PhytoKeys 154: 1–9 (2020)
doi: 10.3897/phytokeys.154.53223
http://phytokeys.pensoft.net

SHORT COMMUNICATION

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Description of a new natural *Sonneratia* hybrid from Hainan Island, China

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Academic editor: Hanno Schaefer | Received 14 April 2020 | Accepted 7 July 2020 | Published 3 August 2020

Citation: Zhong C, Li D, Zhang Y (2020) Description of a new natural *Sonneratia* hybrid from Hainan Island, China. PhytoKeys 154: 1–9. https://doi.org/10.3897/phytokeys.154.53223

Abstract

Here, we describe, illustrate and compare a new natural hybrid, *Sonneratia* × *zhongcairongii* Y. S. Wang & S. H. Shi (Sonneratiaceae), with its possible parent species. Based on its morphological characteristics and habitat conditions, this taxon is considered to represent a sterile hybrid between *S. alba* and *S. apetala*. In China, the new hybrid is only reported in the mangrove forest in Dongzhai Harbour, Hainan Island. It has intermediate characteristics with its parents by elliptical leaf blades, peltate stigma, terminal or axillary inflorescence with 1–3 flower dichasia, cup – shaped calyx (4–6 calyx lobes) and no petals. We also provide a key for the identification of *Sonneratia* species.

Keywords

Sonneratia, new hybrid, Dongzhai Harbour, Hainan Island

Introduction

Sonneratiaceae is a small tropical plant family consisting of only two small genera, *Sonneratia* and *Duabanga*. The inland genus *Duabanga* is an evergreen component of the rainforest belt, comprising two species within a more restricted range in Malaysian, Indonesia and China (Tomlinson 1986; Goutham-Bharathi et al. 2012). *Sonneratia*, a genus of mangroves, is one of the most important components of the intertidal zones of the tropical and subtropical coastal regions, ranging from East Africa through Indo-

Malaya to tropical Australia and into Micronesia and Melanesia (Tomlinson 1986). This genus is also well-adapted to harsh intertidal zones with high salinity, hypoxia and ultraviolet (UV) radiation (Duke et al. 1998).

Sonneratia consists of six species and three interspecific hybrids (Duke and Jackes 1987; Duke 1994; Goutham-Bharathi et al. 2012; Yang et al. 2016). Amongst these, *S. alba*, *S. caseolaris*, *S. ovata* and *S.* × *gulngai* are the most widespread species (Tomlinson 1986; Goutham-Bharathi et al. 2012; Yang et al. 2016), whereas *S. lanceolata* and *S.* × *urama* are strictly limited to north-western Australia, southern New Guinea and a few locations in Indonesia (Yang et al. 2016). *S. griffithii* has a restricted distribution along the shores of the Andaman Sea, north to Bengal and south to the upper Malay Peninsula (Tomlinson 1986). *S.* × *hainanensis*, a hybrid derived from the cross between *S. alba* and *S. ovata*, is found in Hainan, China (Ko 1985; Wang et al. 1999). It was first reported that *S.* × *hainanensis* was in north-western Borneo as a nom. nud., based on morphological and cytological analyses (Muller and Hou-Liu 1966; Zhou et al. 2005). The parents of *S.* × *hainanensis* are widely distributed; however, more collections are needed. The mangrove *S. apetala* is restricted to southern India and Burma and is the most distinctive species because of its mushroom-like stigma (Tomlinson 1986). In China, *S. apetala* was first introduced in Dongzai Harbour, Hainan Island in 1985 from Bangladesh (Peng et al. 2012). Due to its accelerated growth and high tolerance of environmental stresses, *S. apetala* has been used as the pioneer species for mangrove restoration in estuarine and coastal areas. The species, *S. alba*, is an endemic species on Hainan Island (Li et al. 2017). Between two mixed populations, plants with intermediate characteristics have recently been encountered that obviously belong to the hybrid. In this study, we describe the new hybrid, *S.* × *zhongcairongii* and its features that distinguish it from both parent species.

