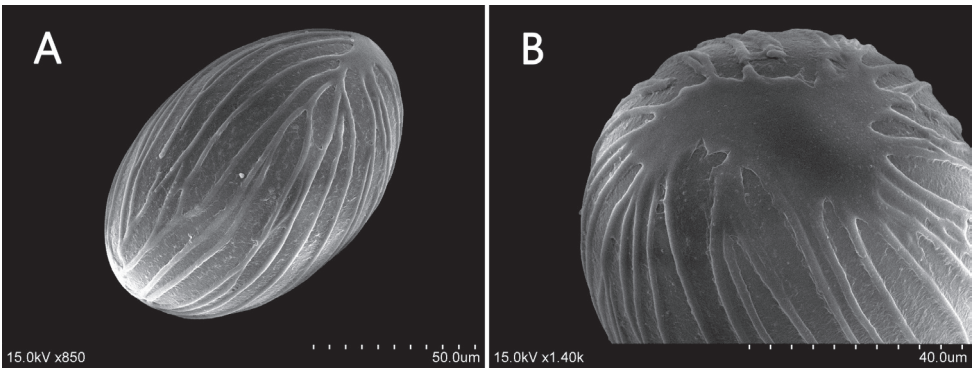

Figure 5. Pollen morphology of *Zingiber chengii* Y.H.Tseng, C.M.Wang & Y.C.Lin, sp. nov. **A** equatorial view **B** polar view.

at apex, enveloping 1/3rd of the length of the seeds. Pollen grains ellipsoidal, 103.16–112.01 × 68.73–81.73 μm with P/E ratio 1.32–1.56, surface inaperturate and with spiro-striate sculpturing (Fig. 5).

Phenology. Flowering between May and July, and fruiting between July and September. Growth and reproduction period between March and September, withering from September to November, and dormant period between December and February (Fig. 2).

Distribution and habitat. Endemic species of Taiwan. Based on the geographical climatic regions and vegetation zones (Su 1984, 1985), *Z. chengii* is distributed only in the northwest inland region, moist areas of cloud forests of the *Machilus–Castanopsis* forest zone at an altitude of 530 m, and is found only on the rock cliff of Yuluo riverside (Hsinchu County) in northern Taiwan (Fig. 4). Common companion species are *Arundo formosana* Hack. (Poaceae), *Sedum actinocarpum* Yamam. (Crassulaceae), *Rhaphidophora hongkongensis* Schott (Araceae), *Pothos chinensis* (Raf.) Merr. (Araceae), *Pilea plataniflora* C.H.Wright (Urticaceae), and *Pyrrosia lingua* (Thunb.) Farw. (Polypodiaceae). Sometimes, *Z. kawagoii* is found nearby; however, no potential hybrid individual has been observed.

Chinese name. Hsia-yeh-chiang (狹葉薑).

Etymology. The species epithet "*chengii*" was given in honor of Mr. Yuen-Chun Cheng (鄭元春) who first discovered the new species.

Conservation status. *Zingiber chengii* has been abundant on the rock cliff of Youluo riverside, where more than 100 individuals have been observed in an area of ca. 400 m^2, since 2014. However, its population gradually decreased due to disturbances by visitors. Additional specimens were discovered along the Yuluo riverside in similar riverine habitats. These areas are difficult to approach due to the presence of hazardous rivers and cliffs. We categorize the new species as Endangered (EN B1; C2a(i)) following IUCN (2017).

Additional specimens examined. *Zingiber chengii*: TAIWAN. Hsinchu County, Hengshan Township (24.694, 121.184), 23 May 2014. *Yen Hsueh Tseng 5615* (TCF); same loc., 29 May 2017. *Chao 4471* (TAIF); same loc., 25 July 2014. *Chiu-Mei Wang*

& Ching-Yao Li 16051 (TNM); same loc., 7 June 2015. *Y.C. Lin 1148* (TCF); Bilin Bridge (24.695, 121.220), 1 July 2015. *Y.C. Lin 1355* (TCF).

Zingiber shuanglongense: TAIWAN. Nantou County, Sinyi Township, Shuanglung Logging Trail, *Y.C.Lin 1294* (TCF); Jenlun Logging Road, *Y.C.Lin 1306* (TCF); Chiayi County, Jhuci Township, Mt. Dadungshan backbend (huitouwan), *Y.C.Lin 1292* (TCF); Kaohsiung City, Taoyuan District, Tengchih, *Y.C.Lin 1256* (TCF); Jiasian District, Mt. Paiyun, *Y.C.Lin 1319* (TCF).

Zingiber kawagoii: TAIWAN. New Taipei City, Shiding District, Mt. Erhkeshan, *Y.C.Lin 1066* (TCF); Nantou County, Jiji Township, Mt. Chichidashan, *Y.C. Lin 1290* (TCF); Chiayi County, Alishan Township, Lungtou, *Y.C. Lin 1278* (TCF), Mihu trail, *Y.C.Lin 1151* (TCF); Kaohsiung City, Maolin District, Shanping, *Y.C. Lin 985* (TCF); Pingtung County, Shizi Township, Shuangliu Forest Recreation Area, *Y.C. Lin 1303* (TCF).

Zingiber pleiostachyum: TAIWAN. Syntype: Pingtung County, Bankinsing mountains, *A. Henry 147* (K & UPS) & *1659* (K).

Identification key to the species of *Zingiber* in Taiwan

1 Ligules reduced, weakly bilobed; labellum yellowish ..... ***Z. oligophyllum***
– Ligules bilobed; labellum violet or reddish **2**
2 Spike rarely has sterile bracts; capsule ovate; 1/3rd of seed enveloped by the aril ..... ***Z. chengii***
– Spike has sterile bracts; capsule elliptic; 3/4th of seed enveloped by the aril **3**
3 Corolla tube yellowish; 1/2 to 1/3 of lateral staminodes connate to labellum; the capsule length is 1/2–2/3 of the persistent bract..... ***Z. kawagoii***
– Corolla tube cream-white; 1/3 to 1/4 of lateral staminodes connate to labellum; capsule equal to or longer than the persistent bract..***Z. shuanglongense***

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Paraphlomis kuankuoshuiensis (Lamiaceae), a new species from the limestone areas of northern Guizhou, China

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Abstract

Paraphlomis kuankuoshuiensis (Lamiaceae), a new species found in the limestone areas of northern Guizhou, China, is described and illustrated in this paper. Based on its tubular-campanulate calyx, this taxon should be a member of sect. *Paraphlomis* Prain. The new species resembles *P. patentisetulosa* C.Y. Wu & H. W. Li, *P. hispida* C.Y. Wu, and *P. hirsutissima* C.Y. Wu & H.W. Li, but differs from these three taxa in the following aspects: the stems are very short (<7 cm), with one or two short internodes, giving the impression of having a tuft of basal leaves; it has sparsely setose hairs on the outer surface of the calyces and short fruiting calyces. The florescence, fruit period, habitat, and the geographical distribution of *P. kuankuoshuiensis* are also quite different from the three closely related species.

Keywords

Guizhou, karst, limestone flora, new taxon, Paraphlomideae, *Paraphlomis kuankuoshuiensis*

Introduction

Paraphlomis (Prain) Prain is a genus of about 24 species in Lamiaceae (Ko et al. 2014), of which 23 *Paraphlomis* species and seven varieties were recorded from China (China Botanical Flora Editorial Committee 1977, Li and Hedge 1994, Xiang et al. 2010). The genus is characterized by erect galeate corollas with longer upper lips than lower

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lips; rounded and bearded upper corolla lips, five-toothed calyces, and two-cleft, subequal style apices (Ko et al. 2014).

Paraphlomis was separated from *Phlomis* by Prain in 1901 (Azizian and Moore 1982) and was supported as an independent genus (Pan et al. 2009). Scheen et al. (2010) placed the genus *Paraphlomis* in the tribe Lamioideae and they suggested that its phylogenetic position is uncertain although their analyses do place two accessions of *Paraphlomis* in the vicinity of *Phlomis*. Based on the DNA sequence data from chloroplast regions, Bendiksby et al. (2011) established a new tribe, Paraphlomideae which includes three genera: *Paraphlomis* Prain, *Matsumurella* Makino, and *Ajugoides* Makino. Results from Li et al. (2016) also supported the circumscription of the tribe.

In recent years, a small number of new *Paraphlomis* taxa were reported across mainland China, including *P. breviflora* B.Y. Ding, Y.L. Xu et Z.H. Chen (Ding et al. 2019) in the Zhejiang Province; *P. javanica* (Blume) Prain var. *pteropoda* D. Fang & K.J. Yan and *P. javanica* (Blume) Prain var. a*ngustifolia* C.Y. Wu & H.W. Li f. *albinervia* D. Fang & K.J. Yan (Yan and Fang 2009), are both from the Guangxi Province. In addition, Xiang et al. (2016) treated two varieties of *Paraphlomis* species as new synonyms: *P. javanica* var. *pteropoda* D. Fang et K. J. Yan as *P. javanica* (Blume) Prain var. *javanica* and *P. javanica* var. *angustifolia* f. *albinervia* D. Fang et K. J. Yan as *P. javanica* var. *angustifolia* (C. Y. Wu) C. Y. Wu et H. W. Li, respectively.

During fieldwork, a new species of *Paraphlomis* was discovered in Kuankuoshui National Natural Reserve, Suiyang County, Guizhou Province, China. Based on its tubular-campanulate calyces, the new species was placed in Sect. *Paraphlomis*. This species has bristled tubular-campanulate calyces, conspicuous calyx teeth, and oblong-elliptic and hairy leaves which resemble *P. patentisetulosa* C.Y. Wu et H.W. Li, *P. hispida* C.Y. Wu and *P. hirsutissima* C.Y. Wu & H.W. Li. However, the new species differs from these three taxa in a variety of ways. For instance, it has very short stems (< 7 cm), with one or two short internodes, giving the impression of having a tuft of basal leaves; it has sparsely setose hairs on the outer surface of the calyx and short fruiting calyces. Morphological characteristics indicate that this species differs from the above mentioned *Paraphlomis* species and should be considered a new species in this genus.

Materials and methods

All morphological characteristics were measured using dissecting microscopes. The flowering and fruiting specimens of the potential new species were checked at ZY (Thiers 2019). Three specimens of *P. patentisetulosa* were observed at IBSC and their collecting numbers were 37835 (Type), 163476, and 12441. One specimen of *P. hispida* (92449) was observed at IBK. The following traits (some of them not described in "Flora of China") were carefully surveyed: indumentum, length of the corolla, shape and length of the bracteoles, (fruiting) calyx tubes and teeth, and nutlets (92449 has no nutlet).

Digital specimens, including 33 taxa belonging to 19 *Paraphlomis* species (Table S1), were checked at AU, BH, BNU, FJFC, GXMG, IBK, JIU, JJF, KUN, NAS, PE, and SM herbaria through NSII platform (http://www.nsii.org.cn/2017/home.php),

with the additional consultation of online databases, including the Plant Photo Bank of China (http://ppbc.iplant.cn/), Chinese Field Herbarium (http://www.cfh.ac.cn/), and Global Plants (http://plants.jstor.org/).

Results

Paraphlomis kuankuoshuiensis **R.B.Zhang, D.Tan & C.B.Ma, sp. nov.**
urn:lsid:ipni.org:names:77204425-1
Figs 1–2

Diagnosis. *Paraphlomis kuankuoshuiensis* can be distinguished from the morphologically similar species *P. patentisetulosa, P. hispida,* and *P. hirsutissima* by its very short stem (< 7 cm) with one or two short internodes (giving the impression of having a tuft of basal leaves). The three closely related species have stems longer than 15 cm and more internodes. The new species has sparsely setose hairs on the outer surface of the calyces (vs. finely or densely) and short fruiting calyces (5-6 cm vs. 7 cm, 8-9 cm, and to 11 cm). There are some other diagnostic characters between the new species and its three closely related species (Table 1). The flowering from July to August and fruiting from August to September are quite different from the three species (vs. fruiting from November to January). It grows on bare steep rocks, which is a distinctive habitat. The new species distributes in Guizhou Province and is far away from the other three species (Fig. 3).

Type. CHINA. Guizhou Province, Zunyi City, Suiyang County, Kuankuoshui National Natural Reserve, on moist rocks, 28°11'N, 107°04'E, 820 m alt., 22 July 2019, *ZRB1509* (fl., holotype ZY!, isotype IBK!), 24 August 2019 *ZRB1575* (fr., paratype ZY!).

Description. Perennial herb. ***Rhizomes*** short, 2–4 cm, dense and fibrous roots. ***Stems*** 2–5 (–7), unbranched, 2–7 cm, slightly grooved, densely strigose, with 1 or 2 pairs of leaves for each stem. ***Leaves*** long elliptic or long obovate, (thickly) papery, 10–37 × 3–8 cm, apex obtuse or acute, base cuneate, margin serrulate; petioles 0.5–4 cm, adaxially slightly grooved, strigose; lateral veins in 8–12 pairs, obviously concave above and slightly raised below; adaxial surfaces and abaxial veins densely strigose. ***Inflorescence*** with one to two verticillasters; verticillasters 7-46-flowered; flowers shortly petiolate; apical opposite cymes globose, pseudoterminal; bracteoles linear-lanceolate, ca. 5 mm, margin ciliolate. ***Calyx*** tubular-campaniform, red; tube 5–6 mm, sparsely bristled, 10 veins; 5 teeth, unequal, triangular-lanceolate, 1–2 mm. ***Corolla*** white, 2-lipped, ca. 2.2 cm; tube obliquely hairy annulate inside; upper lip oblong, entire, galeate, with pink spots outside; lower lip 3-lobed, with a pink-striped interior and larger middle lobe. ***Stamens*** 4, anterior pair longer, all rising under upper corolla lip; filaments puberulent; anthers two-loculed, forked. ***Style*** filiform, exceeding stamens, apex 2-lobed, lobes subequal. ***Ovary*** 4-loculed, small ovary apex truncate, glabrous. ***Disc*** ring like, not obvious. ***Nutlets*** ca. 2.5 mm long, apex truncate, base attenuate. ***Fl.*** Jul–Aug. ***Fr.*** Aug–Sep.

Distribution and habitat. Based on current field observations, *P. kuankuoshuiensis* is only located in the Dazhuxi and Matixi valleys, the Kuankuoshui National Natural Reserve, Suiyang County, Guizhou Province. The area has a subtropical monsoon cli-

Table 1. Comparing the diagnostics of *Paraphlomis kuankuoshuiensis* sp. nov., *P. patentisetulosa*, *P. hispida*, and *P. hirsutissima*.

	Traits	*P. kuankuoshuiensis* sp. nov.	*P. patentisetulosa*	*P. hispida*	*P. hirsutissima*
Stems	Height (cm)	**2–7**	15–25	Ca. 60	> 20
	Habit	**Erect and tufted**	Ascending	Slightly ascending	Flexuous
	Habitat	**Steep rock surface beside stream**	Beside stream	In tropical forests or thickets	In gravels below tropical forests
	Leaf blades (cm)	10–**37** × 3–8	5.5–14.5 × 2.5–7	3–20 × 1.8–11.5	5.5–13 × 2–5
Fruiting calyces	Shape	Tubular-campanulate	Tubular-campanulate	Tubular-campanulate	**Tubular**
	Length (mm)	**5–6**	To 11	Ca. 7	8–9
	Hairs	**Sparsely** bristly, glabrous inside	Finely bristly outside	Densely hispid, glabrous inside	?
	Tooth length (mm)	Ca. 2	Ca. 3	**Ca. 5**	Ca. 2
	Tooth direction	Erect	Erect	Erect	**Reflexed**
	Nutlet apices	Truncate	**Rounded**	Truncate	?
	Fl.	**Jul–Aug**	?	?	?
	Fr.	**Aug–Sep**	Nov	Nov–Jan	Jan
	Distributed province in China	**Guizhou**	Guangdong	Yunnan [Vietnam]	Yunnan

Note: question mark (?) indicates that that character is not described in the references.

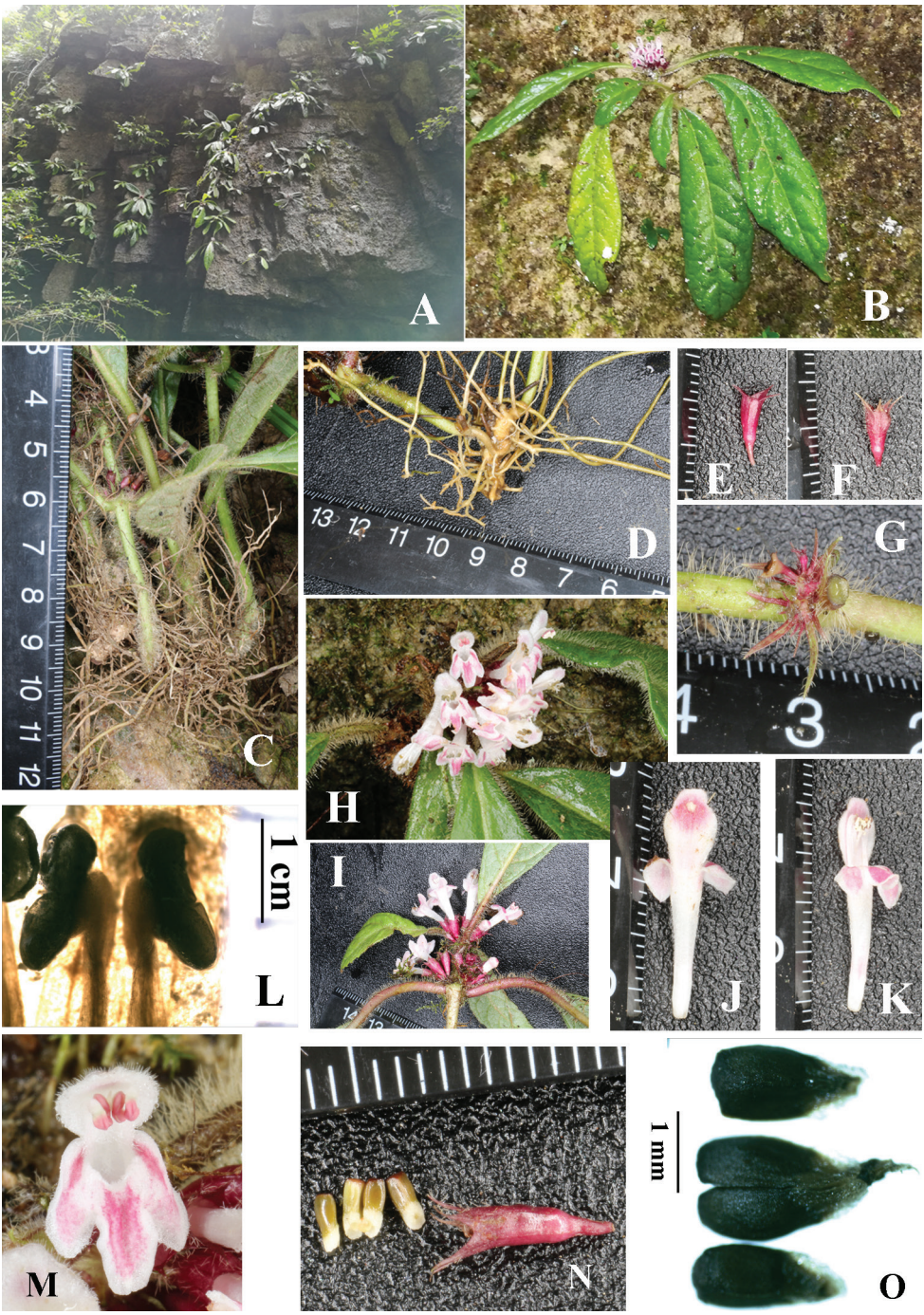

Figure 1. *Paraphlomis kuankuoshuiensis* spe. nov. **A** natural habitat **B** flowering plant **C** short and tufted stems **D** rhizome **E–F** calyces **G** bracteoles **H** frontal view of verticillaster **I** lateral view of verticillaster **J–K** corolla **L** anthers **M** front view of corolla **N** fresh nutlets and fruiting calyx **O** dried nutlets. Photographed by Ren-Bo Zhang.

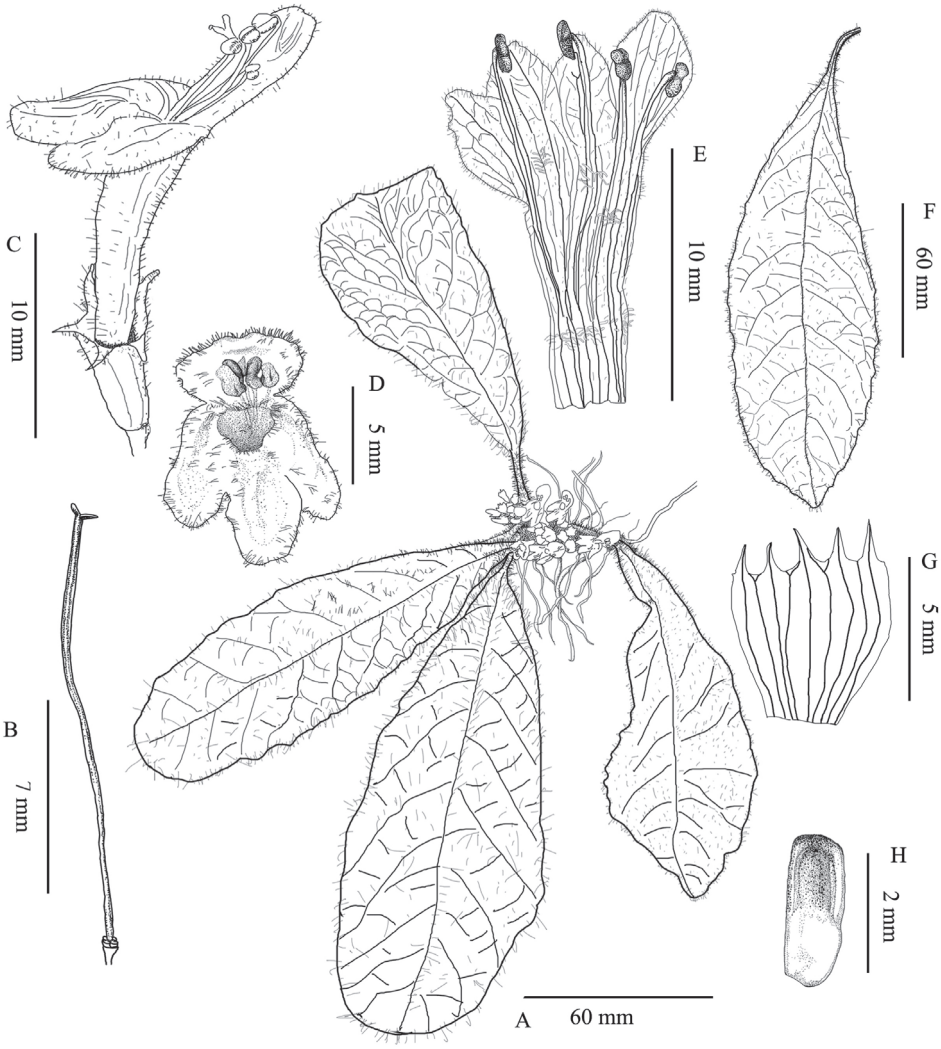

Figure 2. *Paraphlomis kuankuoshuiensis* sp. nov. **A** flowering plant **B** pistil **C** flower **D** front view of corolla **E** opened corolla **F** leaf **G** opened calyx **H** nutlet. Drawn by Tan Deng.

mate and it is wet but not seasonly dry. It grows on moist steep limestone rocks (almost bare) beside streams at an altitude of approximately 820 m, and in groups of several thousand individuals.

Conservation status. This species is currently known to only occur in two valleys, with a population numbering several thousand individuals. It is suggested it be placed in the Near Threatened IUCN category (IUCN 2017).

Phenology. This new species was observed flowering from July to August and fruiting from August to September.

Etymology. The specific epithet '*kuankuoshuiensis*' is derived from the plant's locality: Kuankuoshui National Natural Reserve, Guizhou Province, China.

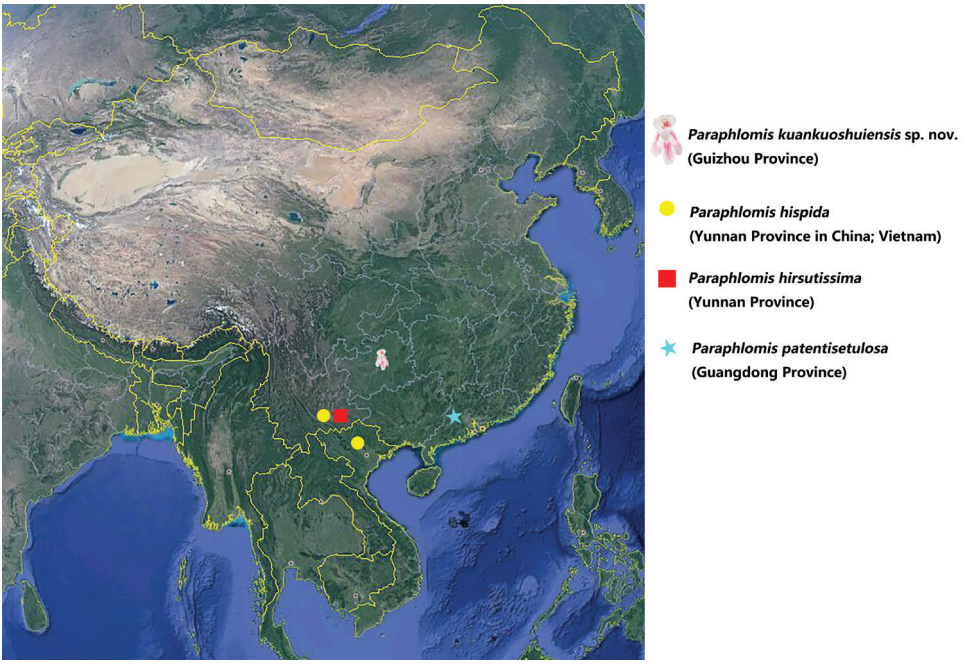

Figure 3. The geographical distribution of *Paraphlomis kuankuoshuiensis* sp. nov. and its three closely related species.

Acknowledgments

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Supplementary material 1

Table S1. Digital *Paraphlomis* specimens checked at herbaria through NSII platform

Authors: Ren-Bo Zhang, Tan Deng, Quan-Li Dou, Ruo-Xun Wei, Lin He, Chong-Bo Ma, Sheng Zhao, Shun Hu

Data type: species data

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Link: https://doi.org/10.3897/phytokeys.139.47055.suppl1

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RESEARCH ARTICLE

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Eriocoma valdesii, a new species from México (Poaceae, Stipeae)

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Abstract

Eriocoma valdesii **sp. nov.**, is described and illustrated. The new species was found growing on calcareous rocky slopes and hillsides between 1700–2721 m in Coahuila, Nuevo León, San Luis Potosí, and Tamaulipas. The new species is morphologically similar to *Eriocoma lobata* but differs in having ligules (2–) 4.5–8.5 mm long with acute to narrowly acute and lacerate apices and florets with a sharp-pointed callus. In addition, we include a key to the species of *Eriocoma* in northeastern México.

Resumen

Se describe e ilustra una nueva especie, *Eriocoma valdesii* **sp. nov.** La nueva especie se encontró creciendo en laderas calcáreas rocosas y laderas entre 1700–2721 m en Coahuila, Nuevo León, San Luis Potosí y Tamaulipas. La nueva especie es morfológicamente similar a *Eriocoma lobata*, pero difiere en tener lígulas de (2–) 4.5–8.5 mm de largo con ápices y flósculos agudos a estrechamente agudos y lacerados con un callo puntiagudo. Además, incluimos una clave para las especies de *Eriocoma* en el noreste de México.

Keywords

Eriocoma, grasses, Poaceae, Stipeae, taxonomy

Introduction

The tribe Stipeae Dumort. comprises temperate, cool-season (C_3) grasses that generally occupy somewhat moist to predominantly dry temperate steppe communities worldwide. They represent an ecologically and morphologically specialized lineage within the

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subfamily Pooideae including approximately 527 species in 33 genera and a single hybrid genus (Tzvelev 1977; Watson and Dallwitz 1992; Barkworth 2007; Romaschenko et al. 2008, 2010, 2011, 2012, 2013, 2014; Soreng et al. 2015, 2017; Peterson et al. 2019). Grasses in this tribe have spikelets with a single floret without a rachilla extension, disarticulation above the glumes, round to pointed well-developed calluses, membranous to coriaceous or indurate lemmas usually with a conspicuous terminal awn, two or three linear-elliptic faintly-vascularized lodicules, and indurate caryopses with a linear hilum (Tzvelev 1977; Clayton and Renvoize 1986; Watson and Dallwitz 1992, Barkworth 2007; Everett et al. 2009; Romaschenko et al. 2012; Clayton et al. 2016; Peterson et al. 2019).

Eriocoma Nutt., recently resurrected to replace *Achnatherum* P. Beauv. for most of the American species, consists of 27 species in North America (Canada, México, and USA), and is characterized by having a maize-like lemma epidermal pattern along with the same features mentioned above for the tribe (Romaschenko et al. 2012, 2014; Peterson et al. 2019). Within México, 7–11 species of *Eriocoma* have been reported (Espejo Serna et al. 2000; Dávila et al. 2018; Sánchez-Ken 2018). The remaining six species of *Achnatherum* in México were placed in *Pseudoeriocoma* Romasch., P.M. Peterson & Soreng, and these all have woody, sometimes scandent bamboo-like culms with ramified branching at the middle and upper nodes (Peterson et al. 2019).

Thirty years ago, in September 1989, Penelope Sue Hoge along with Mary E. Barkworth and Jesus Valdés Reyna gathered material from a new species (referred to as "*valdesii*") near Estación Carneros, Coahuila. Hoge (1992) was working on a master's thesis with Barkworth at Utah State University coined and placed "*valdesii*" as a subspecies of *Stipa alta* Swallen. We (PMP, KR & JVR) visited the same locality in 2012 and 2019, and gathered more material from "*valdesii*" to include in our molecular DNA sequence studies investigating the phylogeny of *Eriocoma* and *Pseudoeriocoma* (Valdés Reyna et al. 2013). Based on our unpublished phylogeny of DNA nuclear/plastid sequences and morphological study we describe "*valdesii*" as a new species of *Eriocoma*. In addition, we include a key to the species of *Eriocoma* that we have seen vouchers of from northeastern México (Coahuila, Nuevo León, San Luis Potosí, Tamaulipas).

Taxonomy

***Eriocoma valdesii* Hoge ex Romasch., P.M. Peterson & Soreng, sp. nov.**
urn:lsid:ipni.org:names:77204848-1
Fig. 1A–M

Type. México, Coahuila, Municipio de Saltillo, 2 km above Estación Carneros just below microondas [25.12306N, 101.11828W], 2270 m, 13 Sep 2012, *Peterson, Romaschenko & Valdés Reyna 24469* (holotype: US-3741901!; isotypes: ANSM!, US-3741902!).

Diagnosis. Differing from *Eriocoma lobata* (Swallen) Romasch. in having ligules (2–) 4.5–8.5 mm long with acute to narrowly acute and lacerate apices (verses ligules ≤ 1.5 mm long with truncate apices) and florets with a sharp-pointed callus (verses florets with a blunt callus) [Swallen 1933; Barkworth 2007; Valdés Reyna 2015].