Materials and method

The morphology of *Sonneratia* species presented here is based on field, vegetative and reproductive characteristics. Field traits were recorded on site, whereas vegetative and reproductive characteristics were observed and measured using fresh specimens, material preserved in 70% ethanol or press-dried specimens. Digital calipers (Mitutoyo, Japan) and a dissecting microscope with calibrated eye (Olympus, Germany) were used to describe the detailed morphological characteristics of samples. All photographs were taken in the field, i.e. in the natural habitat of the species, using a digital camera (cannon EOS RP, Japan). The morphological characteristics of *Sonneratia* species in Hainan Island have been summarized in a key to facilitate identification.

Results

The results of morphometric analysis showed that *S.* × *zhongcairongii* is more similar to its parents *S. alba* and *S. apetala* than to other *Sonneratia* taxa (Fig. 1, Table 1). Additionally, the morphology analysis of *S.* × *zhongcairongii* was intermediate between

that of its parents (Figs 2, 3). The flowers of *S.* × *zhongcairongii* contained several abnormally-developed anthers (Fig. 1L), which might account for the 100% abortion rate and consequently the lack of fruit and seed (Table 1).

Taxonomic treatment

***S.* × *zhongcairongii* Y. S. Wang & S. H. Shi, nothosp. nov.**
Figure 1

Material. Dongzhai Harbour, mangrove forest Hainan Island, China (Fig. 1A), 19°58'12"N, 110°34'48"E, 13 June 2018, Cairong Zhong, No. Saa20180613-001 (Holotype: IBSC; Isotype: IBSC).

Morphological traits. Trees, evergreen, 10–12 m tall, highly branched (Fig. 2A). Bark smooth or lightly fissured flaky, dark grey to pale fleshy green; stem base simple. Leaves simple, opposite, leaf blade leathery, glabrous, pale green, elliptical, 2–9 cm long,1–5 cm wide, apex obtuse, base acuminate, margin entire; petiole 0.3–1 cm; stipules absent. Inflorescence terminal or axillary, 1–3 or 1–5 flowered dichasia; flower bud ellipsoidal, 1.5–2.4 cm in length, 1–1.5 cm width, constricted medially, green, glossy, smooth, slightly angular; Calyx cup-shaped, lobes 4–6, wide ovate (0.8–1.2 cm long, 0.5–0.8 cm wide), apex acute, inner often fleshy green inside. Petals absent; stamens numerous along calyx, white, 1–1.5 cm in length; stigma peltate to 5 mm wide. Fruits not developed.

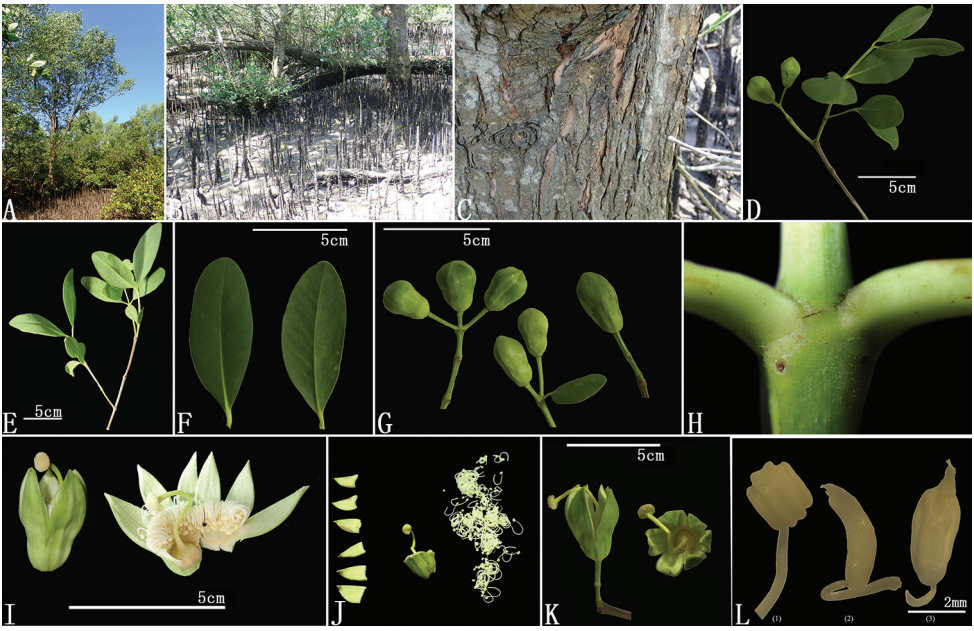

Figure 1. Morphology of *S.* × *zhongcairongii*. **A** Habitat **B** stem with aerial root **C** bark **D** branches **E** leaf branch end with flowers **F** leaves **G** inflorescence **H** minute bract at a dichotomous inflorescence branch **I** flower **J–L**. Dissection of the flower (**J**), pistil (**K**) and stamens (**L**).

Table 1. Comparison of described *Sonneratia* taxa and the new Hainan material.

Character	*S.* ×*zhongcairongii*	*S. alba*[1-2]	*S. apetala*[3]	*S. caseolaris*[1-2]	*S.* ×*gulngai*[1-2]	*S. lanceolata*[1-2]	*S. ovata*[1,3]	*S.*×*hainanensis*[4]	*S. griffithii*[3,5]
Leaf blades	elliptic	obovate or elliptic to ovate	narrowly elliptic to lanceolate	elliptic	elliptic	elliptic	broadly ovate	elliptic or broadly elliptic	obovate or suborbicular
Leaf apices	rounded mucronate	rounded	rounded mucronate	apiculate, mucronate	apiculate, mucronate	apiculate, mucronate	rounded	rounded	obovate mucronate
Leaf base	attenuate oblique	attenuate oblique	attenuate oblique	attenuate oblique	attenuate oblique	attenuate oblique	reniform	broadly cuneate	cuneate
Peduncle	terete	terete	terete	terete or tetragonous	terete	terete or tetragonous	terete	terete	terete
Calyx lobes	4~6; inner often green	6~7(8); inner often red	4; inner often green	5~7; inner often red-streaked	5~7; inner often green	5~7; inner rarely red-streaked	6; inner often red at base	6; inner often red	6-7: inner often green
Petals	absent	white[6], linear-spathulate	absent	red, linear	red, linear	red, linear, rarely double	absent	white	white (absent)*
Stamen	white	white	white	red, rarely white	red	white	white	white	white
Stigma	Mushroom-like, to 5~7 mm wide	capitate but not expanded, 1~3 mm wide	Mushroom-like, to 7~10 mm wide	capitate but not expanded, to 3 mm wide	capitate but not expanded, to 1.7 mm wide	capitate but not expanded, to 3 mm wide	capitate but not expanded, to 3 mm wide	capitate but not expanded, to 3 mm wide	capitate but not expanded, to 3 mm wide
Inflorescence	terminal or axillary, 1-3(-5)-flowered dichasia	terminal cyme occur either solitarily or in groups of three	terminal cyme from branch axis	terminal or axillary, 1-3(-5)-flowered dichasia	terminal or axillary, 1-3-flowered dichasia	terminal or axillary,1(-2)-flowered dichasia	terminal cyme or solitarily or in groups of three	terminal cyme 1-3(-5)-flowered dichasia	terminal cyme 1(-2)-flowered dichasia
calyx (hypanthium)	cup-shaped	cup-shaped	flat-expanded	flat-expanded	cup-shaped	flat-expanded	cup-expanded	cup-shaped	cup-shaped
Fruit	Not developed	Width = corolla width	Width = corolla width	width 5 mm > corolla width	Width = corolla width	width 5 mm > corolla width	width 6-8 mm > corolla width	width 5 mm > corolla width	Width = corolla width
Seeds	Not developed	falcate	falcate	angular irregular	angular irregular	angular irregular	rounded irregular	angular irregular	angular

Taken from [1]Duke and Jackes (1987), [2] Duke (2006), [3]Goutham-Bharathi et al. (2012), [4]Ko (1993), [5]Tomlinson (1986), [6]Wang and Wang (2007).