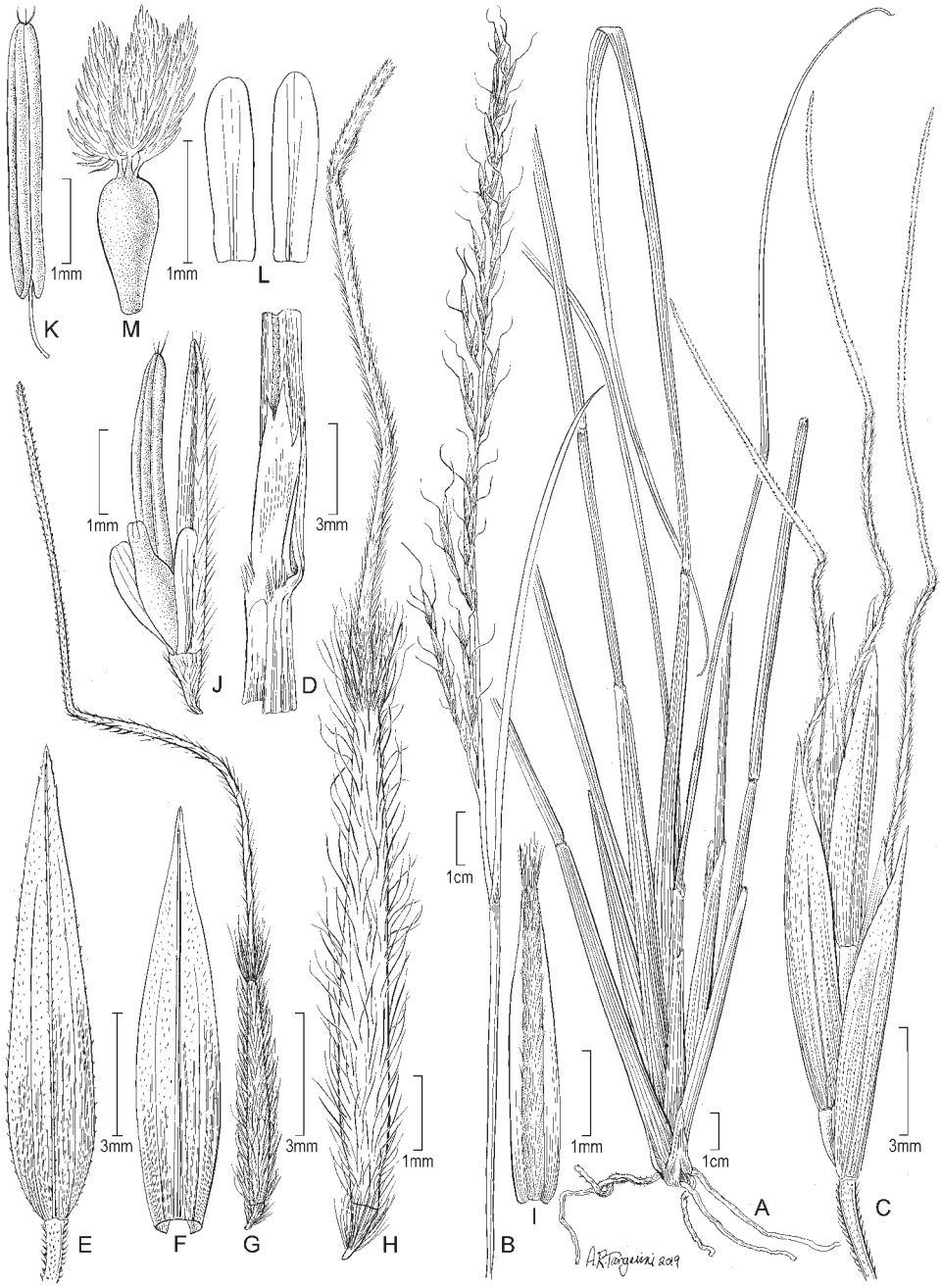

Figure 1. *Eriocoma valdesii*. **A** Habit **B** culm and panicle **C** panicle branch **D** sheath, ligule, and blade **E** lower glume **F** upper glume **G** floret **H** floret, enlarged **I** palea **J** palea, lodicules, ovary, and stamen **K** stamen **L** lodicules **M** ovary. Drawn from the holotype collection (*Peterson, Romaschenko & Valdés Reyna 24469*).

Description. ***Perennials***, cespitose, without rhizomes. ***Culms*** 60–130 cm tall, erect, unbranched above, 2–4 mm in diameter near the base, nodes 3–4 below the inflorescence, glabrous. ***Leaf sheaths*** shorter than the internodes, glabrous, older ones dorsally flattened below; **collar** glabrous or sparsely pubescent; ***ligules*** (2–) 4.5–8.5 mm long, strongly asymmetrical, membranous, margins decurrent, often with small hairs above, the hairs less than 1 mm long, apex acute to narrowly acute, lacerate; ***blades*** (15–) 25–50 (–60) cm long, (2–) 3–5 mm wide, flat to involute, glabrous, smooth below, scabrous above and along margins. ***Panicles*** 12–35 cm long, 1–2 cm wide, narrow and contracted; ***branches*** 1–6.5 cm long, ascending, straight and tightly appressed. ***Spikelets*** 8–13 mm long, usually lanceolate, subterete, rarely laterally compressed, with one fertile floret without rachilla extension, disarticulation above the glumes; ***glumes*** 8–13 mm long, longer than the florets, membranous, mostly hyaline above, 3-veined, unawned, apex long acuminate; ***lower glumes*** 10–13 mm long; ***upper glumes*** 8–12 mm long; ***florets*** (including the callus) 6–7.5 mm long, terete, fusiform, straminious to light brownish; **callus** about 1–1.4 mm long, densely bearded with hairs up to 1.5 mm long, the base sharp-pointed and slightly curved; ***lemmas*** coriaceous, indurate, evenly hairy, the hairs 1–1.4 (–2) mm long, apex 2-lobed, the lobes about 0.2–0.5 mm long; ***lemmatal awns*** 12–24 mm long, 1 or 2-geniculate, the lowest one or two segments twisted and short hairy (sometimes only visible in young material), the hairs less than 1 mm long, upper segment scabrous; ***paleas*** 3.2–5 mm long, shorter than the lemma, hairy, 2-veined, veins not prolonged; ***stamens*** 3, ***anthers*** (2.6–) 3–3.3 mm long, dehiscent, penicillate; ***lodicules*** 2 or 3, about 1.2–1.5 mm long, narrow-elliptic; stigmas 2. ***Caryopses*** 4–6 mm long, fusiform, pericarp adherent, hilum linear.

Distribution. The new species is known from the Municipio de Bustamante in Tamaulipas, the Municipio Catorce in San Luis Potosí, the Municipio de Saltillo in Coahuila, and the Municipios Galeana and Santa Catarina in Nuevo León.

Conservation status. The species is rare in México, but with more collecting it probably will be found in the adjacent state of Zacatecas.

Etymology. The specific epithet honors Jesus Valdés Reyna (1948–), a renowned Mexican agrostologist, friend, and colleague who PMP, RJS, and KR have worked with for more than 35 years.

Ecology. The new species has been found on calcareous (gypsum) rocky slopes and hillsides at 1700–2721 m associated with *Pinus cembroides* Zucc, *P. teocote* Schltdl. & Cham., *Juniperus coahuilensis* (Martínez) Gaussen ex R.P. Adams, *Quercus pringlei* Seemen, *Cowania mexicana* D. Don, *Rhus virens* Lindh. ex A. Gray, *Parthenium incanum* Kunth. *Arctostaphylos pungens* Kunth, *Arbutus xalapensis* Kunth, *Buddleja tomentella* Standl., *Bauhinia ramossisima* Benth. ex Hemsl., *Cercocarpus betuloides* Nutt., *Yucca carnerosana* (Trel.) McKelvey, *Agave lechuguilla* Torr., *A. gentryi* B. Ullrich, *Mimosa biuncifera* Benth., *Eriocoma lobata*, *Muhlenbergia*, *dubia* E. Fourn., *M. pubescens* (Kunth) Hitchc., *Pseudoeriocoma multinodis* (Scribn. ex Beal) Romasch., *Erioneuron avenaceum* (Kunth) Tateoka, *Aristida curtifolia* E. Fourn., *Bouteloua uniflora* Vasey, *Berberis* sp., *Brickellia* sp., *Prunus* sp., *Salvia*, spp., *Stevia* sp., *Tagetes* sp., *Dasylirion* sp., *Ephedra* sp., *Brahea* sp., and *Heliotropium* sp.

Discussion. Another species morphologically similar to *E. valdesii* in having sharp-pointed calluses, although not yet collected in México, is *E. scribneri* (Vasey) Romasch. found in the USA in western Texas, New México, Arizona, Colorado, Utah, and southeastern Wyoming (Barkworth 2007). However, *E. scribneri* differs in having shorter ligules ≤ 1.5 mm long with truncate apices and paleas 2.5–3.5 mm long (verses paleas 4–5 mm long in *E. valdesii*). *Eriocoma arida* (M.E. Jones) Romasch., also with sharp-pointed calluses, differs from our new species in having lemmatal awns 40–80 mm long that are obscurely 1-geniculate and scabrous throughout (Barkworth 2007). Reports of *E. arida* from Hidalgo and Nuevo León, México (Sánchez-Ken 2018) are perhaps in error since Dávila et al. (2018) did not record this species and Barkworth (2007) reported it as not found in México. *Eriocoma perplexa* (P.S. Hoge & Barkworth) Romasch. was reported in Dávila et al. (2018) and Sánchez-Ken (2018) as occurring in Coahuila but it was not included in Valdés Reyna's (2015), Gramíneas de Coahuila. It differs from *E. valdesii* in having shorter ligules 0.2–3.5 mm long [verses (2–) 4.5–8.5 mm long in *E. valdesii*] and a blunt callus only 0.4–0.6 mm long (verses 1–1.4 mm) [Barkworth 1993, 2007]. The new species can sometimes be confused with *Eriocoma robusta* (Vasey) Romasch., a much taller species up to 2.3 m tall with hairy collars, particularly on the flag leaves (glabrous or sparsely pubescent in *E. valdesii*), florets with a blunt callus, and lemmatal awns that are 20–32 mm long with the lower two segments scabrous (lemmatal awns 12–24 mm long and lower two segments short hairy in *E. valdesii*) [Barkworth 2007; Valdés Reyna 2015]. The new species is most similar to *Eriocoma alta* (Swallen) Romasch. since both species share long ligules, long leaf blades up to 60 cm long, and florets with sharp-pointed calluses (Swallen 1943). However, *E. alta* differs from the new species in having dark brown (verses straminious to light brownish in *E. valdesii*) florets 4–5.5 mm long (verses 6–7.5 mm long) with awns 8–12 mm long (versus 12–24 mm long), the awns scaberulous below (verses short hairy below), and short upper glumes 7–8 mm long (verses 8–12 mm long). *Peterson, Saarela & Romaschenko 23219* from Nuevo León differs from other collections of *E. valdesii* in having short, lacerate ligules about 2 mm long.

In our preliminary molecular DNA sequence analysis of most American species of *Eriocoma* there is a strongly-supported *E. lobata* I clade (including the type) found allied with *E. coronata* (Thurb.) Romasch., *E. parishii* (Vasey) Romasch., and *E. perplexa* (Valdés Reyna et al. 2013). In another portion of our tree a strongly-supported clade of five accessions of *E. valdesii* (including *Peterson, Romaschenko & Valdés Reyna 24469*, the type collection) forms a trichotomy with two other strongly-supported clades containing three accessions of *E. alta* (including the type) and seven accessions of *E. lobata* II (Valdés Reyna et al. 2013). All specimens examined below were sampled, except *Hoge, Barkworth & Valdés Reyna 295*, and formed a clade in our DNA analysis with the type.

Specimens examined. México. **Coahuila:** Municipio de Saltillo, Highway 54 from Saltillo to Concepción del Oro, S to just past Estación Carneros, take road on right to tower, 2160 m, 18 Sep 1989, P.S. Hoge, M.E. Barkworth & J. Valdés Reyna 295 (ANSM, UTC); Sierra Madre Oriental, Estación Carneros, carretera 54, camino a la torre de microondas. 25°12'29"N, 101°24'01"W, 2258 m, 8 Sep 2008, Valdés Reyna &

M.E. Barkworth 3085, 3087 (ANSM); 3 km above Estacion Carneros on road to radio tower, 25.12190N, 101.12006W, 2315–2400 m, 30 Oct 2019, *P.M. Peterson, K. Romaschenko & J. Valdés Reyna 26818* (CIIDIR, US). **Nuevo León:** Municipio Galeana, 2.3 mi N of Hwy 31 on dirt road, 24.70478N, 100.16019W, 2222 m, 9 Sep 2010, P.M. Peterson, J.M. Saarela & K. Romaschenko 23219 (US, CIIDIR); 27 km SW of Galeana on Hwy 58 towards San Roberto, 24.68214N, 100.11637W, 2 Nov 2019, *P.M. Peterson & K. Romaschenko 26884* (CIIDIR, US); Municipio Santa Catarina, edge of Parque Nacional Cumbres de Monterey, slopes above Puerto del Canejo, 25.49686N, 100.58644W, 2538–2721 m, 6 Sep 2010, P.M. Peterson, J.M. Saarela, K. Romaschenko & I. Cabral Cordero 23158 (US, CIIDIR). **San Luis Potosí:** Municipio Catorce, 3km E of San Jose de Coronados, 23.59105N, 100.89556W, 6 Nov 2019, *P.M. Peterson & K. Romaschenko 26941* (CIIDIR, US). **Tamaulipas:** Municipio de Bustamante, 16 km al SE de Bustamante hacia La Presita y Tula. 23°21'N, 99°40'W, 1700 m, 26 May 1982, J. Valdés Reyna & M.A. Carranza 1474 (ANSM, US-3103546).

Key to the species of *Eriocoma* in northeastern México

1 Callus sharp-pointed; ligules apices acute to acuminate, often lacerate, (2–) 4.5–8.5 mm long **2**

– Callus blunt and obtuse; ligules apices truncate, entire usually ≤ 2 mm long (rarely up to 3 mm) **3**

2 Florets dark brown, 4–5.5 mm long; lemmatal awns 8–12 mm long, scaberulous below; upper glumes 7–8 mm long..... ***E. alta***

– Florets straminious to light brown, 6–7.5 mm long; lemmatal awns 12–24 mm long, the awns short hairy below; upper glumes 8–12 mm long..... ***E. valdesii***

3 Flag leaves with a densely pubescent collar, the hairs 0.5–2 mm long; apex of lemma entire, not lobed; lemmatal awns 20–32 mm long..... ***E. robusta***

– Flag leaves with a glabrous or sparsely pubescent collar; apex of lemma lobed, the lobes (0.3–) 0.5–1.2 mm long; lemmatal awns 8–18 (–22) mm long..... ..... ***E. lobata*** **(I clade)**

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RESEARCH ARTICLE

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Two new species of the Andean genus *Xenophyllum* (Senecioneae, Compositae)

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Abstract

Two new species of *Xenophyllum* are described from the Andes, *X. funkianum* **sp. nov.** from Ecuador and *X. lorochaqui* **sp. nov.** from northwestern Argentina. Both species are compared with the morphologically closest taxa and useful characters for their proper identification are provided. Detailed illustrations and distribution maps are also presented, as well as pictures of living plants when available.

Keywords

Andes, Argentina, Asteraceae, Ecuador, taxonomy, *Werneria*

Introduction

The Andean genus *Xenophyllum* V.A.Funk (Senecioneae) was coined to embrace 21 species that were traditionally placed under the Neotropical genus *Werneria* Kunth (Weddell 1856; Blake 1928; Rockhausen 1939; Cabrera 1948). Funk (1997) transferred to *Xenophyllum* those species developing genuine or rhizome-like stems and narrowed the *Werneria* concept to the species strictly rosettiform or scapiform. Such circumscription was later adopted by most botanists working on this plant group (e.g., Nordenstam 1999; Freire and Ariza-Espinar 2014; Jørgensen 2014; Beltrán 2016; Calvo et al. 2017).

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The species belonging to *Xenophyllum* are strictly Andean, distributed from northeastern Colombia to northern Argentina and Chile. They are suffruticose plants displaying involucral bracts fused at the base, capitula radiate (disciform in one species), ray florets usually white (yellow or pink in a few species), filament collar balusterform, and style branches truncate with a crown of sweeping hairs or penicillate. Two main subgroups can be differentiated according to the type of growth form. One includes the species forming dense mats or hummocks, which have rhizome-like stems with marcescent leaves along them. The other subgroup embraces those species with genuine erect stems forming clumps or even developing a shrubby habit.

Ongoing studies aiming to obtain a modern and comprehensive taxonomic revision of the genus *Xenophyllum* led us to describe two new species, one from Ecuador and the other from Argentina. The Ecuadorian species has a restricted distribution area nearby the Chimborazo Volcano and is known from a few gatherings. The Argentinian species thrives in the northwestern provinces and was widely confused with other members of the genus. Detailed descriptions, illustrations, distribution maps, and taxonomic discussions are provided for each species, as well as pictures of living plants when available.

Materials and methods

This contribution is the result of an intensive review of the published bibliography and the revision of herbarium specimens kept at BA, BM, BR, GH, LIL, QCA, QCNE, US, and W. Additionally, a digital herbarium specimen was obtained from SI; herbarium acronyms follow Thiers (2019+). A Standard 16WL microscope was used for the examination of the achene trichomes. Fieldwork was conducted in Ecuador.

Taxonomy

1. *Xenophyllum funkianum* J.Calvo, sp. nov.
urn:lsid:ipni.org:names:77204849-1
Figs 1, 2

Diagnosis. *Xenophyllum funkianum* is well characterized by its creeping rhizome-like stems 20–35 cm long, the straight linear leaves prolonged into a sheath-like base that bears arachnoid trichomes, the dark-burgundy sessile involucres with 13–14 involucral bracts, the 12–13 white ray florets somewhat purplish beneath, and by having white-villous achenes.

Type. Ecuador. Chimborazo: Mt. Chimborazo area, at the end of *Polylepis* road and beginning of hike to *Polylepis* forest, 1°31'50"S, 78°52'55"W, 4233 m, 20 Apr 2018, *V.A. Funk & J.M. Bonifacino 14059* (holotype: US!; isotypes: MO!, QCA!).

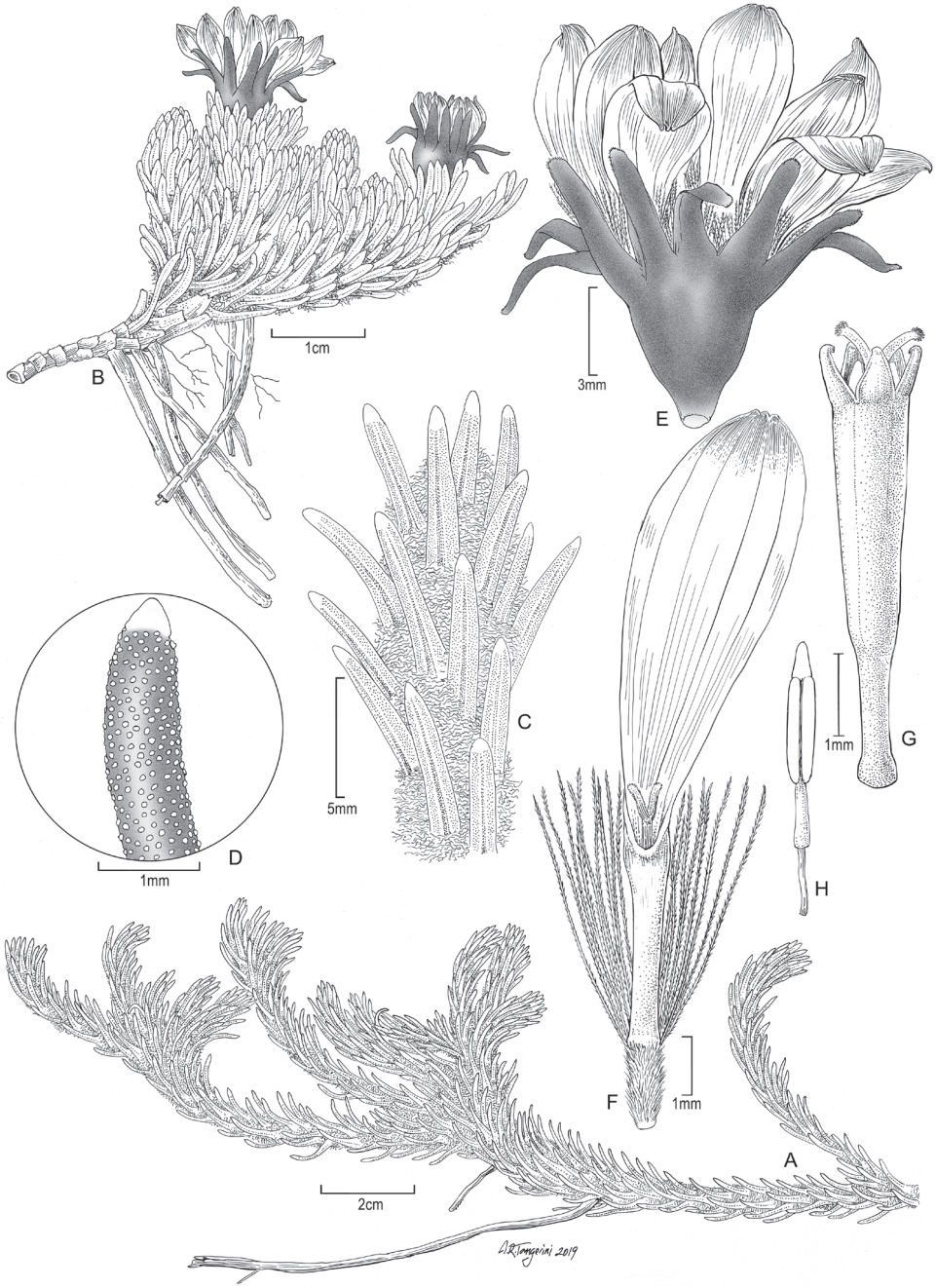

Figure 1. *Xenophyllum funkianum* **A** habit **B** habit with capitula **C** stem apical part **D** detail of leaf apex **E** capitulum **F** ray floret and achene (frontward bristles removed) **G** disc floret without pappus and achene **H** stamen. All details drawn from *Funk & Bonifacino 14059* (US). Illustration by Alice Tangerini.

Figure 2. *Xenophyllum funkianum* **A** capitulum **B** involucre and leaves **C** habit **D** apex of achene trichomes (20× Standard 16WL); material taken from *Funk & Bonifacino 14059* (US).

Description. Suffruticose plants, forming creeping lax mats, with rhizome-like stems 20–35 cm long, 0.3–0.5 cm in diam., covered by arachnoid indumentum and leaf-base remnants resembling paleae, horizontal, simple or branched from the base. ***Stems*** 2–3 cm long (aerial part), arachnoid. ***Leaves*** simple, alternate, imbricate, straight, prolonged into a sheath-like base that bears arachnoid trichomes; leaf laminas linear, 5.3–7.8 mm long, 0.8–0.9 mm wide, entire, rather acute, callous-tipped at the apex, elliptical in cross section, glabrous, unconspicuously nerved above, 1-nerved beneath (only conspicuous on the lower third), fleshy, shiny, papillose. ***Capitula*** radiate, solitary, terminal, erect, sessile. ***Involucres*** 9–11 mm long, 5–7 mm wide, cupu-

liform, with bracts fused at the base, glabrous; involucral bracts 13–14, 4.7–6.9 mm long, 1.0–1.7 mm wide at the base, acute at the apex, dark-burgundy; without supplementary bracts. ***Ray florets*** 12–13, corollas 8.9–11.6 mm long, 2.3–3.0 mm wide, 4-veined, subentire to 3-toothed at the apex, conspicuously surpassing the involucre, white, somewhat purplish beneath. ***Disc florets*** 20–23, corollas 5.0–5.6 mm long, 5-lobed, yellowish; style branches truncate with a crown of sweeping hairs, yellowish; anther bases obtuse; anther appendages two times longer than wide, ca. 0.4 × 0.2 mm. ***Achenes*** cylindrical, with white-villous trichomes (immature); pappus 3.9–6.2 mm long, barbellate, whitish. Chromosome number unknown.

Distribution and habitat. Endemic to Ecuador (provinces of Bolívar and Chimborazo) (Fig. 3). It grows in exposed places and sandy soils of the dry superparamo, at elevations of 4100–4300 m.

Phenology. Flowering from April to July.

Etymology. The epithet honors the American botanist Vicki A. Funk (1947–2019), who greatly contributed to the understanding of the family Compositae worldwide.

Discussion. *Xenophyllym funkianum* is morphologically close to *X. rigidum* (Kunth) V.A.Funk, a species distributed in central Ecuador which overlaps its distribution area. They can be easily differentiated by the leaf lamina size (5.3–7.8 × 0.8–0.9 mm in *X. funkianum* vs. 12.6–13.5 × 2.3–2.4 mm in *X. rigidum*), involucre size (9–11 × 5–7 mm in *X. funkianum* vs. 11.5–12.8 × 7.2–11.3 mm in *X. rigidum*), and number of disc florets (20–23 in *X. funkianum* vs. 38–41 in *X. rigidum*). Moreover, *X. rigidum* is a larger plant and the capitula are completely enclosed among the leaves. *Xenophyllym funkianum* also shows morphological affinities with *X. humile* (Kunth) V.A.Funk; indeed, previous botanists confused the new species with it. They differ in the leaf shape (straight in *X. funkianum* vs. usually articulate in *X. humile*), involucre length (9–11 mm in *X. funkianum* vs. 4.6–9.3 mm in *X. humile*), and achene indumentum (white-villous in *X. funkianum* vs. glabrous in *X. humile*). Their way of growing is also different; *X. humile* forms dense mats or hummocks, whereas *X. funkianum* is rather a creeping plant. Another similar species is *X. roseum* (Hieron.) V.A.Funk, a species known from the Ecuadorian provinces of Azuay and Cañar that does not overlap the distribution area with the new species. Any confusion is unlikely since *X. roseum* displays pink ray florets and the young leaves usually bear a quickly deciduous arista up to 0.5 mm.

The white-villous achene indumentum of *X. funkianum* is composed of twin filiform trichomes, with acute to subacute, asymmetrical, slightly forked apex (Fig. 2D). This type of indumentum is also found in *X. rigidum* and *X. roseum*; however, most species of the genus have glabrous achenes.

Additional specimens examined (paratypes). Ecuador. Bolívar: road to Salinas, 1.8 km W of Guaranda-Ambato hwy., 1°25'S, 79°0'W, 25 Jun 1989, *L.J. Dorr & I. Valdespino 6474* (QCA barcode 159734, QCNE-47994, US barcode 00622748); **Chimborazo:** Mt. Chimborazo area, side road ends and connects to trail that leads to the *Polylepis* forest, 1°32'S, 78°53'W, 20 Apr 2018, *V.A. Funk & J.M. Bonifacino 14061* (US); W side of the Chimborazo volcano, arenal around loma Guagua Lozán, 1°27'S, 78°54'W, 3 Jul 1999, *P. Sklenář 7528* (QCA barcode 161918, QCNE-159009, PRC n.v.).

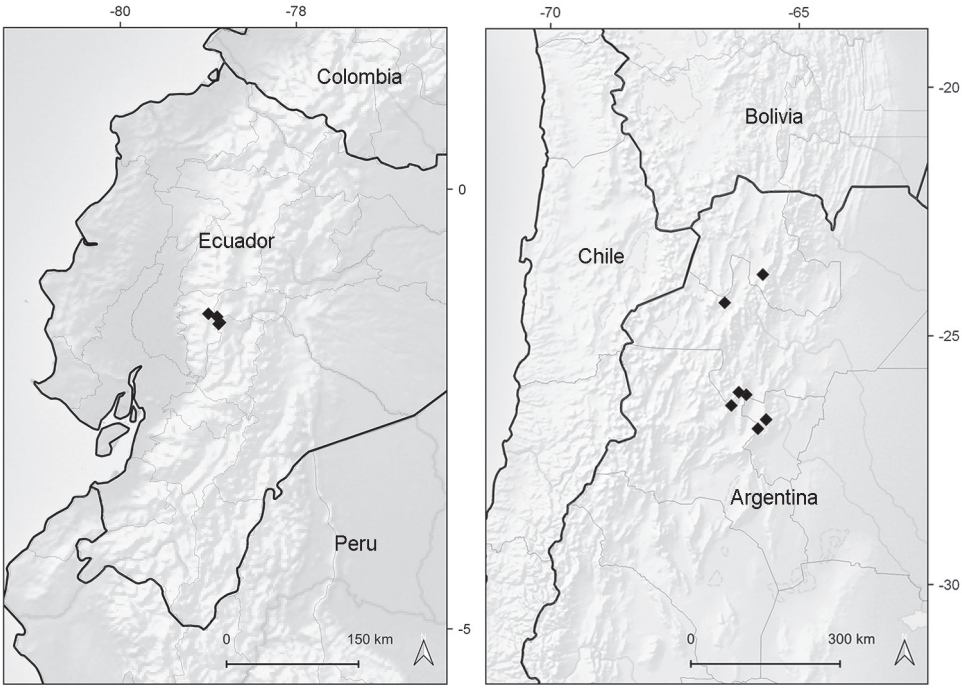

Figure 3. Distribution map of *Xenophyllum funkianum* (left hand) and *X. lorochaqui* (right hand).

2. *Xenophyllum lorochaqui* J.Calvo & V.A.Funk, sp. nov.
urn:lsid:ipni.org:names:77204850-1
Fig. 4

Diagnosis. *Xenophyllum lorochaqui* can be identified by the glabrous erect stems 10–20 cm tall, which usually only bear leaves on the upper part, leaf laminas 7.9–11.5 mm long, leaf apex 3-notched with the central lobe entire or barely notched and longer than the lateral ones, involucres with ca. 13 involucral bracts, and by displaying 26–39 ray florets with white corollas.

Type. Argentina. Catamarca: El Cajón, Negroara, [26°24'S, 66°22'W], 15 Jan 1914, *L. Castillón 3365* (holotype: LIL-26677!; isotypes: BM s.n.!, BR s.n.!, US barcode 00622893!, W-334!).

Description. Suffruticose plants, forming clumps of erect stems, 10–20 cm tall. ***Rhizomes*** 5–10 cm long, 0.6–0.8 cm in diam., horizontal to oblique, glabrous. ***Stems*** branched, glabrous, usually only bearing leaves on the upper part. ***Leaves*** simple, alternate, imbricate, prolonged into a sheath-like base glabrescent or with evanescent arachnoid trichomes; leaf laminas linear, broadened upward, 7.9–11.5 mm long, 2.3–2.7 mm wide, entire, 3-notched at the apex, with the central lobe longer than lateral ones, conduplicate upward in cross section, glabrous, unconspicuously nerved on both faces, fleshy, matte; central leaf lobe 1.0–1.6 mm long (lateral ones 0.5–0.8 mm long),

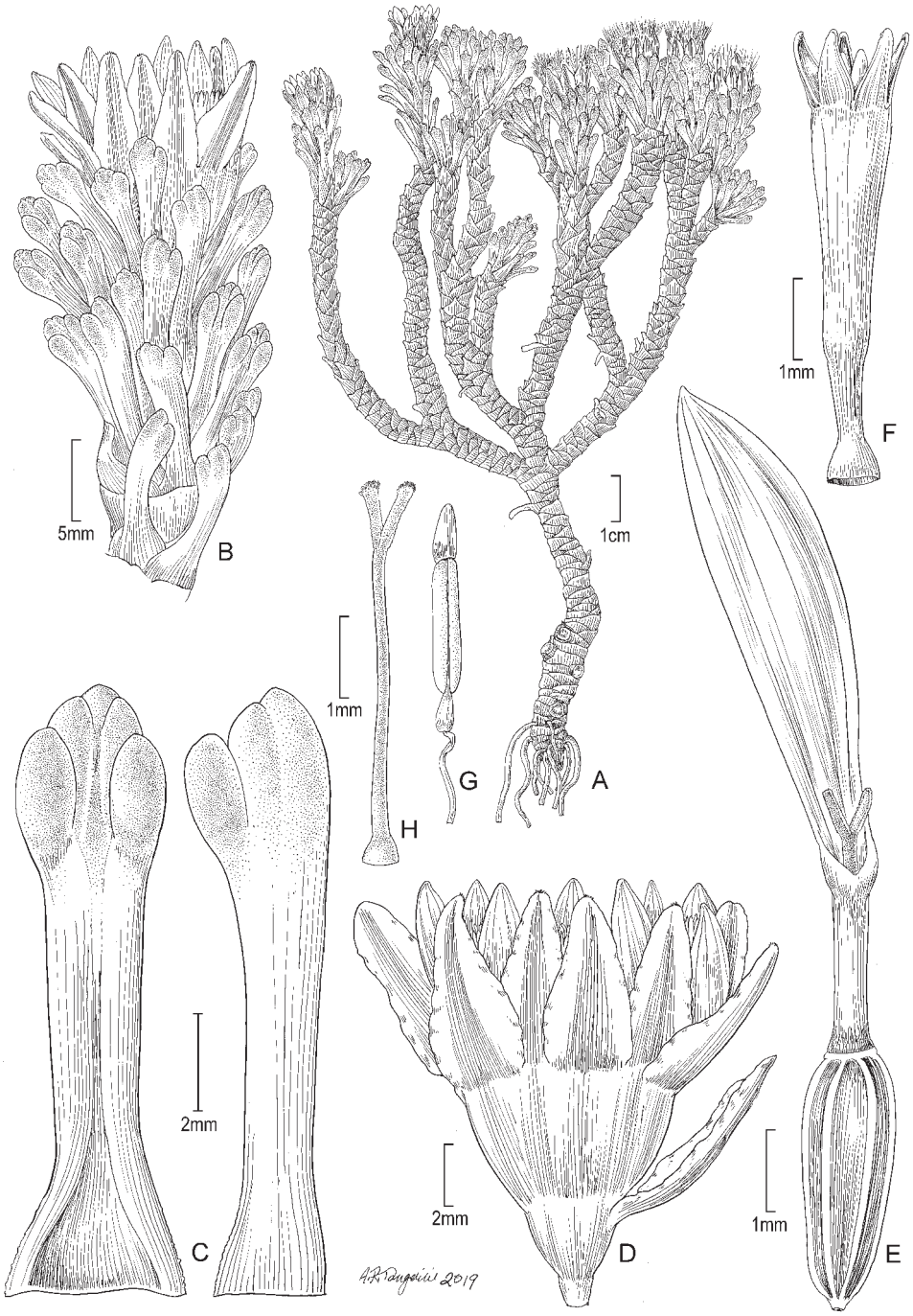

Figure 4. *Xenophyllum lorochaqui* **A** habit **B** stem apical part with capitulum **C** adaxial leaf surface (left hand) and vertical leaf profile (right hand) **D** capitulum **E** ray floret with achene (pappus removed and not drawn) **F** disc floret without pappus and achene **G** stamen **H** style. **A, B** drawn from *Díaz s.n.* (GH) and **C–H** from *Castellanos s.n.* (BA). Illustration by Alice Tangerini.

1.3–1.6 mm wide at the maximum width point, entire or notched, obtuse. ***Capitula*** radiate, solitary, terminal, erect, sessile. ***Involucres*** 10.3–10.9 mm long, 6.6–8.7 mm wide, cupuliform, with bracts fused at the base, glabrous; involucral bracts ca. 13, 5.9–7.0 mm long, 1.4–2.5 mm wide at the base, obtuse at the apex, greenish; without supplementary bracts. ***Ray florets*** 26–39, corollas 8.3–9.2 mm long, 1.1–1.4 mm wide, 4-veined, subentire to 3-toothed at the apex, conspicuously surpassing the involucre, white. ***Disc florets*** 40–57, corollas 4.2–5.5 mm long, 5-lobed, yellowish; style branches truncate with a crown of sweeping hairs, yellowish; anther bases auriculate; anther appendages two times longer than wide, ca. 0.5 × 0.2 mm. ***Achenes*** 2.5–3.1 mm long, 0.7–0.9 mm wide, cylindrical, 8–9-ribbed, glabrous; pappus 4.3–6.1 mm long, barbellate, whitish. Chromosome number unknown.

Distribution and habitat. Endemic to northwestern Argentina (provinces of Catamarca, Jujuy, Salta, and Tucumán) (Fig. 3). It grows in exposed rocky slopes and bare soils of the dry Puna ecoregion, between elevations of 3500−5000 m.

Phenology. Flowering from January to March.

Etymology. The epithet *lorochaqui* is the vernacular name of this plant as it was stated on the labels of the collections made by the Argentinian botanist León Castillón (pupil of botanist Miguel Lillo). It means parrot's foot referring to the leaf shape. The Spanish word "loro" means "parrot" and derives from "roro", used by some Taíno peoples and presumably adopted by the Spaniards during the colonization. On the other hand, "chaqui" is a Quichuan word meaning "foot".

Discussion. *Xenophyllum lorochaqui* is morphologically close to *X. incisum* (Phil.) V.A.Funk, *X. dactylophyllum* (Sch.Bip.) V.A.Funk, and *X. poposa* (Phil.) V.A.Funk, and it partially overlaps its distribution area with *X. incisum* and *X. poposa*. The differences against *X. incisum* are the leaf lamina length (3.2–7.3 mm vs. 7.9–11.5 mm in *X. lorochaqui*), the length of the leaf apex lobes (similar vs. central lobe longer than lateral ones in *X. lorochaqui*), the involucre length (6.4–8.3 mm vs 10.3–10.9 mm in *X. lorochaqui*), the involucral bract number (ca. 8 vs. ca. 13 in *X. lorochaqui*), and the ray floret number (8–13 vs. 26–39 in *X. lorochaqui*). *Xenophyllum incisum*, moreover, is a species restricted to the banks of the salt lagoons and plains with a certain humidity of the desertic Puna ecoregion. With regard to *X. dactylophyllum*, the leaf apex shape let anyone readily discriminate from one another. In this latter species, it is ca. 9-divided (finger-like) with the primary division extending deeper than the subsequent ones, whereas in *X. lorochaqui* the leaf apex is 3-notched with the central lobe longer than lateral ones. *Xenophyllum dactylophyllum* is distributed from central Peru to central Bolivia. Some useful characters to differentiate the new species from *X. poposa* are the stem indumentum (arachnoid vs. glabrous in *X. lorochaqui*), the leaf lamina length (2.5–6.1 mm vs. 7.9–11.5 mm in *X. lorochaqui*), the involucral bract number (8–9 vs. ca. 13 in *X. lorochaqui*), and the ray floret number (8–11 vs. 26–39 in *X. lorochaqui*).

It is important to bring to light some considerations that previous botanists made regarding the identification of this species. The Argentinian D. Rodríguez identified it

in sched. as "Werneria incisa Phil. vel aff.!" (*Werneria incisa* or similar [≡ *X. incisum*]), and annotated "f. foliis triplo longioribus" (leaves three times longer); see *Rodríguez 1382*. This latter remark perfectly matches one of the aforementioned characters that discriminates *X. lorochaqui* from *X. incisum*. On the other hand, L. Castillón identified his own collection as "Werneria dactylophylla Wedd. aff.", which also reveals the failure of providing an accurate identification; see *Castillón 3365*. Later, Cabrera (1948) and Freire and Ariza-Espinar (2014) placed the collection *Rodríguez 1382* under the varietal name *X. incisum* var. *pubescens* (Rockh.) Cabrera & S.E.Freire.

On an orthographic note, it is important to state that the epithets *lorochaqui* and *poposa* respond to the respective vernacular names of these species, and therefore, they are nouns in apposition not to be declined.

Additional specimens examined (paratypes). Argentina. Jujuy: Tumbaya, cerro Moreno, 23°46'S, 65°44'W, 7 Feb 1929, *S. Venturi 9289* (US barcode 00622892); **Salta:** Cafayate, sierra de los Quilmes, 26°11'S, 66°4'W, 28 Jan 1943, *A. Castellanos s.n.* (BA-47088); abra del Gallo, ca. 40 km al SW de S. Antonio de los Cobres, en el camino a Pastos Grandes, 24°20'S, 66°30'W, 17 Dec 1946, *A. Krapovickas 3215* (LIL-433562, SI s.n.); nevado del Cajón [sierra de Quilmes], 26°8'S, 66°13'W, 1 Mar 1914, *D. Rodríguez 1382* (BA-25293, BR s.n.); **Tucumán:** cerro Muñoz, 26°52'S, 65°50'W, Jan 1916, *L. Castillón s.n.* (BR s.n. [mixed with *X. poposa*, individual on the bottom]); Tafí, cumbres de San José (La Mina), 26°41'S, 65°40'W, Mar 1933, *Díaz s.n.* (GH s.n., LIL-58643); Tafí, cumbre de Chasquivil, 26°41'S, 65°40'W, 12 Jan 1945, *D. Olea 252* (LIL-122530); Chicligasta, estancia Las Rosas, 15 Jan 1927, *S. Venturi 6342* (US barcode 00622889); Tafí, sierra del Cajón [sierra de Quilmes], Los Chuscos, 7 Feb 1926, *S. Venturi 6647* (US barcode 00622888).

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Xochiquetzallia (Asparagaceae, Brodiaeoideae), a new genus segregated from the paraphyletic *Dandya*

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Abstract

A new genus, *Xochiquetzallia*, for the Brodiaeoideae, Asparagaceae family is here proposed. A taxonomic analysis based on morphology highlights its synapomorphies. The characters that distinguish *Xochiquetzallia* are the absence of a pith in the gynophore and the presence of an entire stigma. The recognition of *Dandya purpusii* as a monotypic genus is supported by the development of a short floral tube (< 2 mm) and a pith in the gynophore, as well as a divided stigma shared with the other genera of the *Milla* clade, *Bessera*, *Jaimehintonia*, *Petronymphe* and *Milla*. A key to its taxonomic determination is given for both the *Xochiquetzallia* species and the *Milla* clade genera.

Keywords

Asparagales, geophyte, gynophore, Mexico, *Milla* clade

Introduction

Dandya H.E. Moore is a genus endemic to Mexico and one of the five genera of the *Milla* clade (Gutiérrez et al. 2017). *Dandya purpusii* (Brandegee) H.E. Moore, the type species, has been placed in several genera in the past (Moore 1953) and molecular evidence suggest that generic limits in the complex are weak when few species are included in their phylogenetic analyses (Pires et al. 2001, Pires and Sytsma 2002, Gándara et al. 2014). Recently, Gutiérrez et al. (2017) conducted a study on the phylogeny of

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the *Milla* clade based on morphological, anatomical and molecular evidence (cDNA and ITS) and recovered two clades (Fig. 1). One clade recovers three species of *Dandya* plus *Milla mortoniana* strongly supported as sister to *Dandya purpusii* and the other four genera of the *Milla* clade (*Bessera*, *Jaimehintonia*, *Milla* and *Petronymphe*). Their results showed apomorphic structural characters that support the genera. The analyses clarify the phylogenetic relationships of genera and species of the *Milla* clade. The most relevant outcome is that *Dandya* is paraphyletic where three species of *Dandya* with distribution in the Balsas River Basin share the same ancestor as *Milla mortoniana* (Fig. 1). These four species (*D. balsensis*, *D. hannibalii*, *D. thadhowardii* and *M. mortoniana*) have as a synapomorphy the entire stigma. The genus *Milla* is paraphyletic due to the exclusion of *Milla mortoniana*. The members of *Milla* share four synapomorphies (thin pedicel, floral tubes > 60 mm, anthers with a bicollateral bundle and 20-30% of the ovary adnate to the floral tube) not present in *M. mortoniana*. *Dandya purpusii* shares with *Bessera*, *Jaimehintonia*, *Milla* and *Petronymphe* the dissected stigma, but no other character is mentioned. Based on Gutiérrez et al. (2017) results, here we identify characters that are consistent with the phylogeny and create a new genus for the clade of *Dandya* and a *Milla* species, *Dandya* is circumscribed, and taxonomic keys are given that allow differentiating the genera of the *Milla* clade and the new genus.

Material and methods

Plant morphology was analyzed from field collected and herbarium material (ARIZ, BH, CHAPA, F, FC, GH, IEB, JEPS, MEXU, NY, RSA, UAMIZ, US and XAL). We studied the floral morphology from organisms collected in the field, except for *Milla mortoniana* (material removed from herbarium, MEXU). Morphological characters, vegetative and reproductive, were observed and analyzed with the help of a microscope (Nikon SMZ-2T) and terminology follows various authors (Moore 1953, Lenz 1971, Rahn 1998, Harris and Harris 2001). In addition, floral and foliar anatomical characters (Gutiérrez et al. 2010, 2015) were incorporated. The complete list of 60 characters and characters' states used to delimit the monophyletic groups for the *Milla* complex can be consulted in Gutiérrez et al. (2017). Those characters that were recovered as synapomorphies or unique character combinations are here used to construct the keys for the *Milla* complex genera and the species of the new genus here proposed.

Results

Based on the phylogenetic clades recovered by Gutiérrez et al. (2017) and the deep morphological analysis of the species, we proposed the amended circumscription of *Dandya* and the new genus *Xochiquetzallia*.

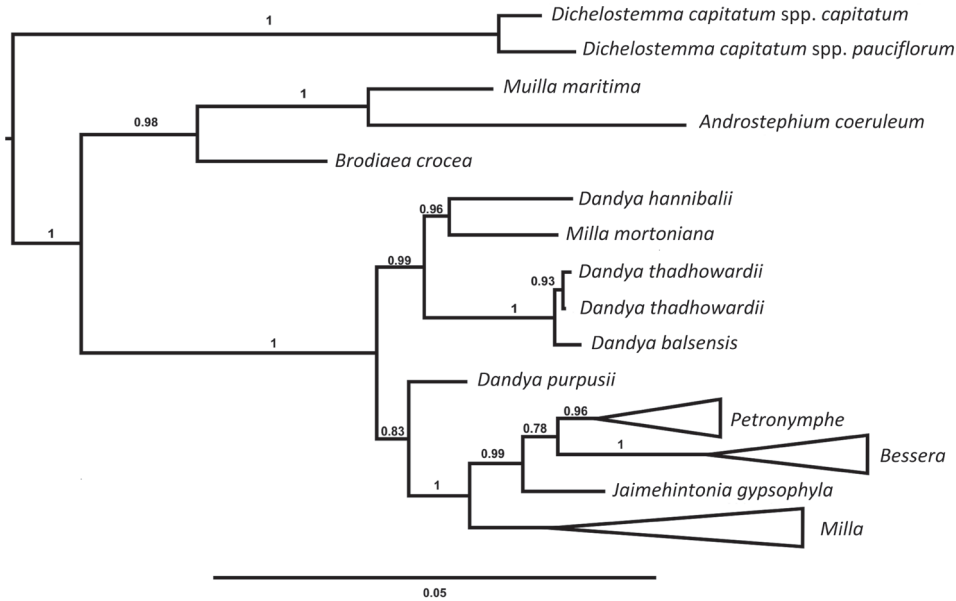

Figure 1. Phylogenetic relationships of the *Milla* complex genera (modified from Gutiérrez et al. 2017).

Taxonomic treatment

Dandya H.E. Moore (1951)

Diagnosis. Perennial herbs, geophytic; terete; subcampanulate flowers, tube 1.5–3.0 mm long, erect; gynophore with pith, stigma divided.

Dandya purpusii (Brandegee) H.E. Moore

Dandya purpusii (Brandegee) H.E. Moore, Gent. Herb. 266–268 (1953).
Muilla purpusii Brandegee, Univ. Calif. Publ. Bot. iv, 177 (1911).
Bloomeria purpusii (Brandegee) Macbride, Contr. Gray Herb. Ser. 2. 56: 1-20 (1918).
Brodiaea purpusii (Brandegee) Ingram, Madroño xii, 27 (1953).

Description. Perennial herbs, 28–47 cm tall, including corm and inflorescence. Fibrous roots. Corm subglobose compressed, fleshy, 1.0–1.7 cm in diameter; tunic formed by the wide bases of the leaves, brown or dark brown, covering up to 2.0 cm from the base of the scape. Leaves 2–3, 13–27 cm long, dark green, linear, subterete, with scabrous surface, hyaline prominences on the veins; base truncated, apex acute.

Inflorescence in umbel; Scape of 27–42 cm long, usually longer than leaves, terete, surface smooth or with acute prominences. Floral bracts 2–3, linear-lanceolate, triangular, 4.0–8.5 mm long; bracteoles, one per flower. Flowers 6–11, pedicels 2.0–4.0 cm long, subcampanulate, erect, articulate, floral tube 1.5–3.0 mm long; tepals blue, 6 in 2 series, external tepals ovate-lanceolate, 6.0–10.0 × 1.5–3.0 mm, apex acute and papillose, base cuneate, entire margin; internal tepals ovate-lanceolate, 6.0–9.5 × 1.6–3.0 mm, apex obtuse and papillose, base cuneate, entire margin. Stamens 6; filaments free, adnate to the throat of the tube, widened toward the base, 4.0–6.0 mm; anthers oblongs, yellow, basifixed, 1.5–2.0 mm; gynophore 0.5–1.1 mm long, adnate to the floral perigone formed three cavities, present pith. Ovary cylindrical, 2.5–5.5 mm, fused at its base to the floral perigone; style filiform, 2.1–4.0 mm; stigma divided, papillose; capsule loculicidal, subcylindric, glabrous, brown, 10.0–12.0 mm long; seed oblong-falciform, compressed, black, bright, 3.0 × 5.0 mm.

Type species. MEXICO. Coahuila; Sierra de la Paila, October 1910, *Purpus 4959* (holotype UC!; isotypes F!, GH!).

Specimen examined. MEXICO: Coahuila, Municipality of Ramos Arispe, Valle de los Ángeles, Sierra de la Paila, 6 August 1975, *M. F. Robert* & *J. Passini 4675* (ENCB); El Cidral, Sierra de la Paila, 20 August 1987, *J. A. Villarreal 3980* (TEX); 5.9 miles east of the road between Yucatan and Mexico, highway 40, west of the mountains along a gravel road to 17.2 miles north of Mexico highway 40, 1650 m elevation, 19 September 1996, *J. M. Porter 11308* & *J. T. Columbus* (RSA); 15 km north of Estación Marte, on secondary road, 1550 m elevation, 24 October 2011, *J. Gutiérrez et al. 1225* (FEZA, CHAPA, MEXU, UAMIZ).

Xochiquetzallia J.Gut., gen. nov.

urn:lsid:ipni.org:names:77204851-1
Fig. 2

Diagnosis. Perennial herbs, geophytic; terete or flattened leaves; subcampanulate or hypocrateriform flowers, tube 1.0–25.0 mm long, erect or reclined; gynophore without pith, stigma entire.

Description. Perennial herbs, 20–60 cm tall, including corm and inflorescence. Fibrous roots, some fleshy. Corm subglobose compressed, fleshy, 1.0–2.5 cm in diameter; tunic formed by the wide bases of the leaves, brown or dark brown, covering up to 2.0 cm from the base of the scape. Leaves 5–9, 20–49 cm long, dark green, linear, flattened or terete, with glabrous or scabrous surface, hyaline prominences on the veins; base truncated, apex acute. Inflorescence in umbel; Scape of (16–) 20–50 cm long, usually shorter than leaves, terete, surface smooth or with acute prominences. Floral bracts 2–3, linear-lanceolate, triangular, 3.0–9.0 mm long; bracteoles, one per flower. Flowers 4–20, pedicels 0.8–3.5 cm long, subcampanulate or hypocrateriform, erect or decumbent-descending, articulate, floral tube 1–25 mm long; tepals white or blue, 6 in 2 series, external tepals elliptic, 8.0–16.0 × (1.5–) 2.0–7.0 mm, 1–3 veins, apex acute

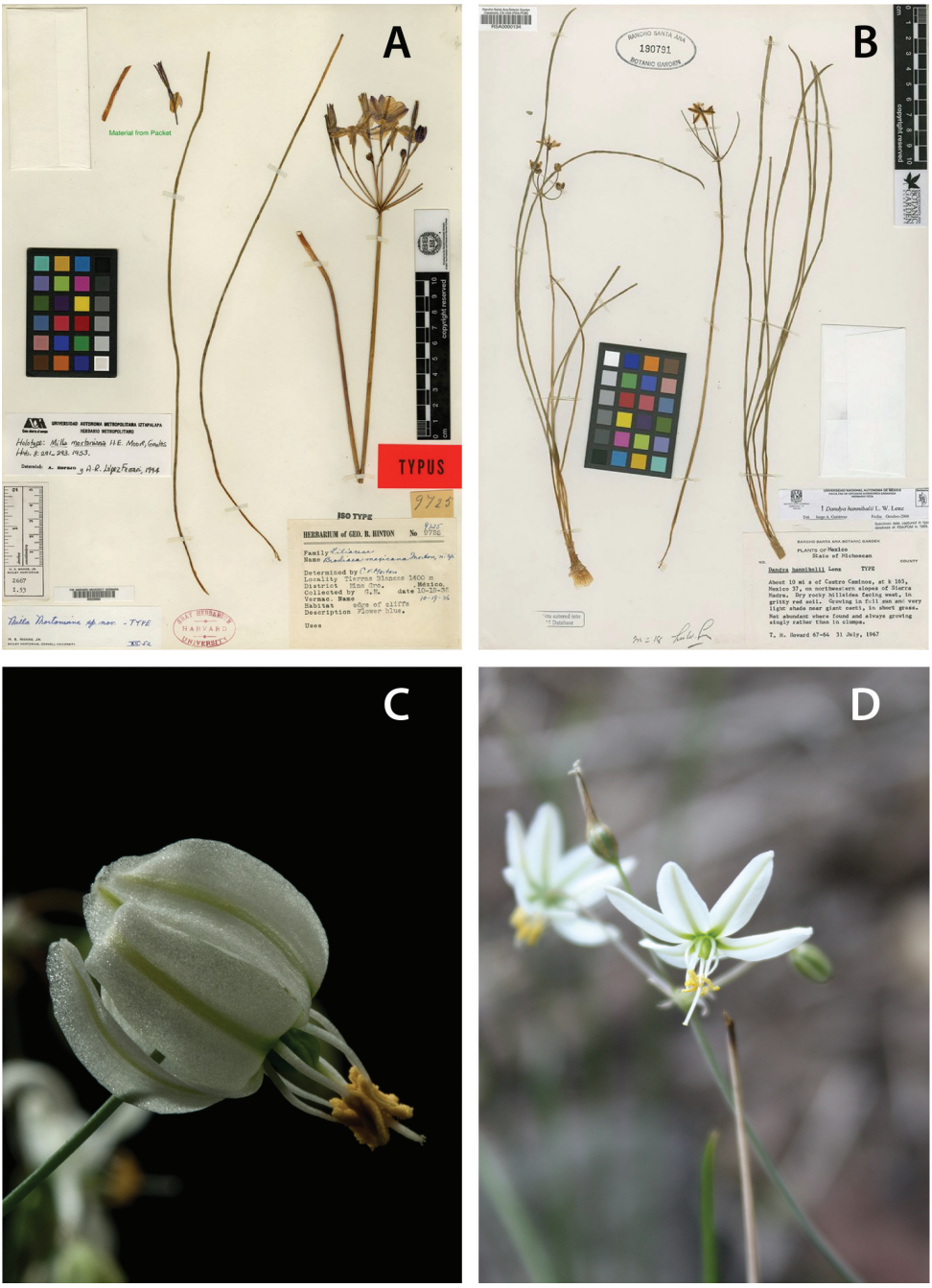

Figure 2. Species of the genus *Xochiquetzallia*. **A** *Xochiquetzallia mortoniana* **B** *X. hannibalii* **C** *X. balsensis* **D** *X. thadhowardii*. **A** and **B** taken from the "Global Plants JSTOR".

and papillose, base cuneate, entire margin; internal tepals elliptical to broadly elliptical, (6.5–) 8.0–16.0 × (2.0–) 3.0–11.0 mm, apex obtuse and papillose, base cuneate, entire margin. Stamens 6; filaments free, adnate to the throat of the tube, widened toward the base or columnar, 2.0–5.0 (–7.0) mm; anthers linear, lanceolate-deltoid, yellow, basifixed, 1.0–2.5 mm; gynophore 0.8–1.6 mm long, adnate to the floral perigone formed three cavities. Ovary cylindrical, 1.0–5.0 mm, fused at its base to the floral perigone; style filiform, 1.8–7.0 mm; stigma entire, papillose; capsule loculicidal, subglobose or subcylindric, glabrous, brown, 6.0–13.0 mm long; seed oblong-falciform, compressed, black, bright, seed coat papillose, 4.0 × 1.5 mm.

Type species. *Xochiquetzallia mortoniana* (H.E. Moore) J.Gut.

Etymology. This genus is named in honor of the goddess of Aztec flowers, in Nahuatl "Xōchiquetzalli" (beautiful flower) "xṓchitl" (flower), "quétzalli" (beautiful). The Aztecs developed majestic architectural works, had extensive knowledge of astronomy and great respect for nature, particularly plants.

Key to the taxonomic determination of the genera of the *Milla* clade

1 Stigma entire..... ***Xochiquetzallia***
– Stigma dissected..... **2**
2 Connate stamens, dorsifixed anthers ..... ***Bessera***
– Free stamens, dorsifixed or subdorsifixed anthers **3**
3 Subcampanulate flowers, gynophore < 2 mm..... ***Dandya***
– Tubular flowers, gynophore > 2 mm **4**
4 Flowers green-yellow, orange-red; tepals ascending or erect..... ***Petronymphe***
– Flowers white, purple or pink; tepals divaricate..... **5**
5 Diffuse-ascendant tepals; filaments 7-8 mm; floral tube < 15 mm long..... ..... ***Jaimehintonia***
– Divaricated tepals, occasionally reflexed; filaments < 7 mm; floral tube >15 mm long ..... ***Milla***

New combinations for *Xochiquetzallia*

***Xochiquetzallia balsensis* (López-Ferr. & Espejo) J.Gut., comb. nov.**
urn:lsid:ipni.org:names:77204852-1

≡ *Dandya balsensis* López-Ferr. & Espejo in Act. Bot. Mex. 18: 11–15, f. 1–2. (1992), basionym Type:– MEXICO. Morelos: Municipality Talquiltenango, road between Valle de Vázquez and Chimalacatlán, 1200 m elevation, 25 June 1989, *A. Flores Castorena 1075* & *D. Martínez Alvarado* (holotype, UAMIZ!) (Figs 2C, 3).

Specimens examined. MEXICO, Morelos: Municipality Talquiltenango, road between Valle de Vázquez and Chimalacatlán, 1200 m elevation, 25 June 1989, *A. Flores Castorena 1075* & *D. Martínez Alvarado* (isotypes, ENCB! IEB!); Ibid, 06 July 2006, *J. Gutiérrez 797* (CHAPA, FEZA, UAMIZ, MEXU); 9 June 2007, *J. Gutiérrez 839* (CHAPA, FEZA, UAMIZ, MEXU).

***Xochiquetzallia hannibalii* (L.W. Lenz) J.Gut., comb. nov.**
urn:lsid:ipni.org:names:77204853-1

≡ *Dandya hannibalii* L.W. Lenz in Aliso 7(3): 316, f.2. (1971), basionym Type:– MEXICO, Michoacán: about 10 miles south of Cuatro Caminos, at km 165, Mexico 37, on the northwestern slopes of Sierra Madre, 31 July 1967, *T. M. Howard 67-64* (holotype, RSA 190791!) (Figs 2B, 3).

Specimens examined. MEXICO, Michoacán: Municipality of Huetamo, Balsas road km 72, near Las Cruces bridge, 9 July 2006, *J. Gutiérrez 805* (CHAPA, FEZA, UAMIZ, MEXU); ibid., 2 September 2006, *J. Gutiérrez 813* (CHAPA, FEZA, UAMIZ, MEXU).

***Xochiquetzallia mortoniana* (H.E. Moore) J.Gut., comb. nov.**
urn:lsid:ipni.org:names:77204854-1

≡ *Milla mortoniana* H.E. Moore in Gentes Herbarum 8: 291 (1953), basionym Type: MEXICO, Guerrero: Distrito Mina, Tierras Blancas, 1400 m., 19 October 1936, *Hinton 9725* (holotype GH!; isotypes NY!, US!) (Figs 2A, 3).

Specimen examined. MEXICO, Michoacán: Municipality of Aquila, *Sánchez-Mejorada et al. 4301* (MEXU!).

***Xochiquetzallia thadhowardii* (L.W. Lenz) J.Gut., comb. nov**
urn:lsid:ipni.org:names:77204855-1

≡ *Dandya thadhowardii* L.W. Lenz in Aliso 7(3): 314, f.1. (1971), basionym Type: MEXICO, Guerrero: About 25-30 miles south of Iguala, on hillsides in calcareous soil, at km 216 on Mexico 95, July 1964, 1965, 1966, *Howard 64-74* (holotype!, RSA 100784) (Figs 2D, 3).

Specimens examined. MEXICO, Guerrero: Municipality of Cutzamala de Pinzón, 3 km north of Cutzamala river, road to Bejucos, 340 m elevation, 21 July 1986, *A. Espejo*

2481 & *T. Chehaibar* (UAMIZ); Municipality of Eduardo Neri, Barranca de Xococoapa, 1000 m elevation, 20 July 1991, *S. Peralta et al. 231* (FCME); Municipality of Xochipala, Llano Delgado, 1035 m elevation, 21 July 1991, *M. Gual 260* (FCME); km 62 highway Iguala-Chilpancingo, 910 m elevation, 4 July 1980, *Campos & Castelo 56* (FCME); ibid., *Campos & G. Velázquez 118* (FCME); 6 km east-northeast of Xochipala, 2 July 1980, *J. Saldivar & Sánchez s. n.* (FCME); ibid., *Velázquez Toledo & Campos 63* (FCME); ibid. on the northwest hillside, 13 July 1991, *M. Luna Flores 43* (FCME); Km 169 highway Iguala-Chilpancingo, 9 June 2007, *J. Gutiérrez 840* (CHAPA, FEZA, UAMIZ, MEXU); Highway Iguala-Chilpancingo, 2 km towards Filo de Caballo, 9 June 2007, *J. Gutiérrez 841* (CHAPA, FEZA, UAMIZ, MEXU); Municipality of Coyuca de Catalán, 3 km west of Coyuca de Catalán, 10 June 2007, *J. Gutiérrez 844* (CHAPA, FEZA, UAMIZ, MEXU). Michoacán: Municipality of Huetamo de Nuñez, 500 m towards Petachícuaro, 430 m elevation, 20 July1986, *A. Espejo 2467 T. Chehaibar* (UAMIZ); Petachícuaro, 9 km north of Huetamo, 400 m elevation, 9 July 1982, *José C. Soto* & *Esteban Martínez 4047* (ENCB, MEXU, UAMIZ); Municipality of San Lucas, highway Cd. Altamirano-San Lucas, km. 211, Rancho el Ovispo, 339 m elevation, 9 July 2006, *J. Gutiérrez 805* (CHAPA, FEZA, UAMIZ, MEXU); highway Cd. Altamirano-San Lucas, km. 188, 352 m elevation, 9 julio 2006, *J. Gutiérrez 806* (CHAPA, FEZA, UAMIZ, MEXU).

Key to the taxonomic determination of the species of the genus *Xochiquetzallia*

1 Flowers white, divaricate-recline **2**
– Flowers blue-violet, erect..... **3**
2 Filaments ≤ 3 mm long; style ≤ 4 mm long; known from the State of Morelos ..... ***X. balsensis***
– Filaments > 3.0 mm long; style 4-6 mm long; known from the States of Guerrero and Michoacán..... ***X. thadhowardii***
3 Perianth tube ≤ 2 mm long; tepals ≤ 1 cm long; filaments ≤ 4 mm long..... ..... ***X. hannibalii***
– Perianth tube 2-2.5 cm long; tepals 1.5-1.6 cm long; filaments 2 mm long .. .. ***X. mortoniana***

Note

Xochiquetzallia balsensis (*Dandya balsensis*) and *X. thadhowardii* (*D. thadhowardii*) present morphological similarity and have a sympatric geographic distribution (Fig. 3). López-Ferrari and Espejo-Serna (1992) pointed out that *Xochiquetzallia balsensis* differs from *X. thadhowardii* by the size of the perigonium, filament and style segments, smaller in *X. balsensis*. Also, these authors indicate that in *X. thadhowardii* the anthers are firmly united among them around the style whereas in *X. balsensis* they are free. No differences in the morphological and anatomical characters were found between both species

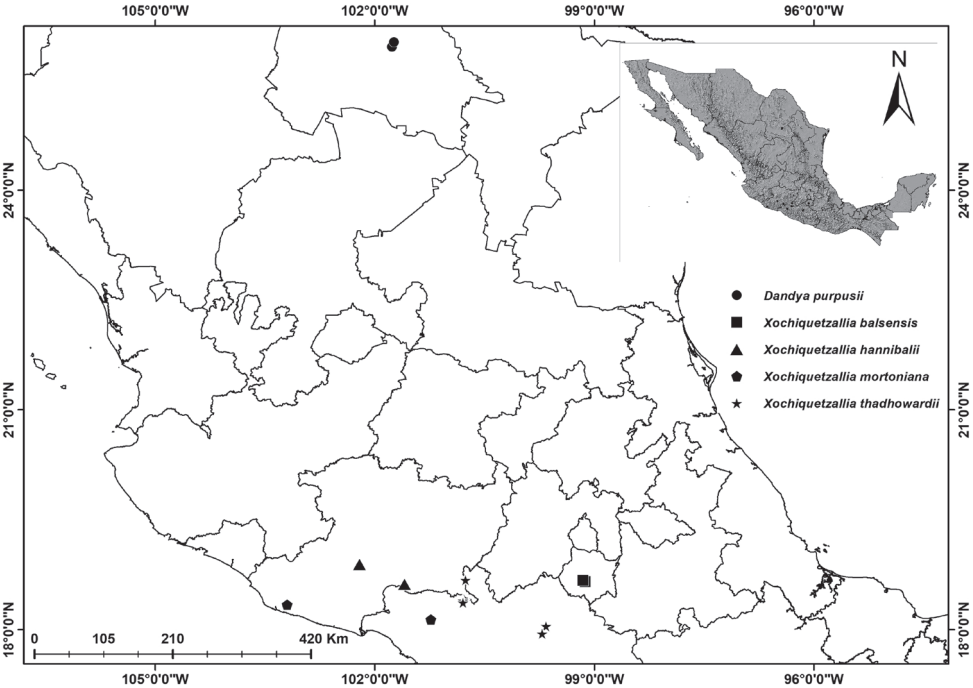

Figure 3. Geographical distribution of the species of *Xochiquetzallia* and *Dandya purpusii*.