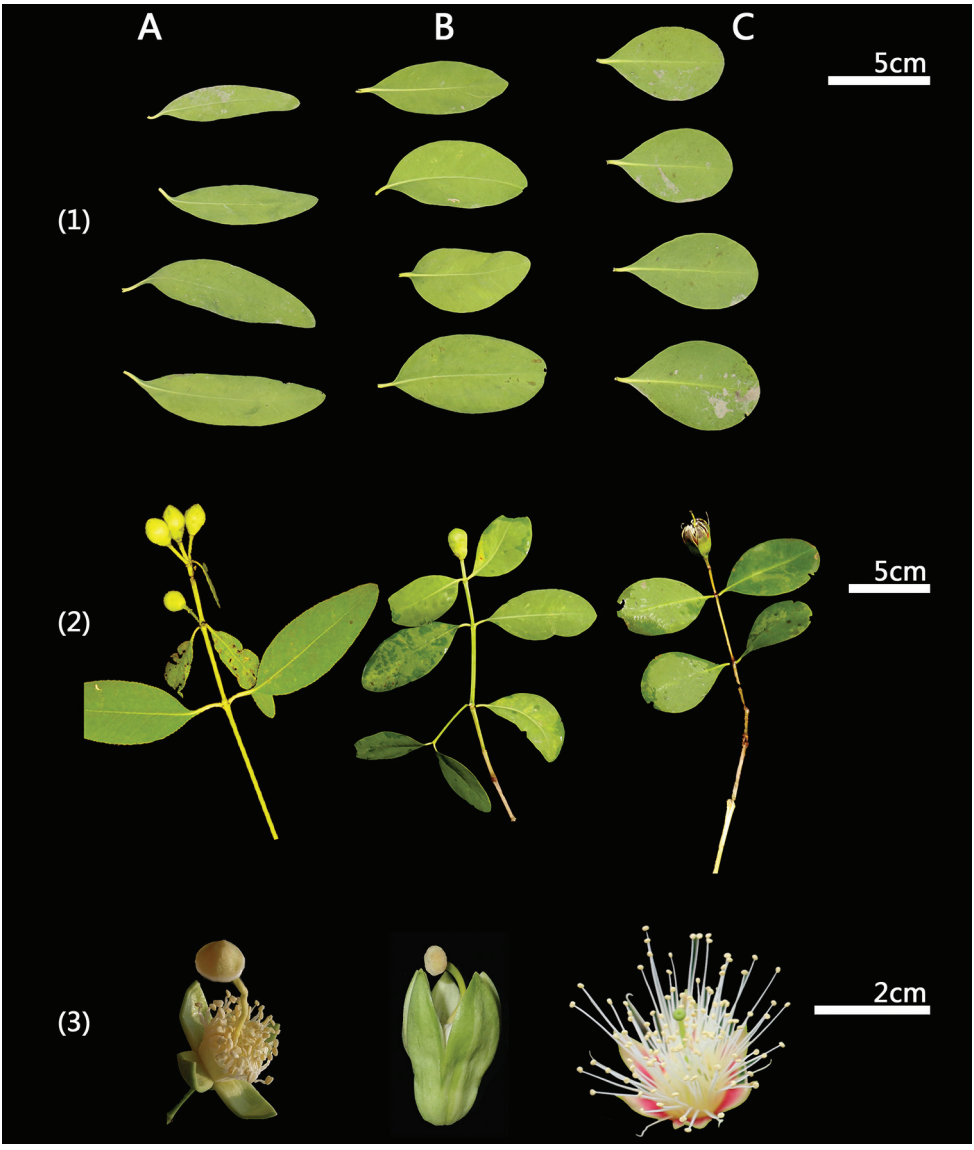

Figure 2. Comparison of the three taxa A *S. apetala* B *S.* × *zhongcairongii* C *S. alba* **1** leaves, **2** branches, **3** flowers.