(Gutiérrez 2009; Gutiérrez et al. 2010, 2015). The analysis carried out by Gutiérrez et al. (2017) shows that the population of the here proposed *Xochiquetzallia balsensis* from the state of Morelos is the only one that differentiates itself by the size of the filaments and the style as proposed by López-Ferrari and Espejo-Serna (1992). Based on our field observations in the type locality of *Xochiquetzallia balsensis* we confirm that their anthers are firmly united among them around the style as in *X. thadhowardii* and the separation of the anthers takes place in advanced stages of the anthesis, as occurs with *X. thadhowardii*. In this sense, it is concluded that *Xochiquetzallia balsensis* should be circumscribed by its filaments no larger than 3 mm long and less than or equal to 4 mm long.

Discussion

In *Dandya* and *Xochiquetzallia*, the connate stamens have been a recurrent character in the descriptions (Moore 1953; Lenz 1971; López-Ferrari and Espejo-Serna 1992). The staminal connation has been described as "crown or cup" at the base of the stamens and it was considered a diagnostic character for *Dandya*. Gutiérrez et al. (2010) did not find connate stamens in *Dandya* and *Xochiquetzallia* in their floral development study of the *Milla* complex. Moreover, they discovered that what was called “crown or cup” is the base of the filaments that is wider than the upper part and gives the appearance of detaching when the stamens are released asynchronously. Gutiérrez et al. (2010), also showed that *Bessera* is the only genus of the *Milla* clade that has connate filaments.

The existence of gynophore has also been a controversial feature. A gynophore was not described for the former species of *Dandya* now in *Xochiquetzallia* (*X. balsensis*, *X. hannibalii* and *X. thadhowardii*; Lenz 1971; López-Ferrari and Espejo-Serna 1992). Gutiérrez et al. (2010), when studying the gynophore, checked if it exists in the *Xochiquetzallia* species. They found that, unlike other genera of the *Milla* clade, the gynophore is short (< 2 mm) and lacks a pith. Also, *Xochiquetzallia balsensis*, *X. hannibalii* and *X. thadhowardii* have an entire stigma, a character shared with *X. mortoniana* which also lacks a pith in the gynophore. A recent study of floral anatomy of *Dandya purpusii*, allowed us to confirm that this species does have a pith in the gynophore as also found in *Bessera*, *Jaimehintonia*, *Milla* and *Petronymphe* (Gutiérrez et al. 2017). The short floral tube (< 2 mm) of *Dandya purpusii* was previously used as evidence to classify this species with the species of *Xochiquetzallia* (*Dandya*) (*X. balsensis*, *X. hannibalii* and *X. thadhowardii*) (Lenz 1971; López-Ferrari and Espejo-Serna 1992). However, the presence of the pith and the dissected stigma were not considered, and now we know both characters present in *Dandya purpusii* are shared with the other four genera. *Dandya purpusii* is distinguished by its ephemeral flowering and has been scarcely collected after its description in 1911 (Brandegee 1911). Further explorations in the distribution area of *Dandya purpusii*, now recognized as the only species of the genus *Dandya*, will hopefully reveal more localities and potentially the discovery of other species that are difficult to locate due to their ephemeral reproductive biology. The disjunct distribution between *Dandya purpusii* and the species of *Xochiquetzallia* suggests that both genera evolved independently and converged on floral shape as an adaptation to pollinators, among them the Lepidoptera.

Moore (1953) considered the floral shape as a discrete character that allowed to separate the genera of the *Milla* complex; for example, diagnostic floral shapes include subcampanulate for *Dandya*, tubular in *Petronymphe*, tubular and campanulate in *Bessera*, and hypocrateriform in *Jaimehintonia* and *Milla*. *Xochiquetzallia mortoniana* presents hypocrateriform flowers and this character allowed Moore (1953) to classify this species as *Milla*. Our investigations here found that *Bessera* species have all floral shape variations described in the genera of the clade (*Bessera tuitensis* has subcampanulate flowers, *B. elegans* campanulate, and *B. tenuiflora* tubular). The floral shapes among *Xochiquetzallia* species are either hypocrateriform or subcampanulate.

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RESEARCH ARTICLE

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Two new species for *Gochnatia* Kunth (Asteraceae, Gochnatieae) and an extension of the tribal range into Ecuador

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Abstract

Two new species are added to the narrowly delimited genus *Gochnatia*. Of these, *G. lojaensis* **sp. nov.** represents a northern extension of the genus and tribe into Ecuador and *G. recticulifolia* **sp. nov.** occurs in northern Peru. In addition to descriptions for the two new species, a key is provided for all known species in the genus *Gochnatia* and a pubescence character is noted that clearly separates *Gochnatia* from *Moquiniastrum*.

Keywords

Andes, *Moquiniastrum*, Compositae, South America, trichomes

Introduction

In the process of working on the treatment of the tribe Vernonieae (Asteraceae) for the Flora of Ecuador (Robinson and Funk 2018), an unidentified specimen that came in on loan from AAU was determined not to be Vernonieae. Although it seemed to belong to the tribe Gochnatieae J.Panero & V.A.Funk, that tribe had not been reported from Ecuador (Funk et al. 2014). In trying to identify the specimen, other Gochnatieae from US were examined and two more specimens were found that were questionable as to species. The first of these three specimens remained in a folder of "work to be done" for a number of years. As the loans were being annotated in

† Deceased

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preparation for their return, the folder reappeared. One of the three specimens was determined to be a slight variant of *Gochnatia arequipensis* Sandwith. The remaining two specimens were more difficult to assign to a known species and eventually we decided they were new to science. The two species can now be described as true members of narrowly defined *Gochnatia* Kunth, a genus that is primarily of Central Andean distribution.

The genus *Gochnatia* was revised by Cabrera (1971) and subsequently it became the basis for a tribe (Panero and Funk 2002, 2007; Sancho and Freire 2009). The recent history of the basal tribes was summarized by Ortiz et al. (2009). Recent papers on the immediate group of genera include Katinas et al. (2008) and Funk et al. (2009, 2014). Generic level papers include those on *Richterago* Kuntze (Roque and Pirani 2001), *Anastraphia* D.Don (Ventosa-Rodríguez and Herrera-Oliver 2011), *Moquiniastrum* (Cabrera) G.Sancho (Sancho et al. 2013), and *Nahuatlea* V.A.Funk (Funk et al. 2017). These efforts have further refined our concepts. Some species that Cabrera included in the genus *Gochnatia* (s.l.) such as the Asian taxa are reinstated in their own genera (*Leucomeris* D.Don and *Nouelia* Franch.) and have been placed in a different tribe (Hyalideae) and are therefore, not part of the Gochnatieae. Others, like *Cnicothamnus* Griseb. and *Cyclolepis* Gillies ex D.Don had not been placed in *Gochnatia* s.l. by Cabrera (1971) and are now associated with the tribe. There are now 7 genera and 57 species in the tribe and *Gochnatia* s.s. now contains 10 species. In contrast, the tribe Hyalideae Panero, typified by the genus *Hyalis* D.Don ex Hook. & Arn., was placed in subfamily Wunderlichioideae and contained four genera: *Ianthopappus* Roque & D.J.N.Hind, *Hyalis* D.Don ex Hook & Arn., *Leucomeris*, and *Nouelia*, and a total of six species. Recent results from next generation sequencing (Mandel et al. 2019) demonstrated that the Hyalideae are now better placed in the Stifftioideae.

Methods

Collections were studied from the following herbaria: AAU and US. Morphological characters were assessed and measured from herbarium material. Florets and fruit were rehydrated in water prior to dissection and measurement. Other characters were measured directly from the herbarium specimens. Some parts such as trichomes were mounted on slides in Hoyer's solution (Anderson 1954). Corolla color, habit and habitat information were taken from the labels of the holotypes. Both species are only known from the type collection.

Results

Two new species are described below: *Gochnatia lojaensis* sp. nov. from the mid-elevations of southern Ecuador and *Gochnatia recticulifolia* sp. nov. from northern Peru.

Gochnatia lojaensis **H.Rob. & V.A.Funk, sp. nov.**
urn:lsid:ipni.org:names:77204856-1
Figs 1–3, 5A, 5C

Type. Ecuador. Prov. Loja: La Toma – Catacocha road ca. km 26, shrub 3 m tall, heads yellow, 79°28'53"W, 03°58'40"S, 2300 m alt., 3 Sep 2000, *Jens Elgaard Madsen with Orlandro A. Sanchez*, *7209* (holotype AAU!; isotypes, LOJA, US frag.!).

Description. ***Shrub*** to 3 m tall, with numerous branches. ***Stems*** grayish, wrinkled when dry; internodes 2–5 mm long, surface with yellowish-gray, evanescent, granular appearing pubescence, composed of tightly glomerulous contorted trichomes, pith solid, ca. 2 mm wide. ***Leaves*** spirally alternate, petioles 7–8 mm long; blades narrowly elliptical, 3–6.5 cm long, 0.9–1.4 cm wide, base obtuse, margins entire, plane, apex subacute, adaxial surface green with thin evanescent pubescence in young leaves, with minute reticulum of prominulous veinlets (veins slightly prominent), secondary veins spreading from midvein at ca. 45° angles; abaxial surface covered with dense yellowish tomentum of slender highly contorted trichomes, trichomes with few thin-walled cells at base, sometimes with slightly off-set apical cells separated by an oblique cross-wall, costa prominent to near leaf-tip. ***Inflorescence*** corymbiform, with clusters of 10–15 heads apical on leafy branches, cluster usually becoming over-topped by younger branches and longer leaves, with small bracteoles 1.0–1.5 cm. long among heads; peduncles 0.7–l.0 cm long, longer peduncles with minute scale-like bracteoles; involucres campanulate, 1–1.2 cm high, ca. 0.8–0.9 cm wide at anthesis, with ca. 50 subimbricate appressed bracts in ca. 6 series, bracts progressing from basal scales ca. 1.5 mm long and wide to many progressively longer lanceolate median bracts to few somewhat deciduous linear inner bracts ca. 9 mm long and 1 mm wide, outer surfaces of bracts glabrous on most exposed surfaces, castaneous, yellow along margins, bases of bracts with yellowish tomentum of slender contorted trichomes. Upper surface of receptacles glabrous, alveolate. ***Florets*** homogamous, ca. 15 per capitulum; corollas yellowish with darkened tips, glabrous outside, ca. 9 mm long, basal tube ca. 4 mm. long, throat 1 mm long, narrowly funnelform, lobes 3.5 mm long, linear, 0.4 mm wide, coiled backward at anthesis Fig. 3A), with protuberant slightly rugulose elongate cells inside; anthers ca. 2.5 mm long (Fig. 3B), basal tails lanceolate, ca. 1 mm long, with fringed with retrorse teeth near and at tips (Fig. 3C), apical appendage indurate, ca. 1 mm long, oblong-ovate with marked apical apiculus; pollen prolate, 30–35 µm diam. and 35–40 µm long; styles slightly broadened and blunt at tips. ***Achenes*** ca. 2.5 mm long, 5-costate (Fig. 3E), densely villosulous with ascending twin-hairs, hairs not cleft at tips usually with one cell longer than other; carpopodium annuliform; pappus of ca. 50 capillary bristles, whitish, mostly ca. 7 mm long, broader and more strongly barbellate near tips (Fig. 3F), some shorter outer bristles with slender tips.

Distribution and ecology. Known only from the type collection which places it in "Matorral vegetation and ravine with disturbed remnants of montane forest."

Conservation status. DD (according IUCN 2019).

Figure 1. Holotype specimen (Madsen and Sanchez 7209, AAU) of *Gochnatia lojaensis* H.Rob. & V.A.Funk, including drawing of obliquely capped tip of a contorted trichome from abaxial surface of leaf.

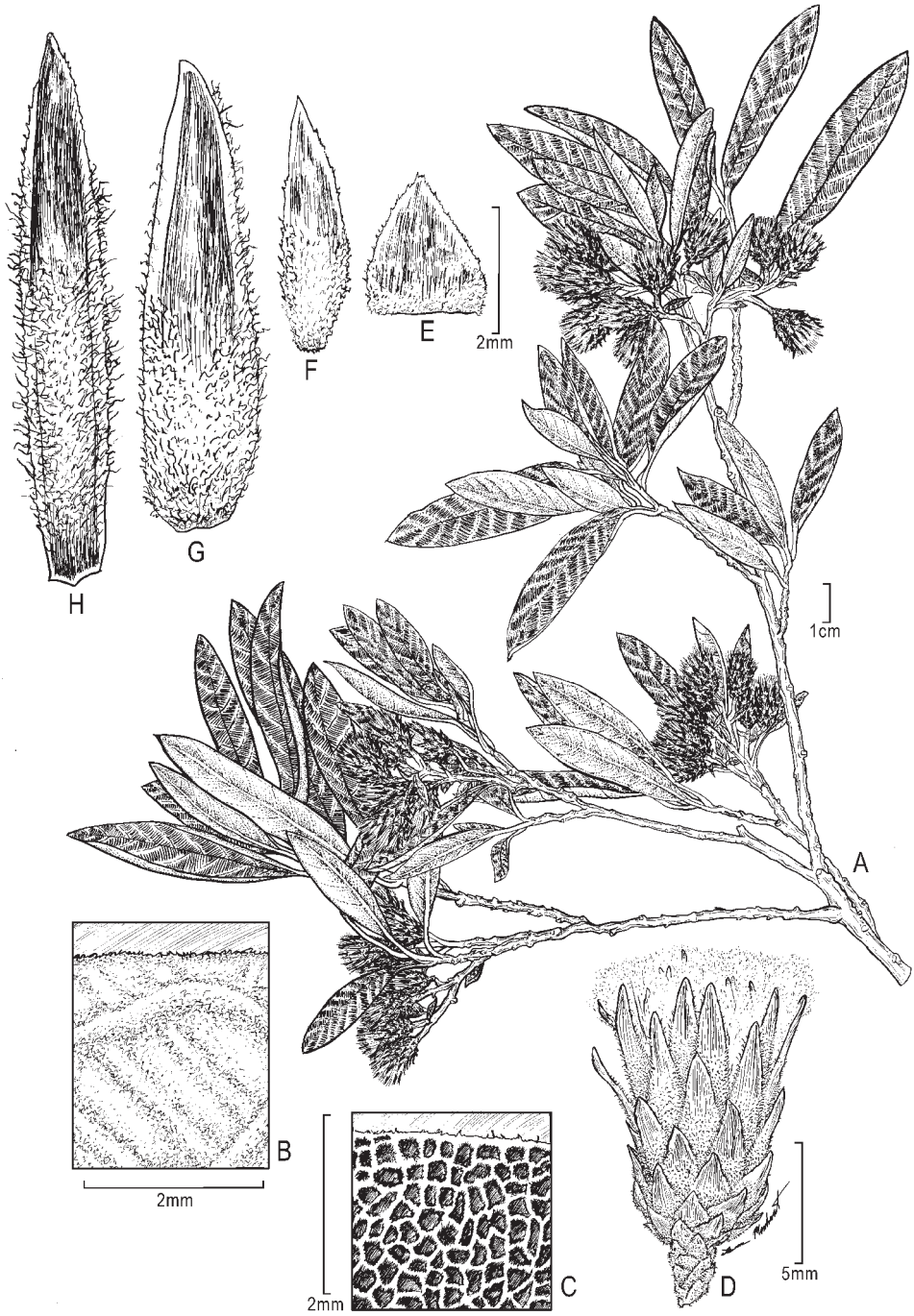

Figure 2. *Gochnatia lojaensis* **A** habit **B** abaxial surface of leaf showing density of pubescence **C** adaxial surface showing venation **D** capitulum **E–H** involucral bracts, inner, median and outer. Drawing by Lauren Merchant (US).

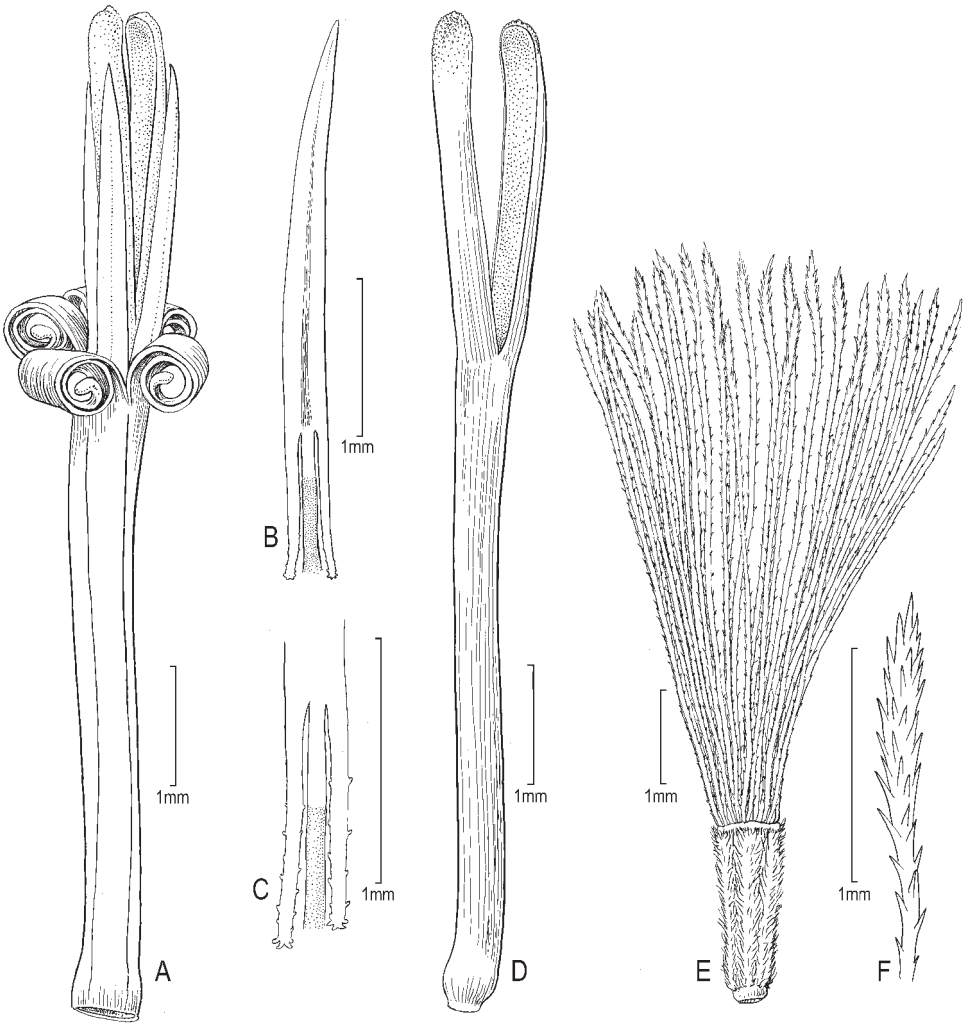

Figure 3. *Gochnatia lojaensis*, floral details **A** corolla with backward rolled lobes and tips of anthers and style **B** anther with fringe of retrorse teeth near and on tips of basal spurs **C** enlargement of basal spur of anther **D** style **E** achene showing more densely scabrid tips of inner pappus bristles, sparse outer pappus not shown **F** enlargement of tip of inner pappus bristle.

Etymology. *Gochnatia lojaensis* is named after the Ecuadorian province where it was collected.

Notes. Distinguishing characteristics include the corymbiform clusters of numerous heads and the narrow castaneous involucral bracts with narrowly blunted tips.

The position of the new species was at first in doubt. It was near the geographic range of *Gochnatia* typified by *G. vernonioides* Kunth from Peru, but it had the more elongate leaves often associated with the presently recognized separate genus *Moquiniastrum*. A detailed study of the plant now confirms a position in *Gochnatia*: the pubescence is particularly indicative, being a thick tomentum and not the loose stalked

T-shaped hairs common in *Moquiniastrum* (Fig. 5F). The hairs do show one interesting tendency toward the T-shaped form, with some hairs having an apical cell that is obliquely mounted on the longer contorted cell. Such an apical cell usually has the lower end slightly projecting, a sub-T-shaped specialization. This remains totally different from the well-developed T-shape form seen in *Moquiniastrum* (Fig. 5F).

Gochnatia recticulifolia **H.Rob. & V.A.Funk, sp. nov.**
urn:lsid:ipni.org:names:77204857-1
Figs 4, 5B, 5D

Type. Peru. Department Ancash: Callejon de Huaylas, trail to cave across Río Santo [Río Santa] from Mancos, shrub to 3 m tall. Flowers yellow, phyllaries green. 9 April 1970, *C. Earle Smith Jr. & Jacinto Blas 4901* (holotype US!). Collected in co-operation with the Seasonal Transhumance and Preceramic Occupation of the Callejon de Huaylas Project – Thomas F. Lynch, Director and according to the label the Vernacular name is *Juanca blanca*.

Description. ***Shrub*** to 3 m tall; stems gnarled, thickened and blackish near base, to ca. 8 mm wide, with scarcely noticeable narrow pith; younger stems as slender shoots, with internodes 3–10 mm long, covered with grayish tomentum. ***Leaves*** alternate, petioles ca. 4 mm long; laminae ovate oblong, mostly 1.6–2.5 cm long, 1.2–1.8 wide, flat or sometimes folded along midvein, base short-obtuse, apex usually rounded with slight mucro, margins flat, not recurved, entire, adaxial surface greenish with minute thin evanescent floccose puberulence, abaxial surface with grayish granular-looking pubescence consisting of slender highly contorted trichomes with few thin-walled cells at base, sometimes with slightly off-set apical cells separated by an oblique cross-wall, with a weakly prominulous midvein, 3 or 4 pairs of ascending, secondary veins, and a minute reticulum of veinlets evident on both surfaces that are not obscured by pubescence. ***Inflorescence*** of a solitary capitulum or 2–3 grouped together at tips of leafy stems; involucres broadly campanulate at anthesis, ca. 9 mm high and 11 mm diam., bracts ca. 40 in ca. 6 gradate series, basal bracts broadly ovate, 1.5–2.5 mm long, to 2.5 mm wide, rounded to obtuse at tips, inner bracts lanceolate, to ca. 7 mm long, acute, outer surface thinly pilosulous with weak indumentum near bases; receptacle slightly crested between areoles. ***Florets*** homogamous 35–40 per capitulum, corollas yellow, ca. 8–9 mm long, without long hairs outside, basal tube ca. 3.5 mm long, throat ca. 1.5 mm long, narrowly funnelform, lobes linear, ca. 3.5 mm long, ca. 0.2 mm wide; anther thecae ca. 1.8 mm long, tails ca. l.2 mm long, with a dense fringe of narrow hairs, apical appendage ca. 0.9 mm long, narrowly ovate with acuminate tip; pollen 30–40 µm in diam. and 50–55 µm long; styles slightly broadened and blunt at tips. ***Achene*** cylindrical, ca. 4 mm long, sericeous with slender setulae; pappus pale yellow with ca. 35 inner capillary bristles, up to 7 mm long, most with distinctly broader and more densely scabrous tips, and with numerous outer shorter weakly barbellate bristles of various lengths with slender tips.

Distribution. Known only from the type collection which places it in northern Peru.

Conservation status. DD (according IUCN 2019).

Figure 4. Holotype specimen (Smith and Blas 4901, US) of *Gochnatia recticulifolia* H.Rob & V.A.Funk. http://n2t.net/ark:/65665/3285d4b9d-0bd0-421f-bc05-f0e82f454950

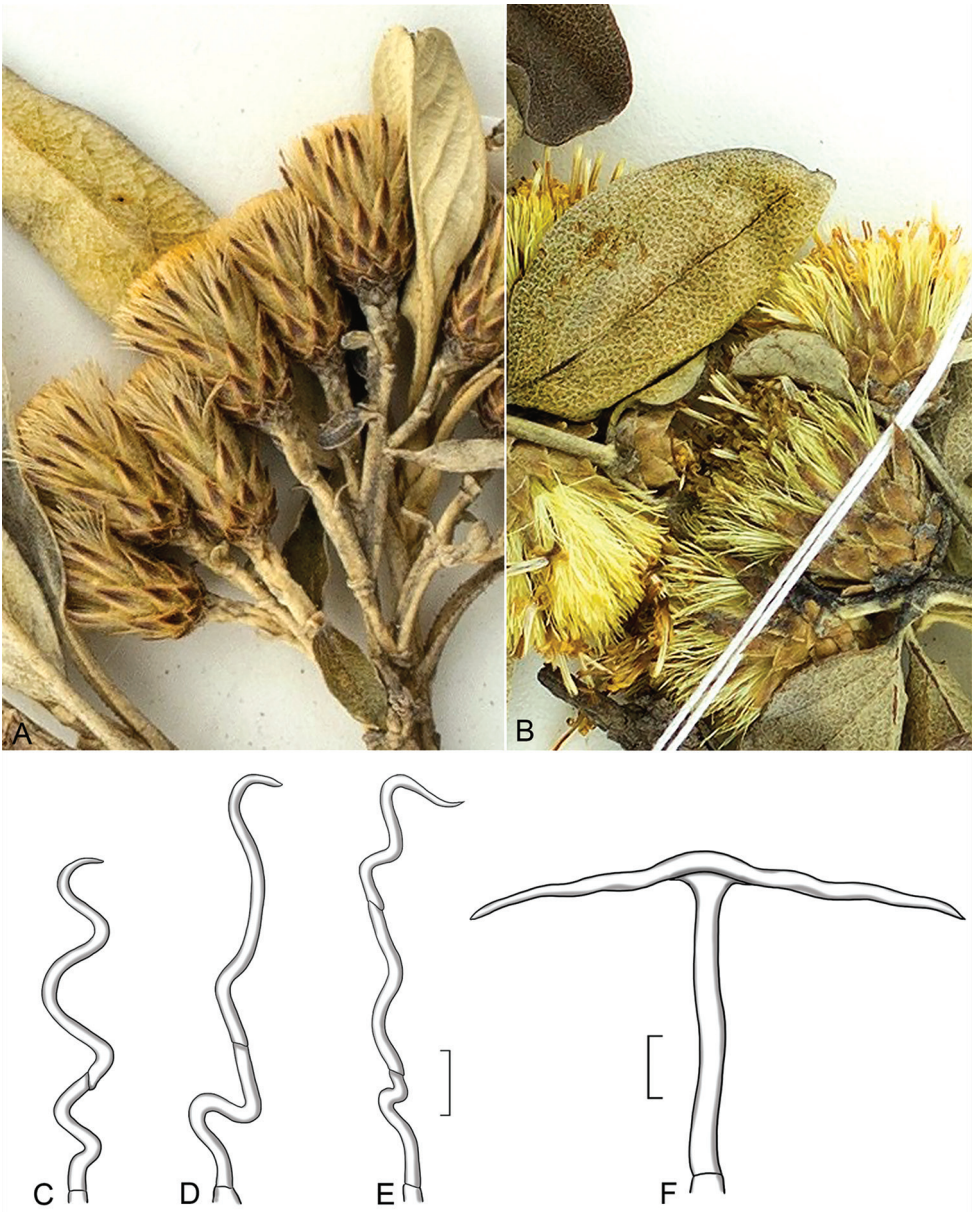

Figure 5. Enlargements of capitula, leaves and trichomes. Capitula and leaves **A** *Gochnatia lojaensis* **B** *G. recticulifolia* **C–F** trichomes from abaxial surfaces of leaves of Gochnatieae: *Gochnatia lojaensis* sp. nov. (**C**), *Gochnatia recticulifolia* sp. nov. (**D**), *Gochnatia vernonioides* Kunth (from Ferreyra 7097, US) (**E**), http://n2t.net/ark:/65665/3ec557cf1-0267-44ee-8649-ee3170d4c7f2 and *Moquiniastrum polymorphum* (Less.) (**F**) G. Sancho (from Ganev 1201-HUEFS 12265, US). http://n2t.net/ark:/65665/3d878282f-4ead-4312-9189-60a09f4a7f43; Scale bars: 30 μm.

Etymology. The epithet for *Gochnatia recticulifolia* is based on the minute reticulum of veinlets that is evident on both surfaces of the leaf.

Notes. The type specimen was original identified in the herbarium as *G. curvifolia* S.F.Blake, a potentially related species of mostly Bolivian distribution. However, *G. curvifolia* has pointed leaf tips and a minute reticulum of the leaf veins mostly obscured by pubescence. The corollas of *G. recticulifolia* have no hint of the pilosity seen in many but not all specimens of *G. curvifolia* and the closely related *G. boliviana* S.F. Blake. *G. recticulifolia* may actually be closer to the unseen *G. vargasii* Cabrera of the Department of Apurimac in Peru, but the latter is distinct in having more acute leaves and serrate leaf margins.

As a result of our investigations we emphasize the trichome character that provides an additional distinction between *Gochnatia* s.s. and *Moquiniastrum*: the trichomes on the abaxial surface of the leaf. In *Gochnatia* they are slender, highly contorted trichomes with a few thin-walled cells at base, sometimes with slightly off-set apical cells separated by an oblique cross-wall (Fig. 5C–E). In *Moquiniastrum* the trichomes are T-shaped, often long-stalked with an elongate cap-cell attached at the mid-point (Fig. 5F). We examined the generitypes of both genera as well as our two new species. *Gochnatia vernonioides* (Fig. 5E), the generitype of *Gochnatia* has some trichomes with two such oblique cross-walls and off-set cells. Certainly, the distribution of this character should be examined for all 10 species in an upcoming monograph of *Gochnatia* s.s. (Sancho et al., in prep.).

The 10 species now recognized in *Gochnatia* can be distinguished by the following key. Many details are from Cabrera (1971), especially regarding *G. vargasii* of which proper material has not been seen.

Key to *Gochnatia* species

1 Involucre greatly attenuated at base, with ca. 10 series of bracts of increasing size ..... ***G. palosanto* Cabrera (Bolivia to Argentina)**

– Involucre abruptly rounded at base, with only 5–7 tiers of bracts **2**

2 Capitula narrow, with 7–12 florets; stems with small oblong to elliptical leaves often in axillary fascicles, mostly 5–20 mm long; petioles less than 2 mm long.... **3**

– Capitula campanulate, with more than 12 florets; leaves ovate, over 20 mm long, petioles 2–6 mm long **4**

3 Involucre 8–9 mm high; capitula with 7–8 florets; corollas 7–9 mm long..... ..... ***G. cardenasii* S.F. Blake (Bolivia)**

– Involucre 10–15 mm high; capitula with 9–12 florets; corollas to 15 mm long... ..... ***G. arequipensis* Sandwith (Central Peru)**

4 Leaves with toothed margins ..... ***G. vargasii* Cabrera (Apurimac, Peru)**

– Leaves with entire margins **5**

5 Lower bracts of involucre broadly ovate **6**

– Lower bracts of involucre lanceolate; corollas not sericeous outside on throat.... **8**

6 Leaves with blunt or rounded tips, surfaces with thin granular appearing pubescence that does not obscure minute reticulum of veinlets; corolla with no evident pilosity on outer surface ..... ***G. recticulifolia*** **(N Peru)**
– Leaves with dense tomentum on at least abaxial surface, reticulum of veinlets obscured; corollas often with pilosity on outer surface of throat **7**
7 Capitula with 12–20 florets; involucres 12–15 mm high, higher than wide at anthesis ..... ***G. curviflora*** **(Griseb.) Hoffm. (S Bolivia to N Argentina)**
– Capitula with at least 40 florets; involucres 12–15 mm high, almost as wide as high at anthesis ..... ***G. boliviana*** **S.F.Blake (Central Bolivia)**
8 Capitula in corymbiform clusters; involucral bracts blunt at narrow tips; leaves lanceolate to narrowly oblong; spurs of anthers with only short teeth..... ..... ***G. lojaensis*** **(S Ecuador)**
– Capitula few at tips of leafy branches; involucral bracts often mucronate to acuminate at tips; leaves ovate; spurs of anthers with dense fringe of hairs **9**
9 Involucres nearly as wide as high at anthesis, 10–11 mm high; involucral bracts shortly mucronate at tips; leaves to 80 mm long, 35 mm wide..... ..... ***G. vernonioides*** **Kunth (N Peru)**
– Involucres higher than wide, to 14–17 mm high; involucral bracts mostly mucronate to aristate at tips; leaves 10–23 mm long, 9–18 mm wide..... ..... ***G. patazina*** **Cabrera (Central Peru)**

Excluded is *Gochnatia lanceolata* Beltram & Ferreyra, with glabrous leaves. The species has been transferred to a new genus *Paquirea* (Panero and Freire 2013).

The gnarled appearance of the stems was found in the newly described *G. recticulifolia* and in one specimen of *G. arequipensis* Sandwith. The lack of this character in all other collections of *Gochnatia* may be an artifact of collecting and it may occur in other species but was omitted during the pressing of the plants.

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RESEARCH ARTICLE

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Solanum hydroides (Solanaceae): a prickly novelty from the land of the sugar loaves, central Brazilian Atlantic Forest

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Abstract

Solanum hydroides Gouvêa & Giacomin, **sp. nov.**, is described from central Brazilian Atlantic Forest. It is known from only three localities in Espírito Santo and Minas Gerais states, where granitic/gneissic outcrops (inselbergs or sugar loaves) are ubiquitous. The new species, here described, belongs to *Solanum* subgenus *Leptostemonum* (or the Leptostemonum clade; i.e. the spiny solanums) and is morphologically related to *S. hexandrum* Vell. and *S. sublentum* Hiern, with which it shares the shrubby habit, decurrent leaf bases and well-developed calyces that become accrescent, covering glabrous fruits. *Solanum hydroides* is unique in its combination of comparatively more delicate habit, indumentum of exclusively stellate eglandular trichomes, accrescent but never inflated fruiting calyces that only partially cover the fruits and comparatively shortly lobed and strictly white corollas. The species is threatened with extinction and assessed as Vulnerable (VU), based on the IUCN criteria.

Resumo

Solanum hydroides Gouvêa & Giacomin, sp. nov., é aqui descrita para região central da Floresta Atlântica brasileira. Ela é conhecida apenas para três localidades, nos estados do Espírito Santo e Minas Gerais, em uma região onde afloramentos graníticos/gnáissicos (inselbergues ou pães de açúcar) são onipresentes. A

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nova espécie pertence a *Solanum* subgen. *Leptostemonum* (ou *Solanum* clado Leptostemonum, i.e. espécies espinhentas com tricomas estrelados) e é morfologicamente semelhante a *S. hexandrum* Vell. e *S. sublentum* Hiern, com quem compartilha o hábito arbustivo, a base das lâminas foliares decurrentes e cálices bem desenvolvidos, acrescentes em seus frutos glabros. *Solanum hydroides* é, contudo, a única espécie que apresenta a seguinte combinação de caracteres: hábito delicado, indumento composto apenas por tricomas estrelados egandulares, cálices frutíferos acrescentes, mas nunca inflados, que cobrem parcialmente os frutos e corolas com lóbulos curtos e estritamente brancas. A espécie é considerada como ameaçada de extinção, na categoria Vulnerável (VU), segundo os critérios da IUCN.

Keywords

Leptostemonum clade, Brazil, inselbergs, new species, eglandular trichomes

Palavras-chave

Clado Leptostemonum, Brasil, inselbergs, espécie nova, tricomas eglandulares

Introduction

Solanum L. (Solanaceae) is one of the largest genera of flowering plants with about 1,400 species, mostly distributed in the Neotropics (Nee 1999; Frodin 2004; Weese and Bohs 2007). Some species have great economic importance, being used as food, such as the potato (*S. tuberosum* L.), tomato (*S. lycopersicum* L.) and eggplant (*S. melongena* L.) and are cultivated practically all over the world; other species have medicinal and ornamental uses (Hawkes 1999). Several species behave as pioneers and are therefore fundamental in the ecological succession, especially in tropical forests (Guariguata and Ostertag 2001). In Brazil, the Atlantic Forest stands out as a centre of diversity for the genus, with 184 species recorded thus far, of which 98 are endemic (Stehmann et al. 2009; Flora do Brasil 2020 under construction 2019). In addition to species level endemism, the Atlantic Forest domain harbours several endemic lineages within *Solanum*, such as the Asterophorum and Inornatum species groups (Giacomin and Stehmann 2014; Gouvêa and Stehmann 2019). In fact, the domain shows an ascending curve of newly described taxa in the last years, demonstrating the insufficiency of taxonomic knowledge (Linnaean shortfall) (Sobral and Stehmann 2009).

The Atlantic Forest domain is considered one of the 36 hotspots of global biodiversity, defined as a region of the world with a large number of endemics and highly endangered, with its original coverage extremely reduced (Myers et al. 2000; Mittermeier et al. 2004, https://www.conservation.org/priorities/biodiversity-hotspots). It comprises an extensive predominantly forest belt, of more than 1.2 million square kilometers, occurring along coastal areas from Rio Grande do Norte to Rio Grande do Sul states in Brazil, with continental intrusions reaching Argentina and Paraguay (Stehmann et al. 2009). Biogeographically, three regions (North, Central and South Atlantic Forest) with distinct paleoecological and floristic histories have been recognised along this longitudinal distribution (Carnaval and Moritz 2008; Carnaval et al. 2014).

The Central Atlantic Forest is delimited to the south by the Doce River and to the north by the São Francisco (Carnaval et al. 2014). Compared with the other two

regions, it presented greater paleoclimatic stability during the Pleistocene climatic cycles (Carnaval and Moritz 2008; Silveira et al. 2019). In South-eastern Brazil, the area corresponding to the Doce, Mucuri and Jequitinhonha basins in Minas Gerais and Espirito Santo states, is amongst the most deforested regions of the domain and huge gaps in knowledge of its biodiversity still exist (Oliveira-Filho et al. 2005; Martinelli 2007; Oliveira et al. 2016). From a landscape perspective, the region is distinctive in its large concentration of granitic/gneissic rock outcrops, also known as inselbergs, with a so-called sugar loaf morphology (Ab'Sáber 1967) and, thus, the area was christened as the land of the sugar loaves (Sugar Loaf Land; de Paula et al. 2016). Inselbergs of this region in general, with their steep slopes, are inhabited by patches of herbaceous-shrubby vegetation, mostly stress-tolerant species (de Paula et al. 2015) and are usually surrounded by forest remnants of varying sizes (de Paula et al. 2017). These outcrops, which stand out in the landscape as islands, provide a broad ecotonal range and islands of open habitat, which favour the occurrence of woody species that demand light (pioneers), including many species of *Solanum* (Guariguata and Ostertag 2001).

During a floristic inventory of one inselberg located in the Brazil´s South-Eastern region (de Paula et al. 2017) and after more extensive herbaria revision by the authors, an undescribed *Solanum* species was revealed. It belongs to the group that comprises prickly plants with stellate trichomes [*Solanum* subg. *Leptostemonum* Bitter or the Leptostemonum Clade] and its discovery supports the need for inventories in the region. We describe here this new taxon with illustrations, comments on habitat, geographic distribution, ecology and a preliminary conservation status.

Material and methods

Observations are all based on examination of herbarium specimens from BHCB, CEPEC, HUEFS, MBML, RB and UEC (acronyms follow Index Herbariorum; http://sweetgum.nybg.org/science/ih/), as well as in-field observations by LFAP and YFG. Type specimens of related taxa were consulted in BR, G and M or through high resolution images available on the Global Plants website (https://plants.jstor.org) and original descriptions of related species were checked when necessary. Measurements of reproductive characters comprise the dimensions of both fresh and dried materials. The terms used to describe the morphological character states are based on Radford et al. (1976). We assessed the conservation status of *S. hydroides* using IUCN Red List Categories and Criteria (IUCN 2019) with extent of occurrence (EOO) and area of occupancy (AOO) measured using GeoCat (Bachman et al. 2011; http://geocat.kew.org/). For the AOO estimation, a cell size of 4 km^2 was used. A full dataset with the examined material of *S. hydroides* is given as a supplementary file (Suppl. material 1). The distribution of the most morphologically similar species (namely *Solanum hexandrum* Vell. and *S. sublentum* Hiern.) were mapped together with the known records of *S. hydroides* and the full dataset used for these species is also given as supplementary material (Suppl. material 2), which was downloaded from the speciesLink platform (http://www.splink.org.br/) and properly cleaned prior to mapping. For SEM seed

observations, seeds of ripe fruits were obtained from dried material, mounted on aluminium stubs, coated with gold-palladium in a Hummer 6.2 sputtering system (Anatech, Union City, CA, U.S.A) and observed with a JEOL JSM-5410LV SEM (JEOL, Tokyo, Japan) at 10 kV at the Pfizer Plant Research Laboratory at The New York Botanical Garden.

Taxonomic treatment

Solanum hydroides **Gouvêa & Giacomin, sp. nov.**
urn:lsid:ipni.org:names:77204874-1
Figure 1

Diagnosis. Differs from *S. sublentum* Hiern in its indumentum of strictly stellate eglandular trichomes and in its accrescent, but not inflated, cupuliform fruiting calyx; also differs from *S. hexandrum* Vell. in its more delicate habit, smaller flowers with white shallowly stellate corollas and in having accrescent, but not inflated, fruiting calyces that partially cover the mature fruits.

Type. BRAZIL. Minas Gerais: Mun. Teófilo Otoni, afloramento rochoso lado esquerdo da MG-418, cerca de 30 km norte de Teófilo Otoni, 17°51'22"S, 41°15'39"W, 560 m elev., 27 Jan 2014 (fl, fr), *L.F.A. de Paula*, *L. Azevedo, R. Fernandes & J. R. Stehmann 669* (holotype: BHCB [BHCB053358]; isotype: RB, to be distributed).

Description. Shrubs 1–1.5 m tall, erect, armed. Branches directed upwards and spreading. Young stems moderately pubescent to tomentose and sparsely to moderately prickly; pubescence of ochraceo-ferruginous to purple-tinged porrect short- to long-stalked stellate trichomes, with multiseriate 0.5–1.5 mm long stalks, the rays 4-8, 0.5–1 mm long, the midpoints 1– to 2–celled, always shorter than the rays; prickles 4–6 mm long, 2–6 mm wide at the base, broad-based and recurved. Bark of older stems glabrescent, drying olivaceous to brown. Sympodial units plurifoliate, the leaves not geminate. Leaves simple, nearly entire to shallowly lobed, the blades 2.8–12.1(21.8) cm long, 2.2–7.5(10.1) cm wide, elliptic to ovate, membranous, slightly discolorous when dry; adaxial surface brown to dark green when dry, densely to moderately stellate-pubescent and prickly, the trichomes like those of the stem but with (1–)4–6 rays, the prickles along the midrib and major veins, to 5.5 mm long and 1 mm wide at the base, straight and laterally compressed; abaxial surface whitish-green when dry, more densely stellate-pubescent than the adaxial surface, the trichomes like those of the adaxial surface, the prickles like those of the adaxial surface but to 6.5 mm long and 2 mm wide at the base; base attenuate to truncate or rounded, less often with 1 or 2 basiscopic lobes, decurrent onto the petiole, sometimes asymmetrical; margins shallowly lobed, the lobes (0)3–5 on each side, 1–12(14.8) mm long, 3.2–11(23) mm wide at base with usually acute, sometimes rounded or obtuse apices, the sinuses 3.2–8.5 mm deep; apex acute to acuminate; primary veins 4–6 pairs, more prominent beneath, prickly on both surfaces; petioles 0.6–3.3 cm long, densely to moderately pubescent with porrect-stellate trichomes like those of the leaves, usually armed with 1–5 prickles. Inflorescence a monochasial cyme (drepa-

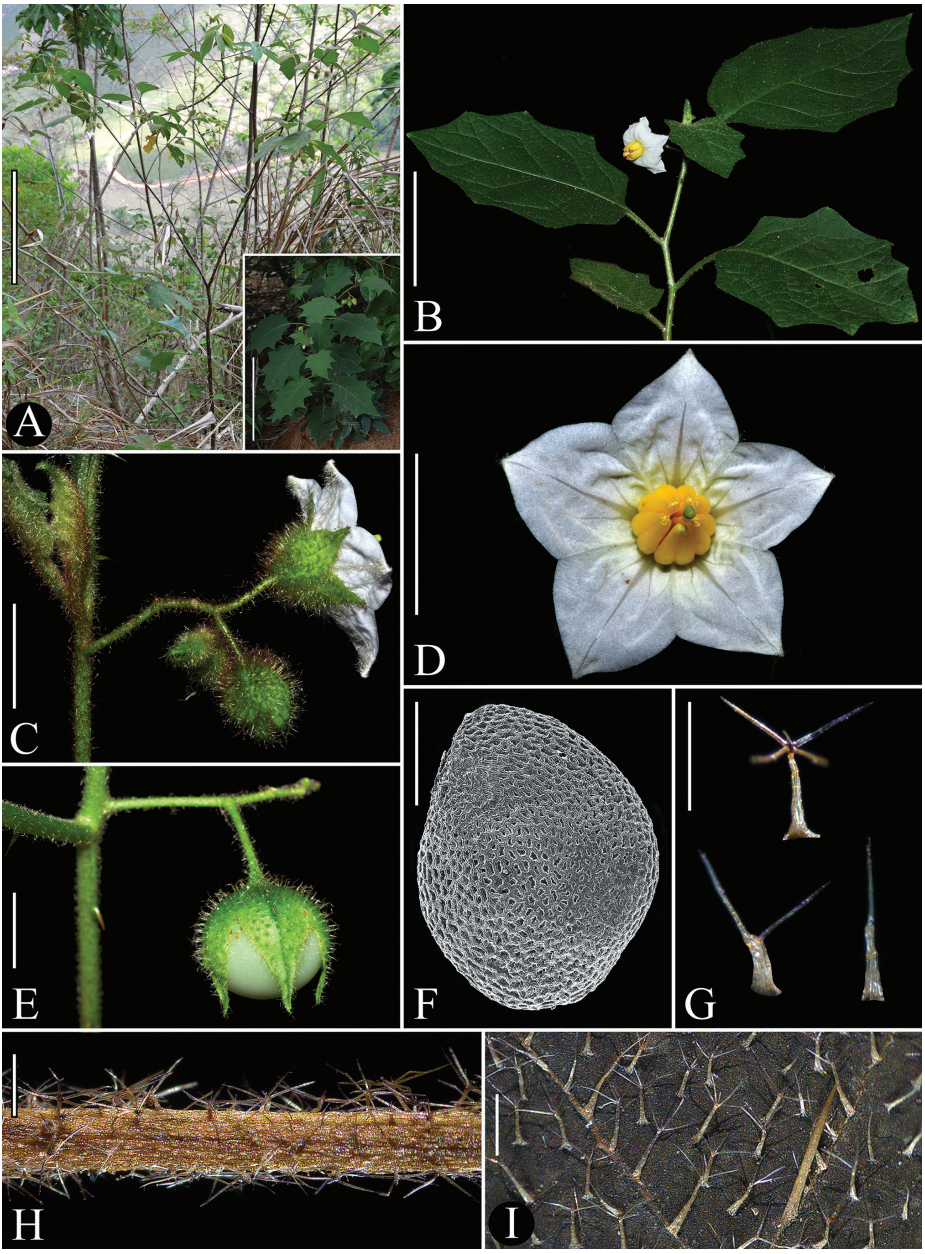

Figure 1. *Solanum hydroides* Gouvêa & Giacomin. (**A**, **G**–**I** field pictures from specimens *L.F.A. de Paula et al. 669*, BHCB; **B–E** *Y.F. Gouvêa & G.V.A. Santos 325,* BHCB). **A** Habit (bottom right corner: young plant with larger leaves) **B** flowering branch **C** inflorescence and a flower in lateral view (note that calyx does not have a plicate aspect at the base of the calyx tube) **D** long-styled flower, front view **E** mature fruit (note the calyx does not completely cover the berry) **F** scanning electron micrograph of seed **G** trichomes; upper: the usual morphology of the stellate trichomes of *S. hydroides* adaxial leaf surface; lower: examples of stellate trichomes with reduced number of rays (note the multiseriate stalks) **H** stem indumentum; **I** adaxial leaf surface indumentum. Scale bars: 30 cm (**A**); 7.5 cm (**B**); 1.3 cm (**C**–**D**); 1 cm (**E**); 0.8 mm (**F**–**I**). Photographs: **A** by L.F.A de Paula **B**–**E**, **G**–**I** by Y.F. Gouvêa.

nium) to 6 cm long, internodal, unbranched, with 4–10 flowers, up to 2 flowers open at a time, the axes glabrescent to densely tomentose, with trichomes like those of the stem but sometimes with the midpoint as long as the rays, usually unarmed; peduncles 0.4–2.3 (-3.8) cm long pedicels 3–17 mm long, 0.5–0.8 mm in diameter at base and up to 1.5 mm at the apex, straight to slightly curved, articulated at base, unarmed, with trichomes like those of the inflorescence axes; pedicel scars evenly spaced 1–7 mm apart. Buds ovoid to ellipsoid, with the corolla enclosed by the calyx until just before anthesis. Flowers 5-merous, heterostylous with long-styled flowers (hermaphroditic) at the base of inflorescence, short-styled (functionally male) flowers more distally and the plants andromonoecious. Calyx tube 2.6–4.3(6) mm long, 6.5–8 mm in diameter at anthesis, widely obconic to cupuliform, the lobes 3–7 mm long, 3–5.5 mm wide, triangular to deltate, with acute apices, glabrous adaxially, densely pubescent to hirsute abaxially with bristly purple-tinged, hyaline or ochraceo-ferruginous porrect to multiangulate long-stalked stellate trichomes, the stalks of the fully developed trichomes multiseriate, 1.1–3.8 mm long, rays 4-8 to 1.5 mm, the midpoints 1–2 celled, shorter than or the same length as the rays, associated with minute, nearly sessile, uniseriate, simple glandular trichomes along the epidermis and sometimes at the basal portion of the stellate trichomes stalks, armed or unarmed, the prickles acicular, 2.8-4 mm long, ca. 0.5 mm wide in flower to 1.1 mm in fruit. Corolla 2.4–3 cm in diameter, 7.1–12.2 mm long, white, shallowly stellate, interpetalar tissue nearly absent, lobed ca. halfway to the base, the fused part (tube) 7.1–12.2 mm long, the lobes 5.9–8.8 mm long, 9.9–12.2 mm wide, acute to apiculate apices, pubescent abaxially on the petal midvein and/or apices with sparse delicate short-stalked porrect-stellate trichomes with stalks to 0.9 mm long. Stamens equal; filament tube to 1 mm long; free portion of the filaments 0.7–1 mm long, glabrous; anthers 6.5–8 mm long, 2.5–3 mm wide, lanceolate, yellow, glabrous, connivent or divergent at the apices, sagittate and slighty gibbous at the base, swollen and papillose abaxially, the pores directed upwards or slightly extrorse, not lengthening to slits. Ovary somewhat conical, glabrous; style 8–10 mm long in long-styled flowers, ca. 3 mm long in short-styled flowers, straight, glabrous; stigma clavate to bilobed, the surface papillose and irregular, the style poorly developed in short-styled flowers. Fruit a globose berry, 0.9–1.8 cm in diameter, green to whitish-green at maturity, drying dark brown, glabrous, matte; fruiting pedicels 1–1.5 cm long, usually unarmed; fruiting calyx partially accrescent, the tube enclosing ½–¾ of the fruit at maturity, the lobes 5.8–8 mm long, 7–9.6 mm wide, with trichomes often with the base of the stalks markedly expanded and bristly, the stalks to 4.8 mm long. Seeds ca. 250 per berry, 2.2–2.6 mm long, 1.6–2 mm wide, pyriform to reniform, not markedly flattened, the surface irregularly pitted, the testal cells pentagonal in outline. Chromosome number not known.

Distribution. Endemic to South-eastern Brazil, with records in three localities in north-eastern Minas Gerais (Mun. Teófilo Otoni) and northern (Mun. Nova Venécia) and central (Mun. Santa Teresa) Espírito Santo States (Fig. 2).

Ecology. *Solanum hydroides* inhabits the edge of seasonal semi-deciduous tropical rainforests associated with granitic or gneissic rock outcrops (inselbergs) and

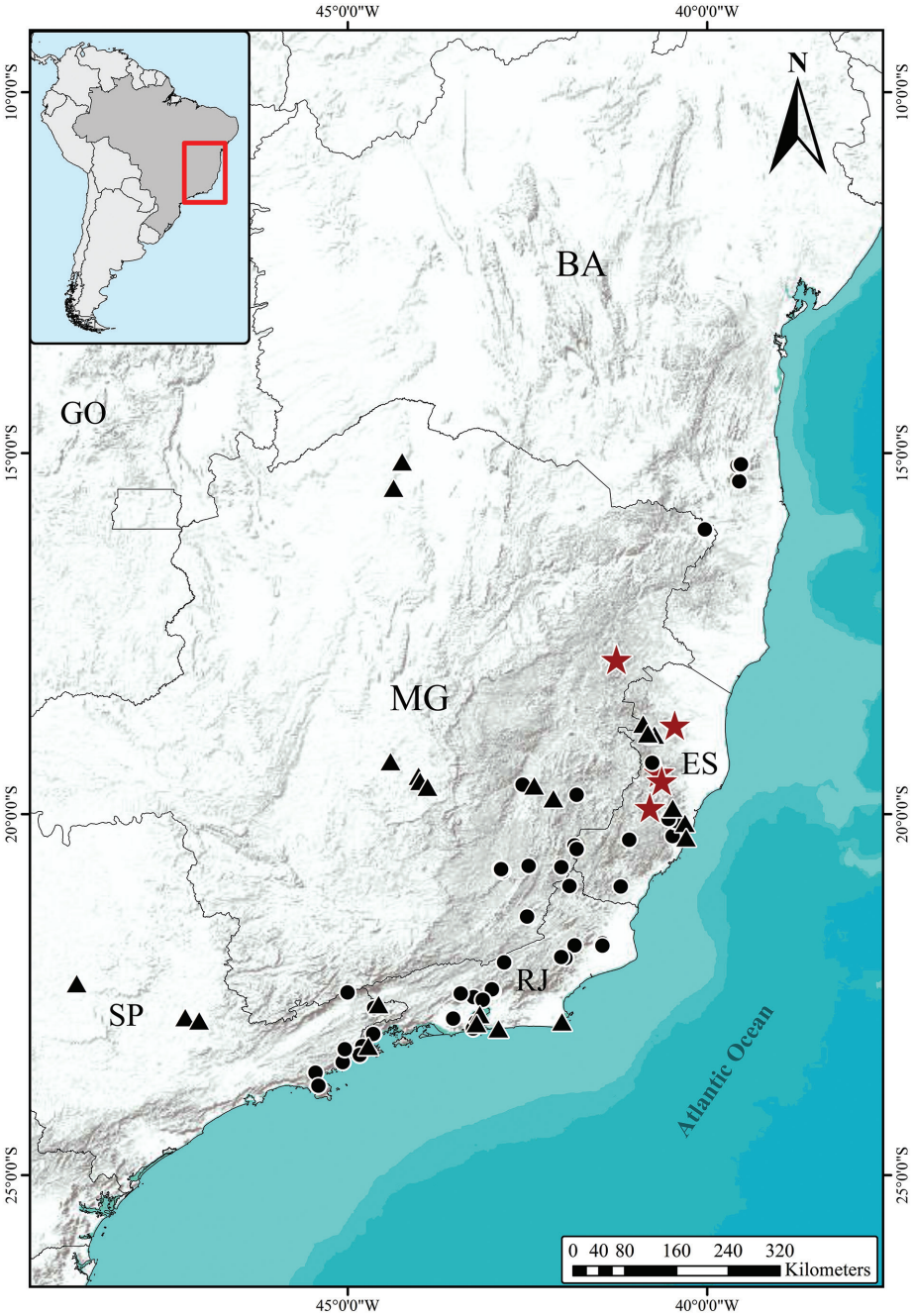

Figure 2. Distribution of *Solanum hydroides* Gouvêa & Giacomin (stars), *S. hexandrum* Vell. (circles) and *S. sublentum* Hiern. (triangles). State acronyms: **BA** (Bahia); **ES** (Espírito Santo); **MG** (Minas Gerais); **GO** (Goiás); **RJ** (Rio de Janeiro); **SP** (São Paulo).

somewhat disturbed sites at their base, like roadsides and clearings; from 300 to 600 m elevation. It also occasionally grows in epilithic vegetation patches lying on the flatter parts of inselbergs.

Phenology. Flowering specimens were collected in January, April, May, August, September and December, suggesting that *S. hydroides* blooms year-round. Fruiting specimens have been found only in January.

Etymology. *Solanum hydroides* is named for the resemblance of the long-stalked stellate trichomes of its calyces to the marine serpulid worm *Hydroides* Gunnerus, 1768 (illustrative images can be found at the Encyclopedia of Life; e.g. https://eol.org/search?utf8=%E2%9C%93&q=Hydroides).

Preliminary conservation status (IUCN 2019). Vulnerable (VU). EOO = 7,766 km^2 (VU - vulnerable); AOO = 28 km^2 (EN - endangered). *Solanum hydroides* is known from only three disjunct localities and is represented by only one collection in one of them (i.e. Serra do Toma Vento, Mun. Santa Teresa, Espírito Santo State). All other specimens were found in vegetation remnants associated with two inselbergs, located in the municipality of Nova Venécia, Espírito Santo state and in Minas Gerais State's municipality of Teófilo Otoni. Both, however, are in the central Brazilian Atlantic Forest, where botanical knowledge gaps are known to exist (Stehmann et al. 2009; Oliveira et al. 2016), suggesting the actual range of *S. hydroides* might be broader than currently known. Further sampling efforts in environmentally similar areas are therefore recommended, for a more accurate conservation status assessment. Nonetheless, the deforestation history of the area and the available geographic distribution data indicate that *S. hydroides* is of conservation concern.

Notes. *Solanum hydroides* shares a set of morphological features with species of a small and still unnamed group, recently proposed on the basis of morphological (Gouvêa et al. 2018) and molecular evidence (Giacomin et al., unpubl. data). This group, endemic to the Brazilian Atlantic Forest, comprises five previously described species: *S. hexandrum*, *S. kollastrum* Gouvêa & Giacomin, *S. robustum* H.Wendl., *S. stagnale* Moric. and *S. sublentum*. They are all medium- to large-sized shrubs with large repand leaves with decurrent bases (except *S. kollastrum*, which has cordate leaf bases), relatively robust and showy flowers with well-developed calyces that are accrescent in fruit and glabrous fruits (except *S. robustum*, which has weakly accrescent fruiting calyces and densely pubescent fruits).

The comparatively smaller leaves and thinner stems, petioles and inflorescence axis give a more delicate overall aspect of *S. hydroides*, differentiating it from all other species of the group, but *S. sublentum*. *Solanum hydroides* can, however, be readily distinguished from *S. sublentum* by the indumentum of stellate eglandular trichomes (Figs. 1G–I) and by the widely obconic to cupuliform shape of the calyx at anthesis (Fig. 1C). In *S. sublentum*, the indumentum is of both conspicuous simple glandular trichomes and stellate eglandular trichomes (Fig. 3H), with the stellate trichomes usually much less numerous than the simple ones and often early deciduous (i.e. present only in new growth). Calyces of *S. sublentum* are somewhat urceolate, inflated and prominently plicate at the base of the calyx tube (Fig. 3D).

Although being a markedly less robust species (compare Figs. 1A and B with 3A), *S. hydroides* can be very similar to some specimens of *S. hexandrum* (a quite vari-

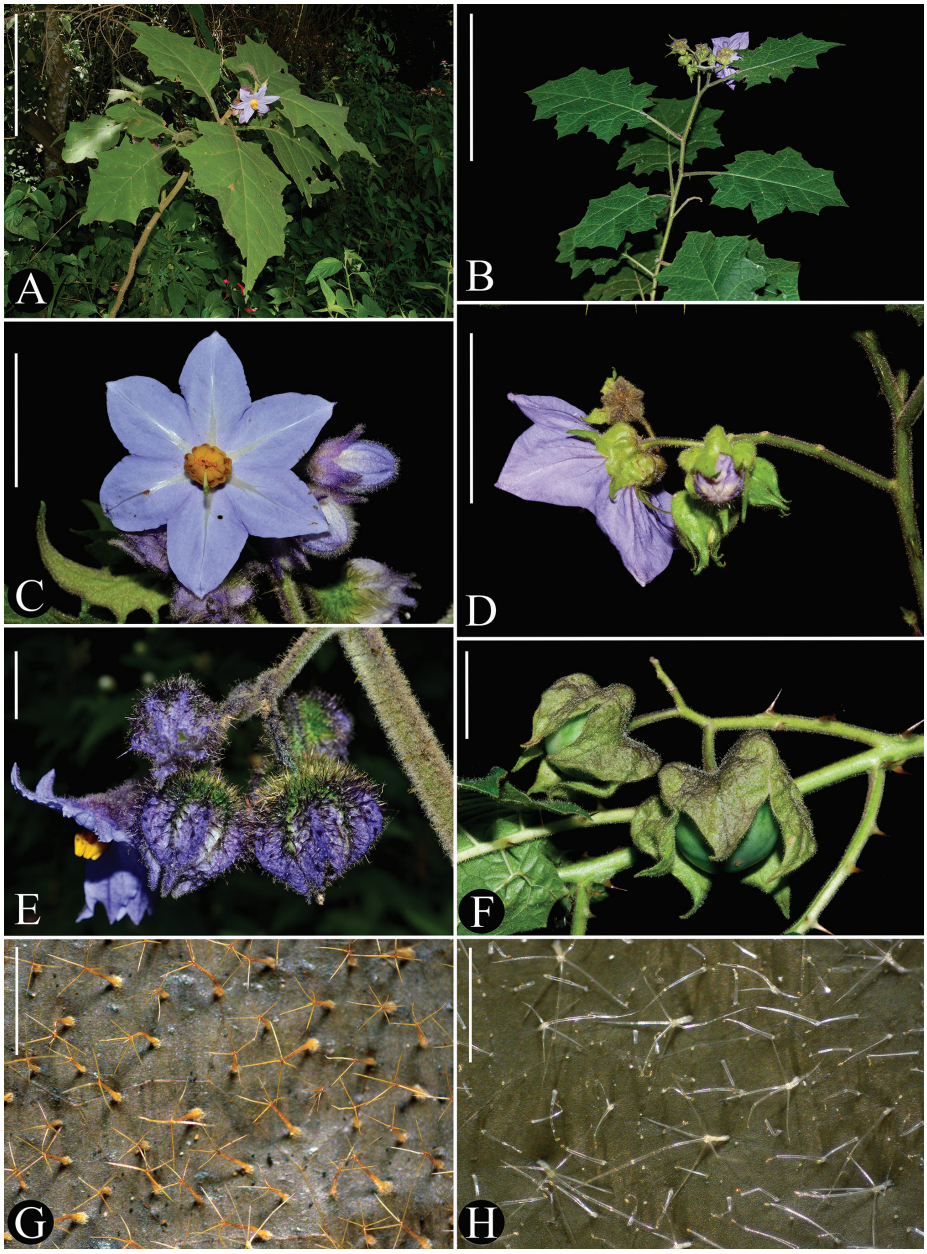

Figure 3. Distinctive characters of species morphologically related to *Solanum hydroides* Gouvêa & Giacomin. [**A**, **C**, **E**, **G**: *S. hexandrum* Vell. (*L.L. Giacomin et al. 875*, BHCB); B, D, F, H: *S. sublentum* Hiern. (*J.R. Stehmann et al. 6372*, BHCB)]. **A–B** Habit (note difference in robustness) **C** long-styled flower, front view **D** inflorescence and flower in back view (note the inflated and plicate aspect of the calyx tube) **E** inflorescence with fruits in different stages of development (note that the inflated fruiting calyx completely covers the fruit in all stages of development) **F** long-styled flower **G** fruits (note the plicate aspect of the fruiting calyx) **H–I** indumentum of the adaxial leaf surface. Scale bars: 15 cm (**A**); 10 cm (**B**); 3 cm (**C**); 2 cm (**D**, **G**); 1.4 cm (**E**); 1 mm (**F**); 1.2 mm (**H**). Photographs: **A**, **C**, **E** by L.L. Giacomin **B**, **D**, **F** by J.R. Stehmann **G–H** by Y.F. Gouvêa.

able species), with which it shares the indumentum of four-rayed stellate eglandular trichomes (Figs. 1H, I and 3G) on the stems, leaves, inflorescence axis and calyces. *Solanum hydroides* differs from *S. hexandrum* in its white and smaller corollas (13–21.5 mm total length), shorter corolla lobes (5.9–8.8 mm long; Fig. 1D), and accrescent, but not inflated, fruiting calyces that only partially cover the mature fruit (Fig. 1E). *Solanum hexandrum* has corollas in various shades of lilac to purple and are larger (24.3–40 mm long), with longer corolla lobes (12.6–25 mm long; Fig. 3C) and the fruiting calyces are accrescent and inflated, completely enclosing the mature fruit (Fig. 3E). The corollas of *S. hydroides* are thin and membranous and easily tear apart between the lobes during the drying process, which can make the lobes on herbarium specimens seem longer than they really are. Hence, one should carefully check before measuring to ensure a correct measurement is taken from herbarium sheets.

Leaf measurements are also useful for distinguishing *S. hydroides* from *S. hexandrum.* The leaves of *S. hydroides* are generally smaller (7.5–13.6 cm long and 5-8.7 cm wide) than those of *S. hexandrum* (17–45 cm long and 10.5–32 cm wide). Nevertheless, like many species belonging to the Leptostemonum clade (sensu Bohs 2005; Stern et al. 2011), the leaves of *S. hydroides* are larger in plants growing in shade and in young individuals (see Roe 1966) and we have seen plants with leaves to 22 cm long and 11 cm wide. Specimens of *S. hydroides,* growing in shade, have a less dense indumentum, with less robust (i.e. stalks with fewer series of cells) and slightly shorter trichomes on stems, leaves and calyx. Corollas of these shade plants are usually larger in relation to the other flower parts (e.g. stamens and calyx).