Distribution. The hybrid is currently found only in Dongzhai Harbour within an area of 48 m^2, mangrove forest, Hainan Island, China.

Habitat and ecology. The hybrid grows in a mangrove forest.

Phenology. The new hybrid flowered from the beginning of March to the end of October.

Conservation status. The new hybrid *S.* × *zhongcairongii* was collected only from the mangrove forest in Dongzhai Harbour. At this site, only two individuals were observed.

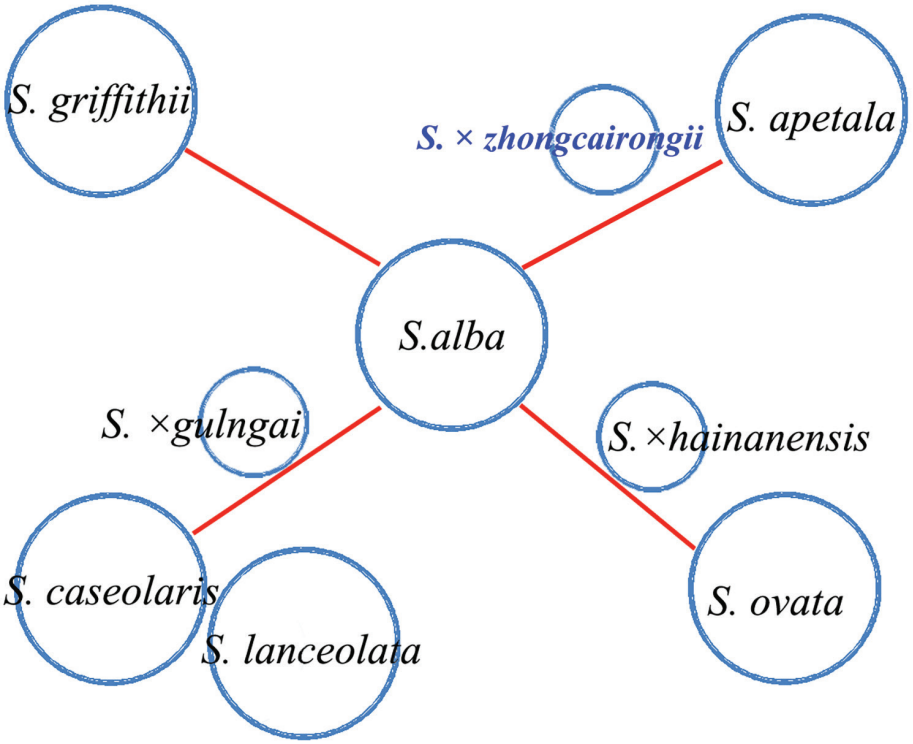

Figure 3. Schematic diagrams of *Sonneratia* taxa and their inter-specific affinities deduced from morphometric analyses. The choice of circle size and line length is arbitrary.

Discussion

To date, only three hybrids including *S.* × *zhongcairongii* have been reported in the genus *Sonneratia*. As with *S.* × *zhongcairongii*, other two hybrids have restricted location in the cross distribution of each parents (Duke and Jackes 1987; Duke 1994; Goutham-Bharathi et al. 2012; Yang et al. 2016). Only two individuals of the new hybrid were observed in China. The parent, *S. apetala*, is an exotic species in China, whose mixed location with *S. alba* started from 1985 (Peng et al. 2012). The morphological characteristics of *S.* × *zhongcairongii* were intermediate between its parents (Figs 2, 3); this result is consistent with the other two *Sonneratia* hybrids (Tomlinson 1986; Duke and Jackes 1987). *S.* × *zhongcairongii* showed complete abortion. However, on the other two hybrids (*S.* × *gulngai* and *S.* × *hainanensis*) can be found fruit and seeds with heavy abortion degrees (Tomlinson 1986; Wang and Wang 2007).