The trichome morphology in *S. hydroides* is not particularly variable within individual plants and amongst plants of the same population; however, there is a significant variation in the number of trichome rays between some populations. Trichomes of specimens from the southernmost known population (in Santa Teresa municipality, Espirito Santo State) are mostly six- to eight-rayed and usually more densely distributed throughout the plant, while those of plants from the other populations (Teófilo Otoni and Nova Venécia municipalities of Minas Gerais State) are mostly four-rayed (Figs. 1H and I). Within individual plants, the variation in trichome morphology is limited to a reduction in the number of rays and is especially evident in plants with four-rayed trichomes. In these plants, the trichomes may lack one to almost all rays (Fig. 1G), sometimes with only the midpoint or a lateral ray remaining and the trichome appearing to be unbranched, but with a basal multiseriate stalk. This kind of variation has been reported in other *Solanum* groups, such as the Brevantherum clade or members of sect. *Acanthophora* Dunal (Nee 1991; Levin et al. 2005; Stern et al. 2013).

The exploitation of natural resources in Brazil is far from being sustainable (Ferreira et al. 2014) and this fact, combined with the rapid fragmentation of the Atlantic Forest (Tabarelli et al. 2004), raises the risks for the vegetation refugia associated with inselbergs found in the domain. Particularly in some regions in south-eastern Brazil, these rock outcrops harbour the last remnants of forest fragments (Martinelli 2007). Therefore, we argue that every remnant of native vegetation of rocky outcrops, no matter the size, is worth preserving and should be inspected. Remnants can harbour new

species and endemics, like *S. hydroides*, despite the massive fragmentation and loss of the surrounding vegetation.

Specimens examined. BRAZIL. **Espírito Santo**: Mun. Nova Venecia, APA da Pedra do Elefante, Serra de Baixo, Pedra do Elefante, inselbergue, 18°46'S, 40°27'W, 653 m elev., 10 May 2008 (fl), *A.P. Fontana et al. 5259* (MBML, RB); Serra de Baixo, Pedra da Torre, inselbergue, 18°46'58"S, 40°26'47"W, 420–500 m elev., 18 Feb 2008 (fr), *C.N. Fraga et al. 1899* (CEPEC, MBML, RB, UPCB); estrada não pavimentada de acesso à Pedra do Elefante, 18°46'40"S, 40°26'37"W, 352 m elev., 1 Apr 2019 (fl, fr), *Y.F. Gouvêa & G.V.A. Santos 325* (BHCB); 18°46'42"S, 40°26'50"W, 301 m elev., 1 Apr 2019 (fl, fr), *Y.F. Gouvêa & G.V.A. Santos 328* (BHCB); morro lado direito na estrada para Pedra do Elefante, afloramento rochoso, inselbergue, 18°46'12"S, 40°26'51"W, 300–600 m elev., 14 Jan 2009 (fl), *L. Kollmann et al. 11385* (CEPEC, MBML, RB, UPCB); Mun. Santa Teresa, Serra do Toma Vento, em inselberg, 19°54'29"S, 40°47'44"W, 747 m elev., 26 Aug 2014 (fl), *T.M. Machado et al. 673* (BHCB). **Minas Gerais**: Mun. Teófilo Otoni, afloramento rochoso lado esquerdo da MG-418, cerca de 30 km norte de Teófilo Otoni, 17°51'33"S, 41°15'46"W, 546 m elev., 8 Jan 2011 (fl, fr), *L.F.A. de Paula 148 et al.* (BHCB); 16 Apr 2011 (fl), *L.F.A. de Paula* & *M. Augsten 247* (BHCB); 17°51'42.1"S, 41°15'54.4"W, 533 m elev., 9 Sep 2011 (fl), *L.F.A. de Paula et al. 388* (BHCB); 17°51'45.9"S, 41°16'00.5"W, 450 m elev., 27 Dec 2011 (fl), *L.F.A. de Paula et al. 581* (BHCB).

Acknowledgements

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Supplementary material 1

Searchable XLS file of all specimens examined of *Solanum hydroides* Gouvêa & Giacomin

Authors: Yuri Fernandes Gouvêa, Luiza Fonseca Amorim de Paula, João Renato Stehmann, Leandro Lacerda Giacomin

Data type: species data

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Link: https://doi.org/10.3897/phytokeys.139.46635.suppl1

Supplementary material 2

Searchable XLS file of all records used to map distributions of *Solanum hexandrum* Vell. and *Solanum sublentum* Hiern

Authors: Yuri Fernandes Gouvêa, Luiza Fonseca Amorim de Paula, João Renato Stehmann, Leandro Lacerda Giacomin

Data type: species data

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Eocene "*Chusquea*" fossil from Patagonia is a conifer, not a bamboo

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Abstract

Chusquea oxyphylla Freng. & Parodi, 1941, a fossilized leafy branch from the early Eocene (52 Ma), late-Gondwanan Laguna del Hunco biota of southern Argentina, is still cited as the oldest potential bamboo fossil and as evidence for a Gondwanan origin of bamboos. On recent examination, the holotype specimen was found to lack any typical bamboo characters such as nodes, sheaths, ligules, pseudopetioles, or parallel leaf venation. Instead, it has decurrent, clasping, univeined, heterofacially twisted leaves with thickened, central-longitudinal bands of presumed transfusion tissue. These and other features allow confident placement in the living Neotropical and West Pacific disjunct genus *Retrophyllum* (Podocarpaceae), which was recently described from the same fossil site based on abundant, well-preserved material. However, the 1941 fossil holds nomenclatural priority, requiring the new combination *Retrophyllum oxyphyllum* (Freng. & Parodi) Wilf, **comb. nov.** No reliable bamboo fossils remain from Gondwana, and the oldest South American bamboo fossils are Pliocene. *Chusquea* joins a growing list of living New World genera that are no longer included in Paleogene Patagonian floras, whose extant relatives are primarily concentrated in Australasia and Malesia via the ancient Gondwanan route through Antarctica.

Keywords

Gondwana, Laguna del Hunco, Poaceae, Podocarpaceae, *Retrophyllum*, South America

Introduction

In 1941, the legendary Argentine botanists Joaquín Frenguelli and Lorenzo R. Parodi of Museo de La Plata (Frenguelli and Parodi 1941; Burkart 1967; Riccardi 2017) described a compressed leafy-shoot fossil from northwest Chubut Province, Argentina

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under *Chusquea* Kunth, a diverse New World bamboo genus (Clark 1989, 1997a; Fisher et al. 2014; Wysocki et al. 2015). *Chusquea oxyphylla* Freng. & Parodi, 1941 (Fig. 1A–C) was one of the earliest taxonomic contributions to the extraordinarily diverse Laguna del Hunco biota (Berry 1925; Dolgopol de Sáez 1941). The assemblage, once thought to be Miocene in age, is now constrained to the early Eocene (ca. 52.2 Ma; Wilf et al. 2003, 2017a); it has remained a subject of intensive study for many decades (e.g., Romero and Hickey 1976; Fidalgo and Smith 1987; Romero et al. 1988), particularly over the past ca. 15 years (for summaries see, e.g., Wilf et al. 2009, 2013, 2019).

Chusquea oxyphylla retains significance today because, at 52 Ma, it is by far the oldest putative bamboo macrofossil and the only one still recognized (by some authors) from Gondwana. Otherwise, reliable South American bamboo fossils are no older than Pliocene (Brea and Zucol 2007; Olivier et al. 2009; Brea et al. 2013), making them much younger than Gondwana, whose final separation began ca. 50 Ma (e.g., Lawver et al. 2011), and contemporary with the closure of the Isthmus of Panama and direct biotic interchange with Central and North America (e.g., Simpson 1950; O'Dea et al. 2016). Worldwide, reliable bamboo macrofossils are no older than Oligocene (e.g., Worobiec and Worobiec 2005; Brea et al. 2013; L. Wang et al. 2013; Q. Wang et al. 2014; Srivastava et al. 2019). The oldest microfossil (phytolith) evidence for bamboos is from the middle Eocene of the Northern Hemisphere (Strömberg 2004, 2005, 2011). Thus, *C. oxyphylla* remains prominent, with variable confidence expressed regarding its affinities, in discussions about the age, paleoecology, biogeography, and possible Gondwanan origins of bamboos (Barreda and Palazzesi 2007; Brea and Zucol 2007; Iglesias et al. 2011; Ruiz-Sanchez 2011; L. Wang et al. 2013; Giussani et al. 2016; Srivastava et al. 2019). However, several authors have doubted that *C. oxyphylla* is a definite bamboo or even a grass (Thomasson 1980; Srivastava et al. 2019).

Chusquea oxyphylla has biogeographic significance for Laguna del Hunco and other Eocene Patagonian floras, which were once considered to be closely allied with extant South American floras from proximal areas such as Paraguay and northern Argentina, where *Chusquea* is a prominent element (Berry 1925; Frenguelli and Parodi 1941). In contrast, several putative New World elements from Laguna del Hunco have been revised recently to taxa whose living members primarily inhabit the Asia-Pacific region via Gondwanan connections (e.g., *Austrocedrus-Libocedrus* to *Papuacedrus*, *Fitzroya* to *Dacrycarpus*, *Zamia* to *Agathis*; Wilf et al. 2009, 2014; Wilf 2012). Moreover, numerous additional taxa have been described from the site that also have Asia-Pacific extant distributions (e.g., Romero and Hickey 1976; Zamaloa et al. 2006; Gandolfo et al. 2011; Carpenter et al. 2014; Gandolfo and Hermsen 2017; Andruchow-Colombo et al. 2019; Wilf et al. 2019). Also, monocots in the Laguna del Hunco flora are scarce in general, otherwise represented by a few leaves of *Ripogonum* (Ripogonaceae; Carpenter et al. 2014) and rare, undescribed palm fruits and leaf fragments (Wilf et al. 2005). The specimen referred to *Poacites* sp. Berry (1925; National Museum of Natural History, Smithsonian Institution [USNM], USNM 219072), on my examination, is too poorly preserved to assign confidently to any plant group, much less to the grasses. Despite the general significance of *C. oxyphylla*, until now

there have been no published re-examinations of the holotype (Fig. 1A–C), otherwise known only from a single photograph in the original publication (Frenguelli and Parodi 1941).

Materials and methods

I examined the holotype of *Chusquea oxyphylla* on 26 May 2019 in the paleobotanical collections of Museo de La Plata, Argentina (**MLP**), specimen MLP-4234 (Fig. 1A–C). Specimen tags indicate "Laguna del Hunco, El Mirador, Chubut" and "Mioceno," which was formerly considered the age of the Laguna del Hunco fossil-lake beds (Berry 1925). The protologue (Frenguelli and Parodi 1941: 235–236) states that the specimen was collected in 1939 or 1940 and came from the "basal layers" ("*capas basales*") of the lacustrine sequence now known as the Tufolitas Laguna del Hunco (Aragón and Mazzoni 1997). However, there was no general stratigraphic section and correlation of the lake beds available in the early 1940s, and Frenguelli and Parodi (1941) more likely were referring to a relative position within a local exposure rather than the full stratigraphic sequence as later understood (Petersen 1946; Aragón and Mazzoni 1997; Wilf et al. 2003). The lithology and preservation of the holotype closely resemble fossils from the horizon of what is now quarry LH4 (see Wilf et al. 2003 for coordinates), which appears to have been the site of most early collections (see Wilf et al. 2019). Quarry LH4 is well exposed at a comparatively accessible location, low on a local hill slope, where the underlying basal strata of the lake beds (subsection E of Wilf et al. 2003) are mostly lost to a local unconformity; thus, LH4 could have appeared to be near the base of the lake beds. However, LH4 actually lies in the middle of the full 170 m stratigraphic section of the Tufolitas Laguna del Hunco at Laguna del Hunco (Wilf et al. 2003) and is now confidently dated to ca. 52.2 Ma using several ^{40}Ar-^{39}Ar dates and paleomagnetic data from strata intercalated with the fossil quarries; in particular, an ^{40}Ar-^{39}Ar age on sanidine of 52.22 ± 0.22 Ma was analyzed from a tuff only 40 cm above quarry LH4 (Wilf et al. 2003, 2005, 2017a).

Photographs were taken at MLP using a Nikon D850 DSLR with an AF-S VR Micro-Nikkor 105 mm f2.8 G IF-ED lens and a Nikon circular polarizer and on a Leica M50 stereoscope with a mounted Canon Powershot S40 camera and Canon Remote Capture 2.2 software. I consulted standard botanical literature for *Chusquea* and other bamboos (McClure 1966, 1973; Clark 1989, 1997a; Stapleton 1997; Judziewicz et al. 1999; Clark et al. 2015) and for podocarp conifers (e.g., de Laubenfels 1969; Farjon 2010; Mill 2016; others cited in Wilf et al. 2017b); these references support the discussion below.

Taxonomic treatment

Podocarpaceae Endl., Synopsis Coniferarum: 203 (1847).

Retrophyllum C. N. Page, Notes of the Royal Botanic Garden of Edinburgh 45: 379 (1989) ["1988", see Mill 2016]).

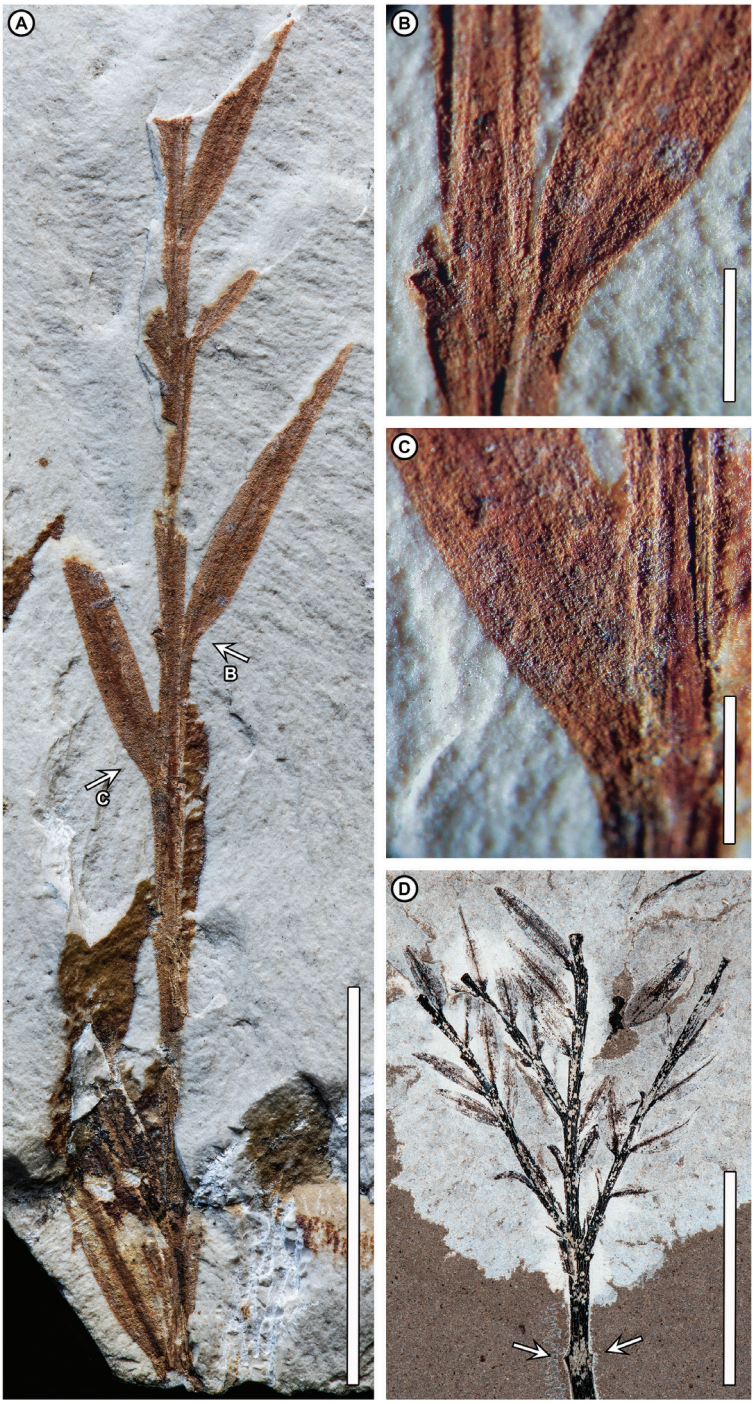

Figure 1. *Retrophyllum oxyphyllum* (Freng. & Parodi) Wilf, comb. nov. from Laguna del Hunco. **A–C** Holotype, MLP-4234, arrows in **A** indicate detail panels in **B, C**. **D** MPEF–Pb 8915a (Museo Paleontológico Egidio Feruglio, Trelew, Argentina) from Laguna del Hunco quarry LH6 of Wilf et al. (2003), part of an extensive suite of fossil *Retrophyllum* material here synonymized (Wilf et al. 2017b; Wilf 2017).

***Retrophyllum oxyphyllum* (Freng. & Parodi) Wilf, comb. nov.**
Figure 1A–C

Basionym. *Chusquea oxyphylla* Freng. & Parodi, Notas del Museo de La Plata, Paleontología 6: 236 (1941: fig. 1).

Synonym. *Retrophyllum spiralifolium* Wilf, American Journal of Botany 104: 1350 (2017).

Holotype. Argentina. Chubut Province: Laguna del Hunco, Tufolitas Laguna del Hunco, Huitrera Formation, early Eocene. Museo de La Plata (MLP), MLP-4234. Collected by J. Frenguelli 1939 or 1940 (Frenguelli and Parodi 1941: 236), precise collection location unknown. The holotype is the only specimen of the basionym.

Amended description. The entire recent description of *Retrophyllum spiralifolium* Wilf, 2017 (Wilf et al. 2017b: 1350–1352), verbatim, is here denoted as the amended formal description of *Retrophyllum oxyphyllum* comb. nov. but is not reproduced here due to its length. The holotype fully conforms to the described foliage, in particular the distichous foliage form, of *R. spiralifolium*. The new combination incorporates all associated material described, illustrated, and justified previously under *R. spiralifolium* (Wilf et al. 2017b), including the distichous foliage form, helical foliage form, reduced foliage forms, and peduncle of pollen cones.

Diagnostic characters. In the absence of a diagnosis of the basionym (Frenguelli and Parodi 1941), a formal amended diagnosis cannot be provided. However, the characters listed in the specific diagnosis for *Retrophyllum spiralifolium* (Wilf et al. 2017b: 1350) all now apply to *Retrophyllum oxyphyllum* comb. nov. That diagnosis (Wilf et al. 2017b: 1350) is reproduced here for ease of use, with the characters preserved in the holotype (Fig. 1A–C) indicated in bold font:

"***Foliage with conspicuous central longitudinal band of thickened tissue and obscure midvein not separating rows of stomata.*** *Lateral resin canals present.* ***Principal leaves decurrent and extensively clasping twig, free portions either distichous and pectinate, with full heterofacial flattening****, or spirally deployed with negligible to slight basal twisting, frequently broken off to leave spirally arranged stubs of clasping por-*

Figure 1. Continued. **A** General view of the holotype, with clasping, overlapping, zigzagging, decurrent, opposite leaf bases; heterofacially twisted, lanceolate free-leaf portions, many of them broken off at departure from the twig and leaving stubs; and thick central tissue band compressed to a coalified black stripe, most conspicuous in the basalmost preserved leaf. Leaves on the left side of the twig in this view are twisted "forward" and those on the right "backward," i.e., counterclockwise in both cases when viewed from leaf to twig; original abaxial or adaxial orientation cannot be determined **B** detail of backward-twisted leaf (at right), with negative relief (from compression) of the raised central band visible, and broken leaf base (at left) **C** detail of forward-twisted leaf, thickened central band, and dense longitudinal striations across the leaf surface marking borders between former stomatal rows **D** terminus of a long penultimate branch (also Wilf et al. 2017b: figs 10–12) with pairs of opposite, ultimate leafy branches, each similar to the holotype (A) with opposite leaves and linear-reduced leaves at the shoot bases (the holotype does not preserve the shoot base). Arrows indicate opposite branch scars on the exposed penultimate branch, completely unlike bamboo nodes. Scale bars: 2 cm (**A, D**); 2 mm (**B, C**).

tions. Leaf apices acuminate to markedly acuminate. Terminal bud protected by reduced, modified leaves. Reduced foliage also including ovoid and narrow forms on separate shoot segments and narrow miniature leaves abruptly or gradually interspersed with principal leaves along shoots. Pollen cones pedicellate, long-cylindrical, in axils of narrow reduced leaves, distichously grouped on a common peduncle."

Amended description of the holotype. The holotype of *Retrophyllum oxyphyllum* comb. nov. (Fig. 1A–C) is a leafy branch segment of axis length 6.4 cm with remains of ca. ten pairs of opposite, distichous (pectinate), decurrent and clasping, ovate-lanceolate, bifacially flattened leaves that are heterofacially twisted into a single plane at their departure from the twig. The clasping portions of the leaves entirely cloak the twig in an overlapping, zigzag pattern. It is not possible to determine whether the preserved view is abaxial or adaxial (see Wilf et al. 2017b). The bases of the leaves' free portions are twisted counterclockwise if viewed laterally from leaf to twig, so that pairs of abaxial and adaxial leaf faces appear in the same plane on either side of the twig. Only ca. four leaves have their free portions well preserved; most leaves are broken off at or near twig departure, leaving behind their clasping leaf bases. Free leaf portion length is to 18.0 mm, width to 2.5 mm, apices acute but not completely preserved. Leaves have no venation visible but preserve a longitudinal, raised central band of thickened, coalified tissue whose width is ca. 25% of total leaf width; the central band presumably obscures the much smaller, true midvein running within. The remaining leaf surface has numerous parallel striations on both faces, continuous across the midvein, with slight relief but no evidence of vein tissue; there are no cross-lineations that could be interpreted as cross-veins.

Discussion

The holotype of *Retrophyllum oxyphyllum* comb. nov. (Fig. 1A–C) does not resemble *Chusquea* or any other bamboo, and all its previously noted similarities to bamboos and other grasses (Frenguelli and Parodi 1941), though reasonable at the time, are superficial. There is no evidence of bamboo-type nodes, sheaths, or ligules as initially described (Frenguelli and Parodi 1941); areas that may resemble those features consist only of the broken departure points of leaf bases diverging from the twig. The decurrent, extensively clasping leaves are quite unlike the characteristically pseudopetiolate leaves of bamboos, and the heterofacially twisted free-leaf bases do not occur, to my knowledge, in any bamboo or grass. In the grass subfamily Pharoideae, pseudopetioles characteristically twist 180° so that all leaf abaxial surfaces face adaxially (e.g., Judziewicz et al. 1999); however, this twisting is homofacial, unlike the fossil, and the leaf architecture of Pharoideae is also completely unlike that of the fossil. The lack of leaf venation in the fossil, other than a single presumed midvein obscured by thickened tissues, contrasts with bamboos, pharoids, and other grasses, which usually have one to several discrete orders of parallel veins connected by numerous, though sometimes obscure, cross-veins and no thickened or raised laminar tissues similar to those in the fossil.

On the other hand, the holotype is easily identifiable as the flip-leaved, podocarpaceous conifer genus *Retrophyllum*; it matches precisely the distichous fossil foliage form of *Retrophyllum spiralifolium*, which was described recently from a suite of 82 specimens collected from both Laguna del Hunco, including quarry LH4, and the early middle Eocene Río Pichileufú site in Río Negro Province (Wilf et al. 2017b). *Retrophyllum* is a genus of six living species of rainforest conifers that is disjunct between the Neotropics and the tropical West Pacific, as reviewed in Mill's (2016) recent monograph. *Retrophyllum* is the only living genus that has heterofacially twisted (flip-leaved), distichous, elliptic to ovate-lanceolate free foliage precisely like that in the fossil, similarly emerging from extensively clasping, overlapping, zigzagging leaf bases below the twist point. *Retrophyllum* is univeined and amphistomatic, as the fossil is inferred to be; the stomata deploy in longitudinal rows that are distributed nearly evenly across the blade, separated by longitudinal striations (that superficially resemble veins) with no grouping into zones or interruption at the midvein (e.g., Mill 2016). Similarly, the evenly spaced longitudinal striations on both fossil leaf surfaces (e.g., Fig. 1C and similar material in Wilf et al. 2017b), once interpreted as veins (Frenguelli and Parodi 1941), mark the areas between the original stomatal rows and trend slightly obtuse to the course of the leaf margin as in living *Retrophyllum*.

Retrophyllum leaves also have a thickened, raised central band, consisting of wings of transfusion tissue that is more or less prominent depending on species (Gray 1962; de Laubenfels 1969). In fossil *Retrophyllum* previously described from Laguna del Hunco (Wilf et al. 2017b) and the fossil studied here (Fig. 1A–C), the transfusion-tissue band is raised and coalified to a thick black stripe of one-fifth to one-third of total leaf width, entirely unlike the slender midveins of bamboos as previously interpreted (Frenguelli and Parodi 1941). Among the prior material here synonymized (Wilf et al. 2017b) is a spectacular, long, leafless branch segment terminating in several opposite, pectinate leafy shoots (Fig. 1D; also Wilf et al. 2017b: figs 10, 11 for complete view), each of these shoots very similar to the holotype (Fig. 1A); the exposed branch has opposite leaf scars typical of *Retrophyllum*, with no bamboo-type axis segmentation or associated features such as nodes, sheaths, sheath scars, buds, or branch complements that would be clearly visible if present. The associated peduncle of pollen cones, each with a subtending leaf having the same distinctive features as the sterile foliage such as twisted bases and thickened transfusion-tissue bands (Wilf et al. 2017b: figs 61–68), is entirely dissimilar to the reproductive organs of any grasses.

The evidence here gathered firmly supports combining *Chusquea oxyphylla* and *Retrophyllum spiralifolium* into *Retrophyllum oxyphyllum* comb. nov., thus preserving the priority of the older name. Additionally, the species description for the new combination is amended to accommodate additional foliage forms and a peduncle of pollen cones that, along with the distichous foliage form, are all considered to represent a single source species and placed in *R. spiralifolium* as justified by Wilf et al. (2017b) based on detailed comparisons of a sample of 82 specimens. These additional fossils and their characters provide a far more complete whole-plant understanding of the ancient species than does the lone holotype. The nomenclatural change does not affect the other two fossil *Retrophyllum* species from South America, *R. superstes* Wilf, 2017

from the terminal Cretaceous of the Lefipán Formation in Chubut, Argentina, and *R. araucoensis* (E.W. Berry) Wilf, 2017 from the Eocene Concepción–Arauco Coal Measures of Chile (Berry 1922; Florin 1940; Greenwood 1987; Wilf et al. 2017b).

Concluding remarks

This revision of a putative *Chusquea* fossil to the podocarp genus *Retrophyllum* removes the last fossil evidence still cited for bamboos in Gondwana (see Introduction). The remaining South American bamboo fossils (see Introduction) are post-Gondwanan and contemporary with the emergence of the Isthmus of Panama. However, phylogeographic data still support a Gondwanan origin of grasses and, in some reports, bamboos in particular (see Clark et al. 1995; Clark 1997b; Bremer 2002; Bouchenak-Khelladi et al. 2010; Hodkinson et al. 2010; Soreng et al. 2017).

The deletion of a living New World genus (*Chusquea*) from the overall floral list for Eocene Patagonia further weakens the New World biogeographic signal of the late-Gondwanan vegetation of South America (see Introduction), which is currently understood to have much stronger links to the tropical West Pacific as discussed extensively elsewhere (e.g., Wilf et al. 2009, 2014, 2019; Gandolfo et al. 2011). Interestingly, when considering the full suite of specimens (Wilf et al. 2017b), *Retrophyllum oxyphyllum* preserves morphological evidence for affinity to both Old and New World living species of *Retrophyllum*. Several of its features are only found among the Old World species, such as wide bands of transfusion tissue and the presence of scale leaves and non-distichous foliage forms, whereas its lateral resin canals and acuminate leaf apices are only seen today in South American *Retrophyllum* species (see Wilf et al. 2017b).

The strongest New World signal remaining in Eocene Patagonia based on well-described macrofossils comes from fossil fruits of *Physalis* (Solanaceae), an entirely American genus (Wilf et al. 2017a). Other fossilized genera from Eocene Patagonia with New World living relatives are, like *Retrophyllum*, disjunct with the Old World today, including *Dicksonia* (Dicksoniaceae: Central and South America, Australasia, Malesia; Berry 1938; Carvalho et al. 2013), *Podocarpus* (Podocarpaceae: Africa, South and Central America, Australasia, East Asia; Berry 1938), *Orites* (Proteaceae: South America and Australia; Romero et al. 1988; González et al. 2007), and basal Asteraceae with closest living relatives in South America and Africa (Barreda et al. 2010, 2012).

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RESEARCH ARTICLE

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Dilochia deleoniae (Orchidaceae), a new species from Mindanao, Philippines

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Abstract

A new species, *Dilochia deleoniae* Tandang & Galindon (Orchidaceae), from Mindanao Island, Philippines is described and illustrated herein. This species is distinct from other known Philippine *Dilochia* species by its terrestrial habit and is distinguished from all known *Dilochia* species by its monopodial inflorescence, rarely branching in two, and a pale yellow to dull orange or brownish-yellow labellum devoid of purple spots.

Keywords

biodiversity, Mount Hamiguitan Range Wildlife Sanctuary, orchid taxonomy, world heritage site

Introduction

Dilochia Lindl. is a genus in the Orchidaceae comprising ten species found in Southeast Asia and New Guinea (Thomas 1993; Sulistriarini 2012; Ormerod 2015; Govaerts et al. 2019). Only two species have been previously recorded in the Philippines (Pelser

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et al. 2011 onwards), *viz. D. elmeri* Ames and *D. wallichii* Lindl., both of which are epiphytic. *D. elmeri* is endemic to the Philippines with extant populations in Luzon (Rizal), Visayas (Samar and Leyte), and Mindanao (Davao), whereas the native range of *D. wallichii* encompasses the Malesian region and Thailand.

The new species was discovered in 2016 by the first author during the botanical survey for the Global Environment Facility (GEF)–funded project, 'Removing Barriers to Invasive Species Management in Production and Protection Forest in Southeast Asia (FORIS)', in the Mount Hamiguitan Range Wildlife Sanctuary (MHRWS). Two flowering individuals of *Dilochia* were documented and collected inside a sampling quadrat. Unfortunately, measurements and the description of characters *in situ* were not made before the specimens were pressed and dried. Several flowering individuals were observed and collected during fieldwork with Central Mindanao University (CMU) and the Botanical Research Institute of Texas (BRIT) in June 2019. Furthermore, fruiting specimens were collected in subsequent fieldwork conducted by CMU together with the first author in August 2019.

Photographs and *in situ* descriptive observations of the colors of vegetative and reproductive structures were captured during botanical inventories in 2016 and 2019. Illustrations and further detailed morphological and microscopic examinations of four voucher specimens preserved in denatured alcohol were recorded at the Botany and National Herbarium Division, National Museum of the Philippines. Measurements of important plant parts were made using Mitutoyo Digimatic Caliper. On detailed examination, the authors realized that this species differs greatly from all other species of *Dilochia*. Therefore, we have described and illustrated the new species *Dilochia deleoniae* Tandang & Galindon, the third species from the Philippines and 11th species in the world.