Backer and van Steenis (1951) compiled a thorough review of the Sonneratiaceae, a family of the order Myrtales. Two genera were described and include *Duabanga* and *sonneratia*. Gao Yunzhang divided the *Sonneratia* genus into two sections, sect. *Sonneratia* and sect. *Pseudosonneratia*, based on the presence or absence of petals (Ko 1985) and which was also used in the research of *sonneratia* Linn. in Australia, New Guinea and

the south-western Pacific region (Backer and van Steenis 1951). By adding one new species found in China (*S. paracaseolaris* Ko, E. Y. Chen et W. Y. Chen), Gao Yunzhang regrouped the *Sonneratia* species in China (Ko 1993). Subsequently, a detailed anatomical analysis containing morphology of leaf, flower, fruit, seed and wood of five species of *Sonneratia* Linn. in China showed that the use of petal presence or absence was appropriate to distinguish species in *Sonneratia* Linn. (Chen 1996). Duke and Jackes worried about the use of petal presence or absence to distinguish between apetalous *S. alba* with *S. ovata* which was found to be less common, normally apetalous (Duke and Jackes 1987). Then the wrong character of *S. alba* was revised from apetalous to white, linear-spathulate (Wang and Wang 2007). Compared with characters of petal, stamen, leaf and flower bud, the stigma morphological characteristics have been used to group nine species and hybrids in *Sonneratia* Linn. (Wang and Chen 2002). In this study, we combined the use of petal presence or absence and stigma morphological characteristics to regroup *Sonneratia* plants and the new hybrid was most closely related to one of its parents, *S. apetala*.

To better distinguish amongst species belonging to the genus *Sonneratia*, we created a classification as shown in Table 1. The distribution range of the hybrid *S.* × *zhongcairongii* often overlaps with that of *S. alba* Smith. and *S. apetala* Buch. -Ham., which provides the possibility of formation of the hybrid species. The same is true for *S.* × *gulngai* N. C. Duke, *S.* × *hainanensis* Ko, E. Y. Chen et W. Y. Chen (Wang et al. 1999). The overlapping distributions of parent species contributed to the greater opportunity to form a natural hybrid (Zhou et al. 2008). Interestingly, one of the parents of all three hybrids is *S. alba*, which may be due to the fact that *S. alba* is a widely-distributed species, although further investigation is needed to determine the exact reason.

Key for the classification of *Sonneratia* species in China

1	Petals present	**2**
–	Petals absent	**3**
2	Petals white	**4**
–	Petals red	**5**
3	Stigma capitate but not expanded	**6**
–	Stigma mushroom-like	7
4	Leaf blades obovate or elliptical to ovate	***S. alba***
–	Leaf blades elliptic or broadly elliptical	***S.× hainanensis***
5	Fruit calyx flat-expanded, fruit width > corolla width by 5 mm	**8**
–	Fruit calyx cup-shaped, Width = corolla width	***S.× gulngai***
6	Leaf blade apices rounded	***S. ovata***
–	Leaf blade apices obovate mucronate	***S. griffithii***
7	Flat-expanded calyx, fruit present	***S. apetala***
–	Cup-shaped calyx, fruit absent	***S. × zhongcairongii***
8	Leaf blade apices rounded	***S. caseolaris***
–	Leaf blade apices apiculate, mucronate	***S. lanceolata***

Acknowledgements

This study was supported by National Science Foundation of Hainan Province, China (grant numbers 318MS176; 319QN214); the National Natural Science Foundation of China (grant number 41776148).