Taxonomy

Dilochia deleoniae **Tandang & Galindon, sp. nov.**
urn:lsid:ipni.org:names:77205270-1
Figs 1–2

Diagnosis. This species is distinct from the two known epiphytic Philippine species by having an entirely terrestrial habit. Further, among the characters that separate it from other known *Dilochia* species, the new species has a monopodial inflorescence or rarely branching in two. It is similar to *D. beamanii* Ormerod (Ormerod 2015) of Sabah, Malaysia in its reproductive structures. Both species have a terminal flower, with similarity in shape and color of bracts, sepals, and petals. Furthermore, their columns are both winged and with small variation in length. However, the new species has a monopodial inflorescence or rarely branching in two, bearing 7 to 9 flowers (vs. a 3- to 6-branched

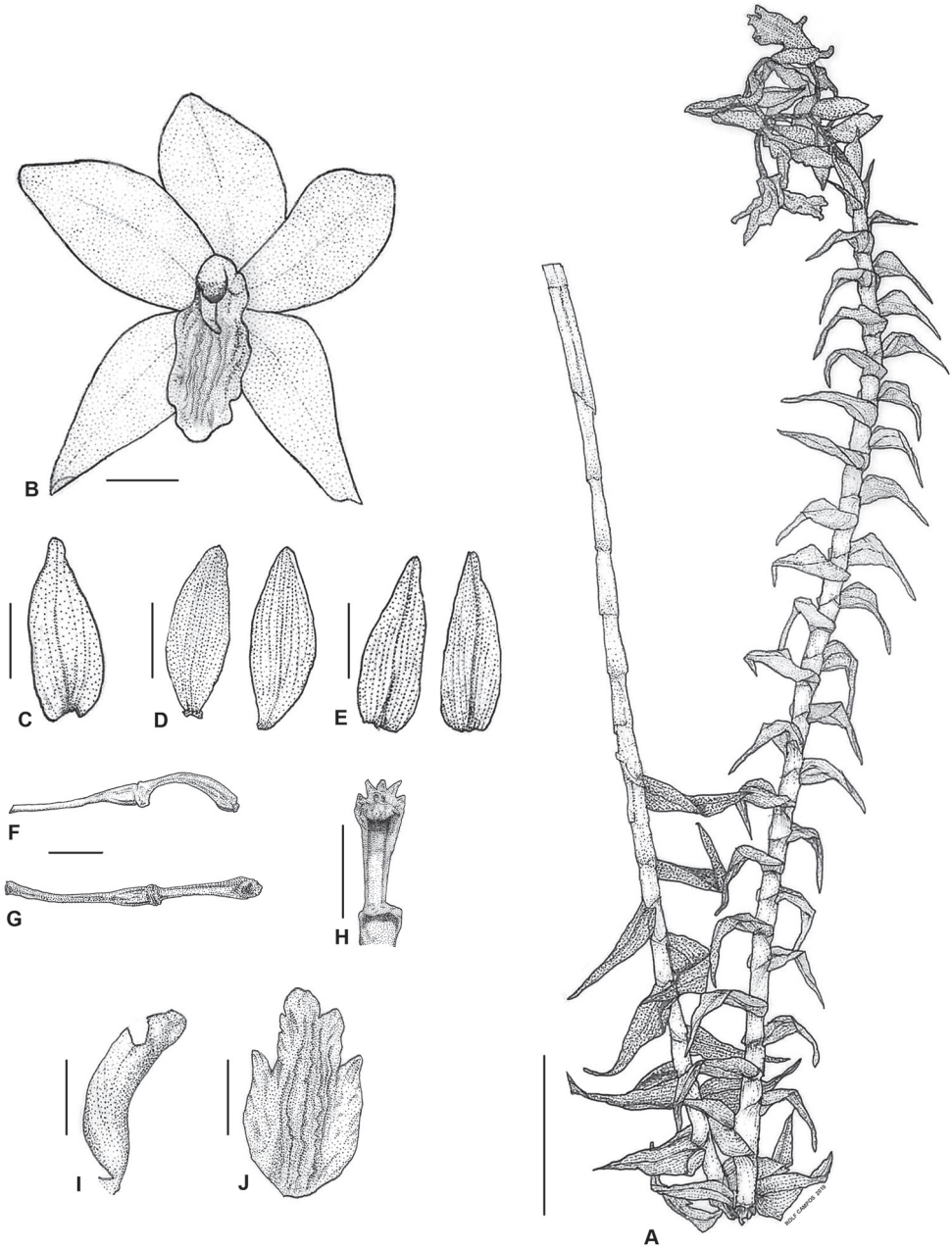

Figure 1. Line drawings of *Dilochia deleoniae* Tandang & Galindon sp. nov. **A** habit **B** flower **C** dorsal sepal **D** pair of petals **E** pair of lateral sepals **F** side view of the pedicel including the ovary and the column **G** front view of the pedicel including the ovary and the column **H** column **I** side view of the labellum **J** front view of the labellum with flattened side lobes. Scale bars: 5 cm (**A**); 1 cm (**B–J**). Illustrated by Rolf Campos.

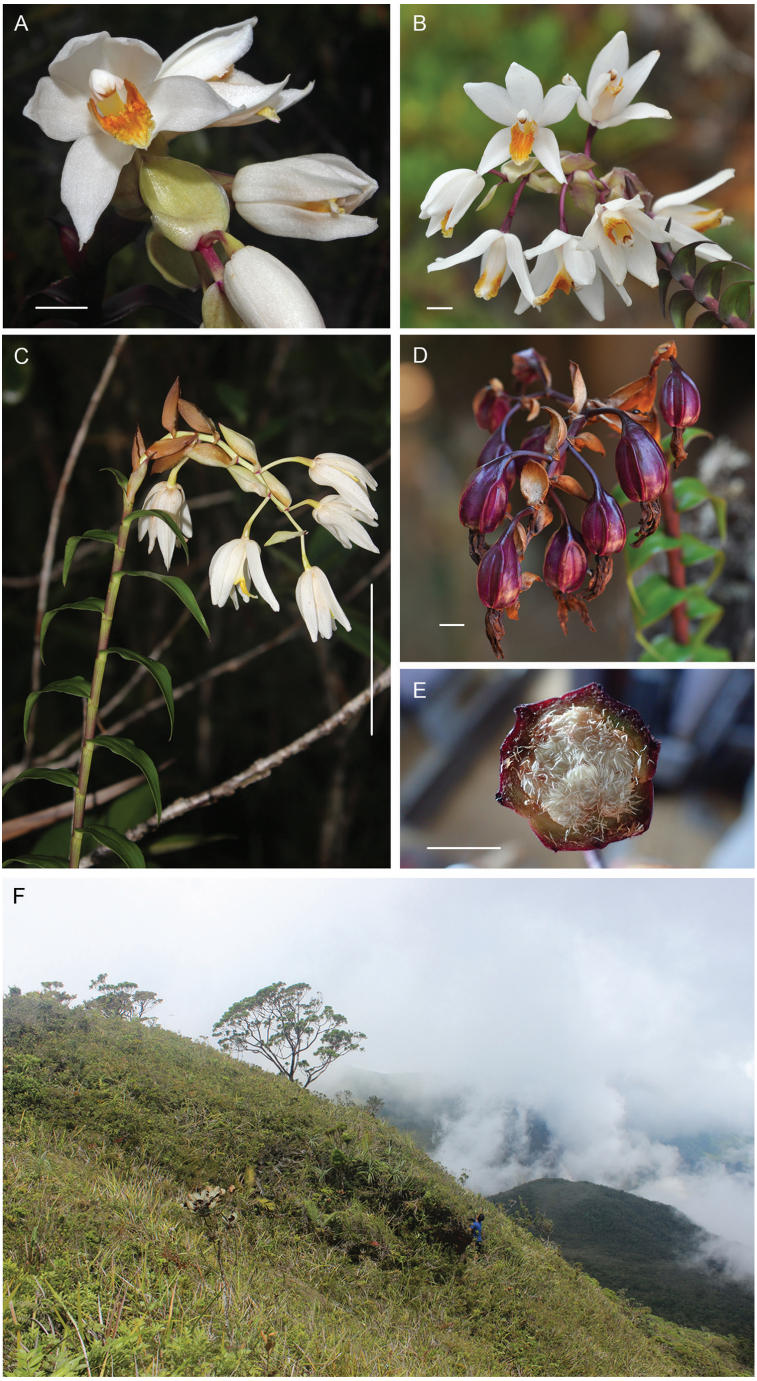

Figure 2. *Dilochia deleoniae* Tandang & Galindon sp. nov. **A** flower details showing the colorations of the sepals, petals, labellum and bracts **B** racemose inflorescence **C** semi-pendulous inflorescence and the alternate arrangement of the leaves **D** dark-purpled fruits **E** cross section of the fruit showing numerous whitish seeds **F** habitat on the summit of Mount Hamiguitan, forest over ultramafic soils. Scale bars: 1 cm (**A, B, D, E**); 5 cm (**C**). **A, C, F** photos by John Michael M. Galindon **B, D, E** photos by Danilo N. Tandang.

inflorescence bearing ≥ 13 flowers in *D. beamanii*); dorsal sepal 11-veined, lateral sepal 10-veined, and petal 8-veined (vs. dorsal sepal 5-veined, lateral sepal 5-veined, and petal 7-veined in *D. beamanii*). In addition, the labellum of *D. beamanii* is yellow-ochre with white margins and apex, and with purple spots, whereas the new species has a labellum with a white base and a pale yellow to dull orange or brownish-yellow lip from the disc to the margins and is consistently devoid of purple spots.

Type. Philippines • Mindanao Island. Davao Oriental: San Isidro Municipality, Mount Hamiguitan Range Wildlife Sanctuary, 6°43'47.40"N, 126°10'53.90"E, forest on ultramafic soil, 07 July 2016, E.R. Tadiosa 2059 with D.N. Tandang (***holotype***: PNH; ***isotypes***: CMUH, BRIT, CAHUP).

Description. Terrestrial clump-forming herb, stem 70.0–182.0 cm × 4.0–6.3 mm (with sheaths), terete, erect, leafy throughout becoming leafless near base. ***Leaf sheaths***: purple becoming light green near leaf base, tubular, longer at lower half of stem, 21.4–38.6 mm long, gradually decreasing to last leaf distally. ***Leaves***: light green abaxially, dark green to purplish adaxially, alternate, spreading, curved downward at distal half, glossy, glabrous, lanceolate, usually larger below stem, 57.1–69.6 × 18.7–23.0 mm, smaller ones distally 22.1–23.5 × 9.0–9.7 mm, prominently 7 or 8 parallel veins adaxially; apex attenuate, margin entire, purple to light green. ***Inflorescence***: terminal, racemose, semi-pendulous, to 65.0 mm long, 7- to 9-flowered; *peduncle* light yellow, glabrous, bearing 3 internodes, 23.3–28.4 mm long, enclosed by 3 sterile acuminate peduncular scales; *peduncular scales* cymbiform, parallel veins numerous, vinaceous abaxially, ivory to cream adaxially, apex acute, 16.4–20.4 × 9.8–14.4 mm wide. ***Floral bracts***: clasping pedicels, glabrous, variable in color from yellow green to cream with vinaceous coloration outside at margin and apex, cymbiform, 14.8–21.3 × 6.5–12.4 mm, apex acuminate. ***Pedicel including ovary***: 20.4–23.1 mm long, terete, glabrous, clavate, pale green with occasional purple markings. ***Ovary:*** dark purple to green, 6-ribbed. ***Flowers***: with creamy white sepals and petals, fleshy, labellum whitish at the base, becoming pale yellow to dull orange or brownish-yellow except white at apex, underside white with yellow margin at epichilium. ***Dorsal sepal***: cymbiform, lanceolate, 26.9–27.7 × 8.8–9.9 mm, apex obtuse-acute, nerves 11. ***Lateral sepals***: obliquely lanceolate, 26.9–28.8 × 7.2–9.3 mm, apex conduplicate, attenuate, nerves 10. ***Petals***: oblong-oblanceolate, 25.8–26.7 × 8.3–9.5 mm, apex subobtuse, nerves 8. ***Labellum***: oblong-elliptic, 3-lobed, 21.1–21.6 mm long; carinae 5, longitudinal on lip disc, undulating, inner 3 originating from base of labellum to tip, 2 outer shorter than 3 middle, originating from middle part of labellum to middle portion of epichilium; *hypochilium* elliptic, 12.0–12.9 × 9.5–10.0 mm, with erect side lobes, margin entire, apex praemorse, 3-keeled over length of hypochilium, side lobes with numerous parallel veins pointing toward margin; *epichilium* oblong-elliptic, 8.1–8.2 × 4.1–4.9 mm, apex rounded, margin crisped; keels 5, inner 3 continuing from hypochilium, longer than outer 2. ***Column***: slender, 16.2–16.7 × 4.3–5.0 mm, white, light yellow at base, narrow-winged, widened at the apex. ***Fruits***: ovate, 21.9–27.3 mm long, dark purple to green, tinge of purple at ridge, ovate, 6-grooved, perianth persistent. ***Seed***: winged, 1.6–2.0 × 0.1–0.2 mm, white, numerous.

Distribution. Endemic to the Philippines. Mindanao Island, Davao Oriental, San Isidro Municipality, Mount Hamiguitan Range Wildlife Sanctuary.

Habitat and ecology. This terrestrial orchid species prefers open to partly shaded habitat, where it is found in clumps or scattered. The populations rarely occur in forest over ultramafic rocks between elevations ca. 1100–1200 meters above sea level (m a.s.l.) but is common in the pygmy forest ecosystem at the mountain summit between 1560 and 1650 m a.s.l. This new species was recorded inside a sampling quadrat, growing with other native orchid species such as *Appendicula tembuyukenensis* J.J.Wood and *Dendrochilum kopfii* Lückel., and with other species such as *Agathis* sp., *Dacrydium beccarii* Parl., *Dacrydium elatum* (Roxb.) Wall. ex Hook., *Falcatifolium gruezoi* de Laub., *Gleichenia vulcanica* Blume, *Leptospermum javanicum* Blume, *Machaerina disticha* (C.B.Clarke) T.Koyama, *M. glomerata* (Gaudich.) T.Koyama, *Medinilla myrtiformis* (Naudin) Triana, *M. theresae* Fernando, *Myrsine amorosoana* Pipoly, *Scaevola micrantha* C.Presl, *Symplocos polyandra* (Blanco) Brand, *Tasmannia piperita* (Hook.f.) Miers, and *Vaccinium* spp.

Additional specimens examined. Philippines • Mindanao Island, Davao Oriental Province, Municipality of San Isidro, Mount Hamiguitan Range Wildlife Sanctuary; 6°43'49.26"N, 126°10'48.22"E; 1204 m elevation; 18 June 2019; Plants and Lichens of the Southern Philippines Survey 758 (BRIT, CMUH, PNH) • Mindanao Island, Davao Oriental Province, Municipality of San Isidro, Mount Hamiguitan Range Wildlife Sanctuary; 6°43'49.15"N, 126°10'45.41"E, 1184 m elevation, 18 June 2019, Plants and Lichens of the Southern Philippines Survey 1316 (BRIT, CMUH, PNH).

Etymology. The new species is named after Ms Josefina De Leon, the former Chief of the Wildlife Resources Division under the Biodiversity Management Bureau of the Department of Environment and Natural Resources, who has pursued wildlife conservation for more than 35 years and who remains a biodiversity conservation advocate. During her time in the Bureau, the FORIS project was launched and researchers from the National Museum of the Philippines were invited to be part of the technical working group that led to the discovery of the new species.

Conservation status. *Dilochia deleoniae* is only known from the 68.34 km^2 Mount Hamiguitan Range Wildlife Sanctuary and is confined to its high elevations particularly in mossy-pygmy forests. The extent of occurrence is < 100 km^2 and area of occupancy is 8 km^2, as based on *GeoCAT* (Bachman et al. 2011; http://geocat.kew.org/) with the default 2 km^2 grid. The mountain range was declared a protected area under Republic Act No. 9303, and was recently designated as a UNESCO World Heritage Site, helping to protect this species from habitat degradation, poaching, and over-collection. However due to 'restricted area of occupancy' and the possible effect of continuous poaching and climate change, this species is 'capable of becoming critically endangered or extinct within a very short time'. Therefore, following the IUCN Categories and Criteria (IUCN 2012), we classify this species as Vulnerable [VU D2].

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RESEARCH ARTICLE

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Typification of 23 names in *Eriobotrya* (Maleae, Rosaceae)

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Abstract

As part of a comprehensive systematic study on the genus *Eriobotrya* and its close relatives from the E & SE Asia, new typifications of 23 names are presented here, along with some nomenclatural notes of the names involved. We lectotypified 22 names including accepted names and synonyms. They are: *E. acuminatissima*, *E. bengalensis* var. *angustifolia*; *E. bengalensis* f. *intermedia*, *E. brackloi*, *E. brackloi* var. *atrichophylla*, *E. elliptica* var. *petelotii*, *E. fragrans* var. *furfuracea*, *E. glabrescens*, *E. grandiflora*, *E. henryi*, *E. oblongifolia*, *E. petiolata*, *E. platyphylla*, *E. poilanei*, *E. prinoides*, *E. prinoides* var. *laotica*, *E. salwinensis*, *E. serrata*, *E. stipularis*, *Hiptage cavaleriei*, *Photinia longifolia*, *Symplocos seguinii*. One neotype of *Photinia dubia* was also proposed in this study, and *E. pseudoraphiolepis* and *Mespilus cuila* were identified as superfluous names. In addition, we also summarized the typification of 18 names for taxonomic reference: *E. angustissima*, *E. balgooyi*, *E. condaoensis*, *E.* × *daduheensis*, *E. elliptica*, *E. fulvicoma*, *E. fragrans*, *E. glabrescens* var. *victoriensis*, *E. hookeriana*, *E. latifolia*, *E. obovata*, *E. malipoensis*, *E. merguiensis*, *E. tengyuehensis*, *E. wardii*, *Mespilus bengalensis*, *Photinia deflexa*, and *M. japonica*.

Keywords

integrative systematics, lectotype, loquat, neotype, nomenclature, *Pyrus*, *Rhaphiolepis*, taxonomy

* These authors have contributed equally to this work

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Introduction

The application of names of taxa at the rank of family and below is determined by means of nomenclatural types (Shenzhen Code, Turland et al. 2018: Art. 7.1), and it is advisable to lectotypify those names with no type or sometimes even no original materials at all (Turland 2019). The type, usually a specimen or illustration, is the only entity permanently linked with the name. As one of the six principles in the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code, Turland et al. 2018), typification will pave the way for taxonomic stabilization of the names. The role of nomenclature in taxonomy was rightly expressed by Davis and Heywood (1963): "biologists must know what organisms they are working with before they can pass on information about them to other people – a function of taxonomy which makes stability of nomenclature an important consideration".

Several groups of the tribe Maleae (Rosaceae) are well-known because of the numerous north temperate fruits and ornamentals, such as apples (*Malus* Mill. spp.), pears (*Pyrus* L. spp.), serviceberries (*Amelanchier* Medik. spp.), chokeberries (*Aronia* Medik. spp.), loquats (*Eriobotrya japonica* (Thunb.) Lindl.), and photinias (*Photinia* Lindl. spp.). Due to the polyphyly of *Sorbus* L. and frequent hybridization within and between genera in Maleae, Christenhusz et al. (2018) argued for merging all members of Maleae into *Pyrus* L., returning to the Linnaean concept, and 849 new names and new combinations in Maleae were proposed. This extreme taxonomic strategy will hardly be appropriate for this ecologically and economically important lineage. Although we listed all new combinations proposed by Christenhusz et al. (2018) in this study, we prefer to recognize the genera in a traditional sense for better communication between plant scientists and the genera publics (Crane et al. 2017; Liu et al. 2019). Due to the rapid radiation and frequent hybridization (Robertson et al. 1991; Campbell et al. 2007), limited markers from plastome and/or nuclear based on Sanger sequencing could not provide enough resolutions for resolving the phylogenetic relationships among the genera in Maleae. With the development of next-generation sequencing, large datasets could be obtained at an affordable cost. Resolving the phylogenetic and evolutionary questions in Maleae is getting much easier and the *Pyrus* s.l. concept might be premature. For example, Liu et al. (2019) used the whole chloroplast genome and entire nuclear ribosomal DNA obtained via genome skimming approach to clarify the generic delimitation between *Photinia* Lindl. and its morphological allies in Rosaceae (Liu et al. 2019); additionally, this method has also been successfully employed to resolve the systematic problems in other angiosperm lineages (Wen et al. 2018; Valcárcel and Wen 2019). Therefore, phylogenomics based on next/third-generation sequencing will provide an opportunity for clarifying the taxonomic and evolutionary problems in Maleae, especially *Eriobotrya* Lindl.

Loquats have been cultivated widely in the world as fruits and/or ornamentals. *Eriobotrya* consists of ca. 15–20 species, and is widely distributed from the Himalayas throughout continental southeast Asia to Japan and the islands of western Malesia (Kalkman 2004). The generic delimitation among the members of Maleae has been

notoriously controversial for a long time, and efforts to resolve the intergeneric relationships have not been successful (Phipps et al. 1991; Campbell et al. 2007; Li et al. 2012; Lo and Donoghue 2012; Verbylaitė et al. 2006; Sun et al. 2018). As part of our integrative systematic studies of *Eriobotrya* and close relatives (Wen et al. 2017; Liu et al. 2020), it will be necessary to typify the taxa described under *Eriobotrya*.

Materials and methods

We summarized the names listed in Tropicos, IPNI (International Plant Names Index), and the Plant List as the first step, and relevant literature has been consulted for the names treated in the present study. For the typification of each name summarized, all the relevant monographs and floras (e.g., Vidal 1965, 1968, 1970; Gu and Spongberg 2003) have been checked as well as the additional original literature publishing the names and combinations (listed below). The rules governing holotype recognization and lectotypification followed McNeill (2014), and Turland (2019), and Turland et al. (2018). Thanks to the world's largest database of digitized plant specimens (JSTOR: Global Plant), we checked 158 images of specimens in the herbaria all around the world, including A, B, BK, BM, C, E, HBG, K, L, M, MO, MSC, NY, P, TCD, UPS, VNMN, and WU. The authors consulted the potential type material in the following herbaria: CDBI, HITBC, IBK, IBSC, KUN, PE, SN, SYS, SZ, US, and WUK (Index Herbariorum 2019).

Typifications

Eriobotrya Lindl., Trans. Linn. Soc. London 13: 96, 102 (1821). Lectotype, designated by L.K.G. Pfeiffer, Nom. 1: 1238 (1873): *Eriobotrya japonica* (Thunb.) Lindl. ≡ *Mespilus japonica* Thunb.

1. ***Eriobotrya acuminatissima*** Nakai, J. Arnold Arbor. 5: 71. 1924. ≡ *Photinia luzonensis* Merr. var. *acuminatissima* Merr. nom. nudum. Type: PHILIPPINES. Luzon: Panay Province, mt. Salibongbong Capiz, June 1919, *A. Martelino & G. Edano 35622* (**lectotype, designated here**: A[barcode 00026487]!; isolectotypes: BM[barcode BM000602127]!, L[barcode L0019714]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.a00026487]

Nakai (1924) clearly cited one gathering (*A. Martelino & G. Edano 35622*) as the type in the protologue, however, he did not indicate the herbarium where the type has been deposited. We located three duplicates in A, BM, and L, all of them from the locality given in the protologue. According to Stafleu and Cowan (1981), most of Nakai's specimens have been deposited at TI; a part of type material kept at A and P. However, we have not found any duplicate in TI. From 1923 to 1925, Nakai visited the principal botanical institutions in Europe and North America, includ-

ing herbarium A (Hara, 1953), and *Eriobotrya acuminatissima* was published in 1924. We concluded that *E. acuminatissima* was described based on the specimens in herbarium A when he visited the herbarium A at Harvard University. We therefore designated the specimen at A as the lectotype, since it was annotated by Nakai: "Type; *Eriobotrya acuminatissima* Nakai".

2. ***Eriobotrya angustissima*** Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 372. 1878. ≡ *Pyrus angustissima* (Hook.f.) M.F.Fay & Christenh., Global Fl. 4:95. 2018. Type: INDIA. Khasia. alt. 5000 ft., without date, *J.D. Hooker & T. Thomson s.n.* (lectotype, designated by Vidal 1965: 574): K[barcode K000758406]! "type"; isolectotype: BM[barcode BM000602192]!. Khasia. between [zugrung Thumblus], 26 July 1850, *s.coll. s.n.* (syntype K[barcode K000758404]!). Mooshye, Shrub 4 feet, 23 September 1850, *s.coll. s.n.* (syntype: K[barcode K000758405]!). [image of lectotype available at http://specimens.kew.org/herbarium/K000758406]

Vidal (1965) lectotypified this name without any explanation. We provide a nomenclature note for the lectotypification herein. In the protologue, Hooker (1878) provided the following locality when he described *Eriobotrya angustissima* in the Flora of British India: "Khashi Mts. alt. 5000 ft. *Simons*; Mooshye, and between Myrung and Nunklow, *Hook.f. & T.*". These two gatherings are syntypes. Four potential syntypes have been located, and one is in BM and the other three in K. These three syntypes at K were mounted on one sheet. The first (K000758406) includes the only blooming specimens collected by J.D.H. & T.T., i.e. J.D. Hooker & T. Thomson, labeled "Hab. Khasia; [...]; alt. 5000 feet; Coll. J.D.H. & T.T." without date. The collection in BM has the same label information. The second (K000758404) was collected from "Khasia. between [zugrung Thumblus]" without a collector, dated 26 July 1850. The third sheet (K000758405) collected from Mooshye was labeled as "Rosaceae?; Shrub 4 feet" also without a collector, dated 23 September 1850. The latter two specimens and the one in BM (BM000602192) are only vegetative branches and thus not optimal for lectotypification. Vidal (1965) designated the blooming specimen (K000758406) as the "type", however, this specimen is actually a lectotype.

3. ***Eriobotrya balgooyi*** K.M.Wong & Ent, Pl. Ecol. Evol. 147(1): 136. 2014. Type: MALAYSIA. Sabah, Ranau District, Bukit Babi [Pig Hill] on the south-east side of Mount Kinabalu, 6°03'N, 116°36'E, 2000–2300 m, 25 May 1984, *J.H. Beaman et al. 9871* (holotype: K[barcode K000618095]!; isotype: MSC). Borneo. Sabah, Kinabalu Park, Mount Tambuyukon, main summit ridge, 2487 m elevation, 14 Apr. 2011, *Van der Ent et al. SNP 24531* (paratypes: SING, SNP), ibid., 2499 m elevation, 4 May 2011, *Van der Ent et al. SNP 25940* (paratypes: SING, SNP); near top of 2nd summit, 2535 m elevation, 6 May 2011, *Van der Ent et al. SNP 26155* (paratypes: L, SING, SNP). [image of holotype available at http://specimens.kew.org/herbarium/K000618095]

4. ***Eriobotrya bengalensis*** (Roxb.) Hook.f. var. ***angustifolia*** Cardot, Notul. Syst. (Paris) 3: 371. 1918. ≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *angustifolia* (Cardot) J.E.Vidal, Adansonia, n.s. 5: 569. 1965. Type: CHINA. Yunnan: Hay-y près Lou-Lan, Pau Ngueou, 29 May 1907, *F. Ducloux 4719* (**lectotype, designated here**: P[barcode P02143256]!; isolectotype: P[barcode P02143257]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143256]

Cardot (1918) described *Eriobotrya bengalensis* var. *angustifolia* in his article "Rosacées Nouvelles D'extreme-Orient". According to Stafleu and Mennega (1995), Cardot's specimens are kept at P. We have located two sheets in P which represent duplicates from a homogeneous collection. The red tag on the sheet barcoded with P02143256 was obviously not made by Cardot, this sheet was not holotype (Art. 9.1, Turland et al. 2018). A further lectotypification thus is necessary. Furthermore, we have not found it to be published anywhere for the lectotypification (cf. Nakai 1924; Vidal 1965, 1968, 1970; Kuan and Yu 1974; Gu and Spongberg 2003). We followed the informal typification designated by the staff in herbarium P, and herein formally designate the sheet (P02143256) as the lectotype.

5. ***Eriobotrya bengalensis*** (Roxb.) Hook.f. f. ***intermedia*** J.E.Vidal Adansonia, n.s. 5: 568. 1965. Type: MYANMAR. "In thicket on the western flank of the N'Maikha-Salween divide, east of Hpimaw. Lat. 26°N, alt. 10000 feet. East Upper Burmarh", April 1919, *G. Forrest 17845* (**lectotype, designated here**: E[E00072976]!, isolectotype: E[E00072977]!, K). VIETNAM. "Prov. de Huê: Bach Ma, 1500 m", *J.E. Vidal 35A* (paratype: P). VIETNAM. "Prov. de Huê: Bach Ma, 1500 m", *J.E. Vidal 35B* (paratype: P). VIETNAM. "Prov. de Huê: Bach Ma, 1500 m", *J.E. Vidal 35C* (paratype: P). [image of lectotype available at http://data.rbge.org.uk/herb/E00072976]

Vidal (1965) mentioned the locality in the protologue "CHINE. – Yun Nan: *Forrest 17845* (E, K). VIETNAM (Sud). – Région de Huê: *Vidal 35A, 35B, 35C* (P)" in his work "Notes sur quelques Rosacées asiatiques (III). Révision du genre *Eriobotrya* (Pomoideae)". We found two specimens of *Forrest 17845* at E with an alternative locality "F. No. 17845. *Eriobotrya*. aff. *E. japonica*. Shrub of 20–25 feet. Flowers creamy-white. In thicket on the western flank of the N'Maikha-Salween divide, east of Hpimaw. Lat. 26°N, alt. 10000 feet. April 1919. East Upper Burmarh". In addition, the printed "YUNNAN, WEST CHINA" was corrected as handwritten "East Upper Burmarh", which may have occurred after Vidal published the name of *Eriobotrya bengalensis* f. *intermedia*. These two duplicates (E00072976 and E00072977) have not been clearly cross-labeled as being part of the same specimen. It is necessary to select one of them as the lectotype. We designated the blooming specimen (E00072976) as the lectotype, as the other one only included a vegetative branch.

6. ***Eriobotrya brackloi*** Hand.-Mazz., Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 1922, lix. 102. ≡ *Eriobotrya cavaleriei* (H.Lév.) Rehder var. *brackloi* (Hand.-Mazz.) Rehder, J. Arnold Arbor. 13(3): 308. 1932. Type: CHINA. Kwangtung (Guang-

dong): In silva and austro-occid. jugi Tsatmukngao prope oppidum lienping ad bor.-or. urbis Kanton sita ad rivos, 800 m, substr. crystallino, 15, 27 July 1920, *R.E. Mell 659* (**lectotype, designated here**: WU[barcode 0059394]!; isolectotype A[barcode 00026469]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.wu0059394]

Handel-Mazzetti (1922) provided the following locality in the protologue when he described *Eriobotrya brackloi*: "Prov. Kwangtung: In silva ad austro-occid. jugi Tsatmukngao prope oppidum Lienping ad bor.-or. urbis Kanton sita ad rivos, 800 m, substr. crystallino, leg. 15. 27. VII. 1920 Mell (Pl. M. S. Nr. 659)". According to Stafleu and Cowan (1979), the main set of specimens and types are kept at W and WU, although there is original material in other herbaria too. We located original material at WU and A, both of them matching the locality mentioned above. We designate the specimen at WU (barcode 0059394) where Handel-Mazzetti worked as the lectotype of the name *E. brackloi*, with the one in A (barcode 00026469) as isolectotype.

7. ***Eriobotrya brackloi*** Hand.-Mazz. var. ***atrichophylla*** Hand.-Mazz., Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 1922, lix. 103. Type: CHINA. Hunan: austro-occ.: In monte Yün-scha prope urbem Wukang, in silva elata frondosa umbrosa. alt. 950 m, 6 June 1918, *H.F. von Handel-Mazzetti 12032* (**lectotype, designated here**: WU[barcode 0059395]!, isolectotype: A[barcode 00026471]!). ibidem, alt. 1300 m, 9 June 1918, *H.F. von Handel-Mazzetti 12060* (syntypes: A[barcode 00026470]!, WU[barcode 0059396]!, WU[barcode 0059397]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.wu0059395]

Handel-Mazzetti (1922) described *Eriobotrya brackloi* var. *atrichophylla* in his article "Sitzung der mathematisch-naturwissenschaftlichen Klasse" and cited two gatherings (syntypes) in the protologue, "950 (Nr. 12.032) et 1300 (Nr. 12.060)", from which the lectotype can be selected. Both of the gatherings match perfectly the locality in the protologue; we choose one duplicate from *H.F. von Handel-Mazzetti 12032*. We located two sheets of *H.F. von Handel-Mazzetti 12032* in WU and A. According to Stafleu and Cowan (1979), the main set of original material are kept in WU and W, so we designated WU(barcode 0059395) as the lectotype, with A(barcode 00026471) as the isolectotype.

8. ***Eriobotrya condaoensis*** X.F.Gao, Idrees & T.V.Do, Phytotaxa 365(3): 290. 2018. Type: VIETNAM. Ba Ria-Vung Tau Province: Con Dao National Park, growing on the slope of hill under tropical evergreen forest, 20m, 8°41'30"N, 106°38'00"E, 21 March 2017, *T.V.Do VNMN_CN 633* (holotype: VNMN!; isotype CDBI!).

9. ***Eriobotrya × daduheensis*** H.Z.Zhang ex W.B.Liao, Q.Fan & M.Y.Ding, Phytotaxa 212(1): 97. 2015. Type: CHINA. Sichuan: Hanyuan County, Dashu Town, Xinmin Village, Mt. Shizishan, in the forest edge at the foot of the mountain, 970 m, 29°17'48.18"N, 102°39'44.94"E, 19 December 2007, *Q. Fan 9292* (holotype: SYS[barcode 190936]!; isotypes [SYS!, IBSC!]).

10. ***Eriobotrya elliptica*** Lindl., Trans. Linn. Soc. London 13(1): 102 (1821). ≡ *Eriobotrya elliptica* (Lindl.) Hook.f. & Thomson, Fl. Brit. India [J. D. Hooker] 2(5): 372. 1878. ≡ *Cotoneaster ellipticus* (Lindl.) Hort ex Loudon, Encyc. Pl. 1208. ≡ *Pyrus elliptica* (Lindl.) M.F.Fay & Christenh. Global Fl. 4:102. 2018. Type: NEPAL. Narainhetty. 1 February 1803, *F. Buchanan-Hamilton s.n.* (holotype: BM[barcode BM000521994]!). [note 1] [image of holotype available at https://data.nhm.ac.uk/object/d27f7005-730e-4ed6-bc6c-e140e89bfd5d/1566345600000]

= *Mespilus cuila* Buch.-Ham. ex D.Don, Prodr. Fl. Nepal. 238. 1825. nom. superfl. [note 2]

Note 1: Lindley (1821) described *Eriobotrya elliptica* in his work "Observation on the natural group of plants called Pomaceae" and provided the following locality in the protologue: "Hab. ad Narainhetty, *Buchanan* (*v. s. sp. Herb. Lambert*)". The specimen(s) used by the original author was indicated as part of Herb. Lambert, however, some specimens of that collection had been purchased by National History Museum (BM) (Miller 1970). We located one specimen in BM labeled as "Nepaul. Dr. Buchanan; Narainhetty. 1st Feb. 1803" which was perfectly in accordance with the protologue. So this specimen could be the original material used by Lindley when he published the name of *E. elliptica* and must be the holotype which was indicated by Vidal (1965).

Note 2: Don (1825) described *Mespilus cuila* with the following locality: "Hab. ad Nrainhetty Nepalensium. *Hamilton*". This specimen was designated as the type of *Eriobotrya elliptica* Lindl. (1821). *M. cuila* thus was a nomenclaturally superfluous name when it was published (Art. 52.1, Turland et al. 2018).

11. ***Eriobotrya elliptica*** Lindl. var. ***petelotii*** J.E.Vidal, Adansonia sér. 2, 5: 552. 1965. Type: VIETNAM. "prov. de Lao Kay, Chapa, 1500 m", January 1929, *M. Pételot s.n.* (**lectotype, designated here**: P[barcode P02143261]!; isolectotype: P[barcode P02143262]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143261]

In the protologue of *Eriobotrya elliptica* var. *petelotii*, Vidal (1965) mentioned: "Vietnam (Nord), prov. Lao Kay, Chapa, 1500 m, en fleurs, janv. 1929, *Pételot s.n.* (P)". We located two syntypes kept at P, from which the lectotype could be chosen. These two specimens both have complete information in accordance with the protologue. We designated the sheet P[barcode P02143261] as the lectotype, as it has been labeled with a red printed tag "TYPE".

12. ***Eriobotrya fulvicoma*** Chun ex W.B.Liao, F.F.Li & D.F.Cui, Ann. Bot. Fenn. 49(4): 264. 2012. Type: CHINA. Guangdong: Xinyi County, Dawuling Natural Reserve, 45 m, 28 April 1932, *Z. Huang 32257* (holotype: WUK[barcode 0109531]!; isotypes: IBK[barcode 00060958]!, IBK[barcode 00060976]!, IBSC[barcode 0298975]!, KUN[barcode 0116268]!, PE[barcode 00799336]!, SZ[barcode 00194329]!). *s. loc.*, 23 April 1932, *Z. Huang 32174* (paratypes: IBSC[barcode 0298973]!, IBK[barcode 00060963]!, IBK[barcode 00060975]!, KUN[barcode

0116267]!, PE[barcode 00799340]!, WUK[barcode 0110493]!, SN[barcode 007751]!, SZ[barcode 00194441]!). *s. loc.*, *Z. Huang 29869* (paratype: IBSC).

13. ***Eriobotrya fragrans*** Champ., Hooker's J. Bot. Kew Gard. Misc. 4: 80. 1852. ≡ *Pyrus williamtelliana* M.F.Fay & Christenh. Global Fl. 4:126. 2018. Type: CHINA. Hong Kong: Mt. Victoria, *J.G. Champion s.n.* (lectotype, designated by Vidal: 557. 1965: K[barcode K000758384]! "type"). [image of lectotype available at http://specimens.kew.org/herbarium/K000758384]

The name *Eriobotrya fragrans* was published in Bentham's paper in 1852, however, it was ascribed to "Champ.", although the description was described by Bentham. The name is therefore cited as *E. fragrans* Champ. instead of *E. fragrans* Champ. ex Benth. as indicated in Tropicos and IPNI.

14. ***Eriobotrya fragrans*** Champ. var. ***furfuracea*** J.E.Vidal, Adansonia sér. 2, 5: 557. 1965. Type: VIETNAM (Sud-Annam). Nha Trang: Massif du Hon Ba, 1000–1500 m, en fleurs, 5 September 1918, *A. Chevalier 38893* (**lectotype, designated here**: P[barcode P02143263]!; isolectotypes: A[barcode 00026481]!, C[barcode C10017884]!, K[barcode K000758407]!, L[barcode L0019413]!, P[barcode P02143264]!, P[barcode P02143265]!, P[barcode P02143266]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143263]

According to Stafleu and Cowan (1976), Chevalier's specimens were deposited in P and PC, although there is original material in other herbaria too. We located eight original specimens in A, C, K, L, and P, and all of them are in accordance with the locality in the protologue "Vietnam (Sud), prov. Nha Trang, massif du Hon Ba, 1000–1500 m". The author (Vidal) designated the specimens in P as type, however, three sheets were located in herbarium P. We designate the specimen (P[barcode P02143263]) with red printed tag "TYPE" as the lectotype.

15. ***Eriobotrya glabrescens*** J.E.Vidal, Adansonia sér. 2, 5: 554. 1965. ≡ *Pyrus serpentae* M.F.Fay & Christenh. Global Fl. 4:121. 2018. Type: MYANMAR. Kachin State: "N. Birmanie, Triangle, Hkinlum village, 2500 m, en fleurs", 4 April 1953, *F. Kingdon-Ward 20616* (**lectotype, designated here**: BM[barcode BM000602189]; isolectotypes: A[barcode 00026482]!, E[00011336]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.bm000602189]

Vidal (1965) designated the gathering *F. Kingdon-Ward 20616* (BM, E) as type. We located three original specimens in A, BM, and E, all of them matched perfectly with the locality in the protologue. We designate the specimens kept at BM with a red printed tag "TYPE" as the lectotype.

16. ***Eriobotrya glabrescens*** J.E.Vidal var. ***victoriensis*** J.E.Vidal, Adansonia sér. 2, 5: 555. 1965. Type: MYANMAR. KachinState: "Birmanie centrale, Mt Victoria, 3000 m, en fleurs", 2 April 1956, *F. Kingdon-Ward 21915* (holotype: BM[BM000602190]!).

Mt Victoria, *F. Kingdon-Ward 22828* (paratype: BM). [image of holotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.bm000602190]

Vidal (1965) designated *Kingdon-Ward 21915* (BM) as type, and only one specimen with a handwritten tag was found in BM. So, the specimen barcoded with BM000602190 is the holotype.

17. ***Eriobotrya grandiflora*** Rehder & E.H.Wilson, Pl. Wilson. (Sargent) 1(2): 193. 1912. ≡ *Eriobotrya deflexa* (Hemsl.) Nakai var. *grandiflora* (Rehder & E.H.Wilson) Nakai J. Arnold Arbor. 5(2): 72. 1924. Type: CHINA. Western Szech'uan (Sichuan): alt. 1600m, May 1904, *Veitch Exped. 3506* (**lectotype, designated here**: A[barcode 00026472]!; isolectotypes: A[barcode 00026473]!, BM[barcode BM000602187]!, HBG[barcode HBG511040]!, K[barcode K000758386]!, P[barcode P02143267]!). Mupin, alt. 1300 m, October 1908, *s.coll. 2999* (paratype). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.a00026472]

Rehder and Wilson (1912) mentioned the following locality when describing *Eriobotrya grandiflora*: "Western Szech'uan: without precise locality, alt. 1600 m, May 1904 (Veitch Exped. No. 3506, type)". The specimens of "Plantae Wilsonianae" were mainly deposited in A (Rehder and Wilson 1912). We have not found potential original material numbered as *Veitch Exped. 3506* among the available collections at A. Nonetheless, we located two specimens of *E.H. Wilson 3506* with the following description: "Coll. E.H. Wilson, (For James Veitch & Sons). Western China. Type. No. 3506. ...". The locality, date, and morphology are perfectly in accordance with the description in the protologue. We located six sheets of *E.H. Wilson 3506* in A, BM, HBG, K, and P, from which the lectotype could be chosen. We chose the sheet kept at herbarium A as the lectotype, where Rehder & Wilson worked. Although both duplicates are from a single gathering (A00026472 and A00026473) and annotated with "Type", they have not been cross-labeled as being part of the same specimen and do not bear a single, original label in common (Art. 9.3, Turland et al. 2018). It is necessary to select one of them as the lectotype. The sheet (A [barcode 00026472]) was designated as the lectotype, since it is in a better condition.

18. ***Eriobotrya henryi*** Nakai, J. Arnold Arbor. 5: 70. 1924. ≡ *Pyrus henryi* (Nakai) M.F.Fay & Christenh. Global Fl. 4:106. 2018. Type: CHINA. Yunnan: Szemao (Simao), 1900, *A. Henry 13018* (**lectotype (**selected by Vidal 1965: 562, first step "type"; **second step, designated here**): A[barcode 00026474]!; isolectotypes: K[barcode K000758388]!, NY[barcode 00436209]!). ibidem, *A. Henry 11644A* (syntypes: A[barcode 00026475]!, MO[barcode MO-176737]!). ibidem, A. *Henry 11644* (syntype: A[barcode 00063057]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.a00026474]

Nakai (1924) described *Eriobotrya henryi* on the basis of three gatherings "*A. Henry*, nos. 13018, 11644, 11644A" which were syntypes. Vidal (1965) wrote "*Henry 13018* (type)", thereby designating the gathering *Henry 13018* as the lectotype [first-step]. We

located two specimens of this gathering in A and K, from which the lectotype could be chosen. The specimen deposited in A is designated as the lectotype [second-step] as it has an autograph of Nakai "*Eriobotrya henryi* Nakai" and Vidal's handwriting selecting the lectotype [first-step] "lectotype; *Eriobotrya henryi* Nakai; J. Vidal 6/1964".

19. ***Eriobotrya hookeriana*** Decne., in Nouv. Arch. Mus. Par. Ser. I, x. 146. 1874. ≡ *Pyrus hookeriana* (Decne.) M.F.Fay & Christenh. Global Fl. 4: 107. 2018. Type: INDIA. Sikkim: 10 August 1862, *T. Anderson 490* (lectotype, designated by Vidal: 563: 1965: P[barcode P02143268]! "type"; isolectotype: A[barcode 00026483]!). Sikkim, *J.D. Hooker & T. Thomson 579* (syntypes: K[barcode K000758396]!, K[barcode K000758397]!, P[barcode P02143269]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143268]

20. ***Eriobotrya latifolia*** Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. ≡ *Pyrus herae* M.F.Fay & Christenh. Global Fl. 4:106. 2018. Type: MYANMAR. Moalmayne; on Thoung Gyne, alt. 5000 ft., *T. Lobb s.n.* (holotype: K[barcode K000758400]!). [image of holotype available at http://specimens.kew.org/herbarium/K000758400]

21. ***Eriobotrya malipoensis*** K.C.Kuan, Acta Phytotax. Sin. viii. 231. 1963. ≡ *Pyrus malipoensis* (K.C.Kuan) M.F.Fay & Christenh., Global Fl. 4:111. 2018. Type: CHINA. Yunnan: Malipo County, Hwang-jin-yinn, 1200 m, 21 January 1940, *C.W. Wang et al. 86318* (holotype: PE[barcode 00004573]!; isotypes: IBSC[barcode 0299391]!, KUN[barcode 0116367]!). ibidem, 13 January 1940, *C.W. Wang 83170* (paratypes: HITBC[barcode 016193]!, IBK[barcode 00366990]!, IBSC[barcode 0299392]!, KUN[barcode 0116366]!, PE[barcode 00799655]!). ibidem, 9 November 1947, *K.M. Feng 13123* (paratypes: KUN[barcode 0116370]!, PE[barcode 00004572]!).

22. ***Eriobotrya merguiensis*** J.E.Vidal, Adansonia sér. 2, 5: 563. 1965. ≡ *Pyrus merguiensis* (J.E.Vidal) M.F.Fay & Christenh. Global Fl. 4:112. 2018. Type: MYANMAR. "Birmanie, Mergui, Mout Myinmolekat, 1200 m, en fruits", 17 January 1930, *R.N. Parker 3098* (holotype: K[K000758399]!). [image of holotype available at http://specimens.kew.org/herbarium/K000758399]

23. ***Eriobotrya oblongifolia*** Merr. & Rolfe, Philipp. J. Sci., C 3: 102. 1908. Type: PHILIPPINES. Mindanao. Misamis: Mount Malindang, May 1906, *E.A. Mearns & W.J. Hutchinson 4680* (**lectotype, designated here**: NY[barcode 00436215]!; isolectotype: US[barcode 00097490]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.ny00436215]

Merrill (1908) mentioned one gathering (*E.A. Mearns & W.J. Hutchinson 4680*) as type. We located two original specimens kept in NY and US, from which the lectotype could be chosen. According to Stafleu and Cowan (1981), Merrill's type and material are deposited in A, FH, NY, PNH, and UC. We, therefore, designate the sheet deposited in NY as the lectotype.

24. ***Eriobotrya obovata*** W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 10: 29. 1917. ≡ *Pyrus obovata* (W.W.Sm.) M.F.Fay & Christenh. Global Fl. 4:114. 2018. Type: CHINA. Yunnan: in the vicinity of Yunnanfu, *E.E. Maire 2450* (holotype: E[barcode E00011331]!; isotypes: E[barcode E00284668]!, K[barcode K000758390]!). [image of holotype available at http://data.rbge.org.uk/herb/E00011331]

Smith (1917) provided the following locality in the protologue when describing *Eriobotrya obovata*: "China: – In the vicinity of Yunnanfu, Yunnan. Maire. No. 2450. In Herb. Edin." We located three original specimens in E and K, two of them kept in E. It should be noted that Smith (1917) indicated the specimens deposited in E as type, and the duplicate (E00011331) annotated "*Eriobotrya obovata* W.W.Sm. Type" with no indication of type on the other specimen. These two specimens have not been cross-labeled as being part of a same specimen. Neither have they born a single, original label in common (Art. 8.3, Turland et al. 2018). The duplicate (E00011331), therefore is the holotype and the other one in E (E00284668) the isotype.

25. ***Eriobotrya petiolata*** Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. ≡ *Pyrus petiolata* (Hook.f.) M.F.Fay & Christenh. Global Fl. 4:115. 2018. Type: Sikkim, 9000 ft, *J.D. Hooker s.n.* (**lectotype, designated here**: K[barcode K000758394]). East Himalaya, *W. Griffith 2085* (syntype: P[barcode P02143222]!). East Himalaya, *W. Griffith 2086* (syntypes: P[barcode P02143223]!, P[barcode P02143224]!). [image of lectotype available at http://specimens.kew.org/herbarium/K000758394]

Hooker (1878) described *Eriobotrya petiolata* with the following locality in the protologue in the Flora of British India: "Eastern Himalaya; Sikkim, alt. 5–9000 ft. Bhotan at Tongsa, *Griffith*."

According to Stafleu and Cowan (1979), the main set of Hooker's type and material has been deposited in K, although some of them are in MANCH and E too. We located one specimen in K with two labels, "Sikkim mts; Jayl? 9000 ft" and "[...] Hat. Sikkim; [...]; alt. 9000 feet; coll. J. D. H.". This locality fitted with the locality provided by Hooker: "Sikkim, alt. 5–9000 ft.", therefore, we designate this sheet K[barcode K000758394] as the lectotype of the name *E. petiolata*. We also located two gatherings from herbarium P collected by Griffith in the East Himalaya, *Griffith 2085* (P02143222) and *Griffith 2086* (P02143223, P02143224). These three specimens partially matched with the locality in the protologue: "Eastern Himalaya; [...] *Griffith*". So, these three specimens deposited in P are syntypes.

26. ***Eriobotrya platyphylla*** Merr., Brittonia iv. 80. 1941. ≡ *Pyrus platyphylla* (Merr.) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: MYANMAR. Upper Burma: hills east of Fort Hertz, 8 December 1931, *F. Kingdon-Ward 10205* (**lectotype, designated here**: A[barcode 00026485]!; isolectotypes: A[barcode 00026484]!, BM[barcode BM000602191]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.a00026485]

Merrill (1941) cited one gathering, *F. Kingdon-Ward 10205*, as the type when describing *Eriobotrya platyphylla*. We located three original specimens, two in A and one in

BM. Merrill's type and material have been deposited in A, FH, NY, PNH, and UC. It is necessary to select one of two sheets in A as the lectotype, therefore, we designate the sheet (A[barcode 00026485]) with a blooming branch as the lectotype.

27. ***Eriobotrya poilanei*** J.E.Vidal, Adansonia sér. 2, 5: 557 (1965). ≡ *Pyrus poilanei* (J.E.Vidal) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: VIETNAM. Haut Donnai: Annam, Canton de Laouan Délégation de Djiriing, alt. 1200 m, 5 June 1933, *E. Poilane 22591* (**lectotype, designated here**: P[barcode P02143226]!; isolectotypes: C[barcode C10017885]!, L[barcode L0019414]!, P[barcode P02143227]!, P[barcode P02143228]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143226]

Vidal (1965) cited the gathering (*E. Poilane 22591*) deposited in P as the type. We located five sheets of this gathering in C, L, and P, three of them kept in the herbarium P. We designate the sheet (P02143226) as the lectotype, since it has a printed red tag "TYPE".

28. ***Eriobotrya prinoides*** Rehder & E.H.Wilson, Pl. Wilson. (Sargent) 1(2): 194. 1912. ≡ *Pyrus prinoides* (Rehder & E.H.Wilson) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: CHINA. Yunnan: Mengtze (Mengzi), alt. 1500 m, *A. Henry 9878* (**lectotype, designated here**): A[barcode 00026476]!; isolectotypes: A[barcode 00026478]!, B[barcode B 10 0295749]!, E[barcode E00011334]!, K[barcode K00075839, excluding the fruiting branch]!, MO[barcode MO-176739]!, NY[barcode 00436210, excluding the fruiting branch]!, NY[barcode 00436211]!, NY[barcode 00436212]!, US[barcode 00097491, excluding the fruiting branch]!). *s. loc.*, *A. Henry 9878* (paratypes: A[barcode 00026477]!, E[barcode E00284667]!, K[barcode K00075839, excluding the flowering branch]!, MO[barcode MO-176738]!, NY[barcode 00436210, excluding the flowering branch]!, US[barcode 00097491, excluding the flowering branch]!). West Szech'uan: Tung Valley, on cliffs, alt. 800 m, May 1904, *Veitch Exped. 3507* (paratypes: A[00137409]!, A[00137410]!) [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.a00026476]

Rehder and Wilson (1912) cited two gatherings (*A. Henry 9878* & *Veitch Exped. 3507*), in which the former was mentioned as type. We found 14 sheets of *A. Henry 9878* among the available collections at A, B, E, K, MO, NY, and US, however, some of them are admixtures of flowering and fruiting branches collected by the same collector at different times. The new species described in "Plantae Wilsonianae" were considered to be on the basis of the specimens deposited in A. Three sheets of the type gathering were located in A, in which two of them are flowering branches and the remaining one is a fruiting branch. We designate one of the flowering specimens (A[barcode 00026476]) as the lectotype, since it is in better condition.

29. ***Eriobotrya prinoides*** Rehder & E.H.Wilson var. ***laotica*** J.E.Vidal, Adansonia sér. 2, 5: 573 (1965). Type: LAOS. Xièng Khouang: 1200 m, en fleurs, 3 November 1920, *M. Poilane 2243* (**lectotype, designated here**: P[barcode P02143229]!;

isolectotypes: P[barcode P02143230]!, P[barcode P02143231]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143229]

Vidal (1965) cited one gathering (*M. Poilane 2243*) as the type in the protologue, however, we located three original specimens among the available collections in P, from which the lectotype could be chosen. The sheet (P02143229) with a red printed tag "TYPE" is designated as the lectotype herein.

30. ***Eriobotrya salwinensis*** Hand.-Mazz., Symb. Sin. Pt. VII. 475. 1933. ≡ *Pyrus salwinensis* (Hand.-Mazz.) M.F.Fay & Christenh., Global Fl. 4: 120. 2018. Type: CHINA. Yunnan: Im str. Laubwalde des birm. Mons. am Ufer des Salwin um Tschamutong von Sijitong bis unter Tjiontson, Phyllit und kristallinischer Kalk, 1625–1700 m, 13 July & 17 August 1916, *H.F. von Handel-Mazzetti 9573* (**lectotype, designated here**: WU[barcode 0059392]!; isolectotype: A[barcode 00026480]!). Mekong – Salwin-Kette, in Gebüschen an Bächen der Seitentäler am 28°12', 2420 m, *G. Forrest 16400* (paratype: WU). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.wu0059392]

Handel-Mazzetti (1933) cited two gatherings in which *H.F. von Handel-Mazzetti 9573* was designated as the type in the protologue when describing *Eriobotrya salwinensis*. According to Stafleu and Cowan (1979), Handel-Mazzetti's type material was mainly deposited in W & WU. We designate the specimen (WU[barcode 0059392]) as the lectotype herein with the duplicate kept in A as the isolectotype.

31. ***Eriobotrya serrata*** J.E.Vidal, Adansonia sér. 2, 5: 558. 1965. ≡ *Pyrus serrata* (J.E.Vidal) M.F.Fay & Christenh., Global Fl. 4: 121. 2018. Type: LAOS. Xièng Khouang: Ban Na Poun, 1200 m, en fleurs, 19 November 1920, *E. Poilane 2345* (**lectotype, designated here**: P[barcode P02143235]!; A[barcode 00026486]!, L[barcode L0019415]!, P[barcode P02143237]!, P[barcode P02143236]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143235]

Vidal (1965) mentioned the following typification in the protologue: "*Poilane 2345* (P)". We located three syntypes in P, from which the lectotype could be chosen, and two other duplicates were also found in A and L. Vidal's type material is commonly considered to be kept in P. We designate the sheet (P02143235) with a red printed tag "TYPE" as the lectotype.

32. ***Eriobotrya stipularis*** Craib, Bull. Misc. Inform. Kew 1929(4): 109. 1929. ≡ *Pyrus stipularis* (Craib) M.F.Fay & Christenh., Global Fl. 4: 122. 2018. Type: THAILAND. Siam: Satul, Adang, 1500 m, on rocky ridge, 16 January 1928, *A.F.G. Kerr 14125* (**lectotype, designated here**: K[barcode K000758408]!; isolectotypes: ABD, BK[barcode 257292]!, BM, K[barcode K000758408]!, TCD[barcode TCD0016606]!). [image of lectotype available at http://specimens.kew.org/herbarium/K000758408]

Craib (1929) mentioned the following locality in the protologue: "Satul, Adang, 500 m, on the rocky ridge, *Kerr* 14125". Vidal (1970) listed three herbaria, ABD,

BM, and K, in which the type has been deposited, however, we located only four original specimens in BK, K, and TCD and did not find any duplicates in ABD and BM. According to Stafleu and Cowan (1976), Craib's type material has been deposited in K and WRSL. We designate the sheet (K000758408) as the lectotype, since it has a complete inflorescence.

33. ***Eriobotrya tengyuehensis*** W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 10: 30. 1917. ≡ *Pyrus tengyuehensis* (W.W.Sm.) M.F.Fay & Christenh., Global Fl. 4:123. 2018. Type: CHINA. Yunnan: Shweli-Salween divide, Lat. 25°5'N, alt. 7000 ft., tree of 40–60 ft., flowers creamy-yellow, open forests, May 1913, *G. Forest 9857* (lectotype, designated by Vidal: 571. 1965: E[barcode E00011333]!). Yunnan: Machang-Kai Valley, north of Tengyueh, Lat. 25°20'N, alt. 6000–7000 ft., shrub of 25–40 ft., flowers creamy-yellow, fragrant, in thickets, April 1913, *G. Forest 9847* (syntype: BM[barcode BM000602188]!). [image of lectotype available at http://data.rbge.org.uk/herb/E00011333]

34. ***Eriobotrya wardii*** C.E.C.Fisch., Bull. Misc. Inform. Kew 1929(6): 205. 1929. ≡ *Pyrus alabaster* M.F.Fay & Christenh., Global Fl. 4:94. 2018. Type: MYANMAR. Namkiu Mountains. Valley of the Sheinghku, 6000–7000 ft., in flower in October, *F. Kingdon-Ward 7618* (holotype: K[barcode K000758392]!; isotype: A[barcode 00026488]! image of the holotype with a small fragment of inflorescence). [image of holotype available at http://specimens.kew.org/herbarium/K000758392]

35. ***Hiptage cavaleriei*** H.Lév., Repert. Spec. Nov. Regni Veg. 10: 372. 1912. ≡ *Eriobotrya cavaleriei* (H.Lév.) Rehder, J. Arnold Arbor. 13: 307. 1932. ≡ *Pyrus athenae* M.F.Fay & Christenh., Global Fl. 4:96. 2018. Type: CHINA. Kouy-Tcheou (Guizhou): Pin-fa, montagne en pente, 20 May 1907, *J. Cavalerie 3220* (**lectotype, designated here**: E[barcode E00011330]!; isolectotypes: A[barcode 00055347]!, E[barcode 00284669]!, K[barcode K000758387]!, P[barcode P02143258]!, P[barcode P02143259]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143258]

Léveillé (1912) did not provide any typification information in the protologue, but mentioned it in his "Flore du Kouy-Tchéou" with the following information: "Pin-fa, montagne en pente, mai 1907, (Cavalerie 3220)". According to Stafleu and Cowan (1979), all of Léveillé's type specimens have been purchased by E in 1919, including the collections by J. Cavalerie. We located six duplicates among the available collections in A, E, K, and P, two of which have been deposited in E. Although all of Léveillé's names have been comprehensively reviewed by Lauener (1983), he did not provide the typification information. Since the sheet (E00011330) has been annotated by Léveillé "*Hiptage cavaleriei* Levl.." and is in a good condition, we designate this sheet as the lectotype, the other five ones as the isolectotypes.

36. ***Mespilus bengalensis*** Roxb., Hort. Bengal. 38; Fl. Ind. ii. 510. 1832. ≡ *Eriobotrya bengalensis* (Roxb.) Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 371. 1878. Type: INDIA. 1824, *N. Wallich 668.2* (neotype, designated by Vidal: 567: 1965: K[K001111550]! "lectotype"; isoneotype: P[barcode P02143255]!). [image of neotype available at http://specimens.kew.org/herbarium/K001111550]

Roxburgh (1832) did not cite any typification except of a locality in the protologue: "[...], a native of Chittagong, [...]". According to Stafleu and Cowan (1983), Roxburgh's main collection should be at K. We have not found any potential original material among the available collections at K, and this was also indicated by Vidal (1965, 1968). Although some of Roxburgh's names have been validated and typified (Robinson 1912; Forman 1997; Turner 2013), *Mespilus bengalensis* has never been typified. Vidal, therefore, selected one specimen, *Wallich 668.2*, from K as the neotype. It should be noted that Vidal (1965) designated it as the lectotype, but later corrected this to neotype in his Flore du Cambodge, du Laos et du Vietnam (Vidal 1968).

37. ***Photinia dubia*** Lindl., Trans. Linn. Soc. London 13(1): 104, t. 10. 1821. ≡ *Eriobotrya dubia* Decne., in Nouv. Arch. Mus. Par. Ser. I, x. (1874) 145. Type: NEPAL. *N. Wallich 668.1* (**neotype, designated here**: K[barcode K001111549]!; isoneotypes: BM[barcode 000521995(BM)]!, E[barcode E00011335]!). [image of lectotype available at http://specimens.kew.org/herbarium/K001111549]

Lindley (1821) provided the following locality in the protologue when describing *Photinia dubia*: "Hab. in Nepalia, *Wallich* (*v. s. sp. Herb. Banks et Lambert.*)". But we have not found any potential original material which was in accordance with the locality in the protologue among the available collections. According to Stafleu and Cowan (1976, 1979), Bank's type material is kept at CGE and K, and Lambert's herbarium was sold to many herbaria including K and BM after his death (Miller 1970). We selected one specimen (K001111549) at K as the neotype with the following tag "668 *Photinia dubia* Lindl. Herb. 1824; 1 Nepalia 1821; [...]", which partially fitted with the locality in the protologue. The duplicate in BM is an isoneotype.

38. ***Photinia deflexa*** Hemsl., in Ann. Bot. ix. 153. 1895. ≡ *Eriobotrya deflexa* (Hemsl.) Nakai, Bot. Mag. (Tokyo) 30: 18, in adnot. 1916. Type: CHINA. Formosa (Taiwan): Bankinsing, May 1894, *A. Henry 498* (lectotype, designated by Vidal 1965: 566: K[barcode K000758389]! "type"; isolectotype: A[barcode 00026740]!). [image of lectotype available at http://specimens.kew.org/herbarium/K000758389]

39. ***Photinia longifolia*** Decne., in Nouv. Arch. Mus. Par. Ser. I, x. 142. 1874. ≡ *Eriobotrya longifolia* (Decne.) Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. Type: BANGLADESH. East Bengal. Mishmi Hills, *W. Griffith 2093* (**lectotype, designated here**: P[barcode P02143220]!; isolectotype: K[barcode K000758398]!). [image of lectotype available at https://plants.jstor.org/stable/10.5555/al.ap.specimen.p02143220]

Decaisne (1874) provided the following locality in the protologue when he described *Photinia longifolia*: "*Loc. nat.* Bengalia orientalis (Griffith, n. 2093.)". We located two original specimens in K and P, from which the lectotype could be chosen. The information of both duplicates perfectly matched with the locality mentioned by Decaisne. According to Stafleu and Cowan (1976), Decaisne's specimens are often kept at BR, but many types at P and PC, but also some at G. We, therefore, designate the syntype (P02143220) in P as the lectotype, and the one in K as the isolectotype.

40. ***Mespilus japonica*** Thunb., Fl. Jap. (Thunberg) 206. 1784. ≡ *Eriobotrya japonica* (Thunb.) Lindl., Trans. Linn. Soc. London 13: 102. 1821. Type: JAPAN. *Thunberg s.n.* (holotype: UPS-THUNB accession no. 11908).

41. ***Symplocos seguinii*** H.Lév., Repert. Spec. Nov. Regni Veg. 10: 431. 1912. ≡ *Eriobotrya seguinii* (H.Lév.) Cardot ex Guillaumin, Bull. Soc. Bot. France 71: 287, in obs. 1924. Type: CHINA. Kouy-Tchéou (Guizhou): Environs de Ou-La-Gay et de Hoang-Ko-Chou, Mars 1899, *J. Séguin & R.P. Bodinier 2617* (**lectotype,** selected by Vidal 1965: 575, first step "type"; **second step, designated here**: E[barcode E00011359]!; isolectotypes: P[barcode P02143232]!, P[barcode P02143233]!). *s. loc.*, 9 April 1898, *J. Séguin & R.P. Bodinier 2262* (syntypes: E[barcode E00011332]!, P[barcode P02143234]!). [image of lectotype available at http://data.rbge.org.uk/herb/E00011359] [note 1]

= *Eriobotrya pseudoraphiolepis* Cardot, Notul. Syst. (Paris) 3: 371. 1918. nom. superfl. [note 2]

Note 1: Léveillé (1912) mentioned two gatherings (*J. Séguin 2262, 2617*) in the protologue when describing *Symplocos seguinii*, so they are syntypes. Vidal (1965) selected the gathering (*J. Séguin 2617*) kept at E and P as the lectotype [first-step]. We located three specimens of this gathering, one is in E and the other two in P. According to Stafleu and Cowan (1979), all of the Léveillé's type specimens have been purchased by E in 1919. We designate the duplicate (E00011359) of *J. Séguin 2617* kept at E as the lectotype [second-step].

Note 2: Cardot (1918) described *Eriobotrya pseudoraphiolepis* with the following locality in the protologue: "Kouy-Tcheou: environs de Ou-la-gay et de Hoang-ko-chou [*Séguin et Bodinier*, 1898 et 1899; nos 2262 et 2617]". It definitely included the type of *Symplocos seguinii* H.Lév. (1912). So *E. pseudoraphiolepis* is a nomenclaturally superfluous name when it was published (Turland et al. 2018: Art. 52.1).

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