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PhytoKeys 154: 11–17 (2020)
doi: 10.3897/phytokeys.154.39105
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Notes on *Brachymenium* in Guyana with a new species from Mt. Ayanganna

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Academic editor: Peter de Lange | Received 14 August 2019 | Accepted 30 June 2020 | Published 3 August 2020

Citation: Robinson H, Golinski GK (2020) Notes on *Brachymenium* in Guyana with a new species from Mt. Ayanganna. PhytoKeys 154: 11–17. https://doi.org/10.3897/phytokeys.154.39105

Abstract

A relative of the African species described by Brotherus as *Bryum perspinidens*, has been discovered in Guyana with erect capsules and a short inner peristome. The Guyana material is recognized as a new species, and both species are placed in the genus *Brachymenium.* The characteristics that distinquish the genus are discussed with reference to the Guyana specimens of *Brachymenium speciosum*.

Keywords

African relationship, Bryaceae, peristome, rostrate operculum

Introduction

Study of bryophyte collections obtained during the Smithsonian Biological Diversity of the Guianas project, has revealed a number of interesting species. Among these are two two collections of a bryaceous moss with capsules identifiable as a *Brachymenium* Schwaegr., Spec. Musc. Suppl. 2(1): 131. 1824, with a leaf that superficially matches the illustration of *Bryum perspinidens* Broth. in the Brotherus treatments in the two editions (1904 and 1925) of Engler and Prantl. The only problems were that the Brotherus illustration was of an African species named as a *Bryum*. The spiniform teeth of the leaf margins were nevertheless similar, and a relationship seemed to be involved. As for the generic placement, the Brotherus (1897) species was described from sterile material so that the placement in *Bryum* Hedw. lacked any real evidence.

The relationship of Guyana Highland species to African species fits a pattern noted by Robinson (1965). In addition, there is ample material from Guyana of another species of *Brachymenium*, *B. speciosum* that is newly discussed and illustrated.

Methods

Specimens in this study were obtained during the Smithsonian Biological Diversity of the Guianas Program conducted over a period of years from 1985 to 2014 (Kelloff et al. 2019). The particular specimens of the new species involved in this study were collected during a separately funded trip conducted by M.D. Clark in 2001 that collected on Mt. Ayanganna. The bryophytes were deposited at the US National Herbarium awaiting identification. They have been in storage since that time.

A note with the specimens indicates that when they arrived in the US they were irradiated during the Anthrax scare of 2001.

Results

The South American material includes one species that seems to be distinct from others from the Western Hemisphere (see for example Allen 2002) and from the related African species.

Brachymenium ayangannensis H.Rob. & G.K.Golinski, sp. nov.

Figure 1

Type. Guyana. Region: Potaro–Siparuni. Mt. Ayanganna, east face, plateau above second of four escarpments. 1380 m, 05°22.550'N, 059°58.350'W. Scrub forest on sandstone and peat, with *Clusia*, *Pagamea* and *Sphagnum*. Epiphyte; sporophytes green. 17 June 2001. *H.D. Clarke 9299*, with *R. Williams*, *C. Perry*, *E. Tripp & J. Kelly* (US).

Description. Stems up to 3 cm tall, leaves not closely spaced, rather firm in structure but contorted when dry and resistant to wetting. Costa percurrent into a long slender acumination, median cells narrowly oval, with firm walls showing slight porosity, mostly 80–100 μm long and ca. 30 μm wide, without shorter quadrate cells at base, margin with numerous rows of linear pale cells forming a strong border, border with numerous cells projecting as spiniform teeth, such spiniform teeth extending onto apical acumination. Synoicous? Seta pale yellowish-red, ca. 17 mm long, smooth. Capsules erect, ca. 2 mm long, with short hypophysis, operculum short-rostrate, higher than wide. Outer peristome teeth reddish, rudimentary, ca. 80 μm long, inner peristome a low pale membrane ca. 70 μm without projecting segments or cilia. Calyptra not seen. Spores ca. 10 μm in size.

Additional material. Guyana. Region: Potaro–Siparuni. Mt. Ayanganna, east face, area near camp at base of fourth of four escarpments. Elev. 1545 m, 05°23.083'N, 059°58.550'W. Dense forest on sandstone and peat, with *Euterpe*, *Clusia*, and

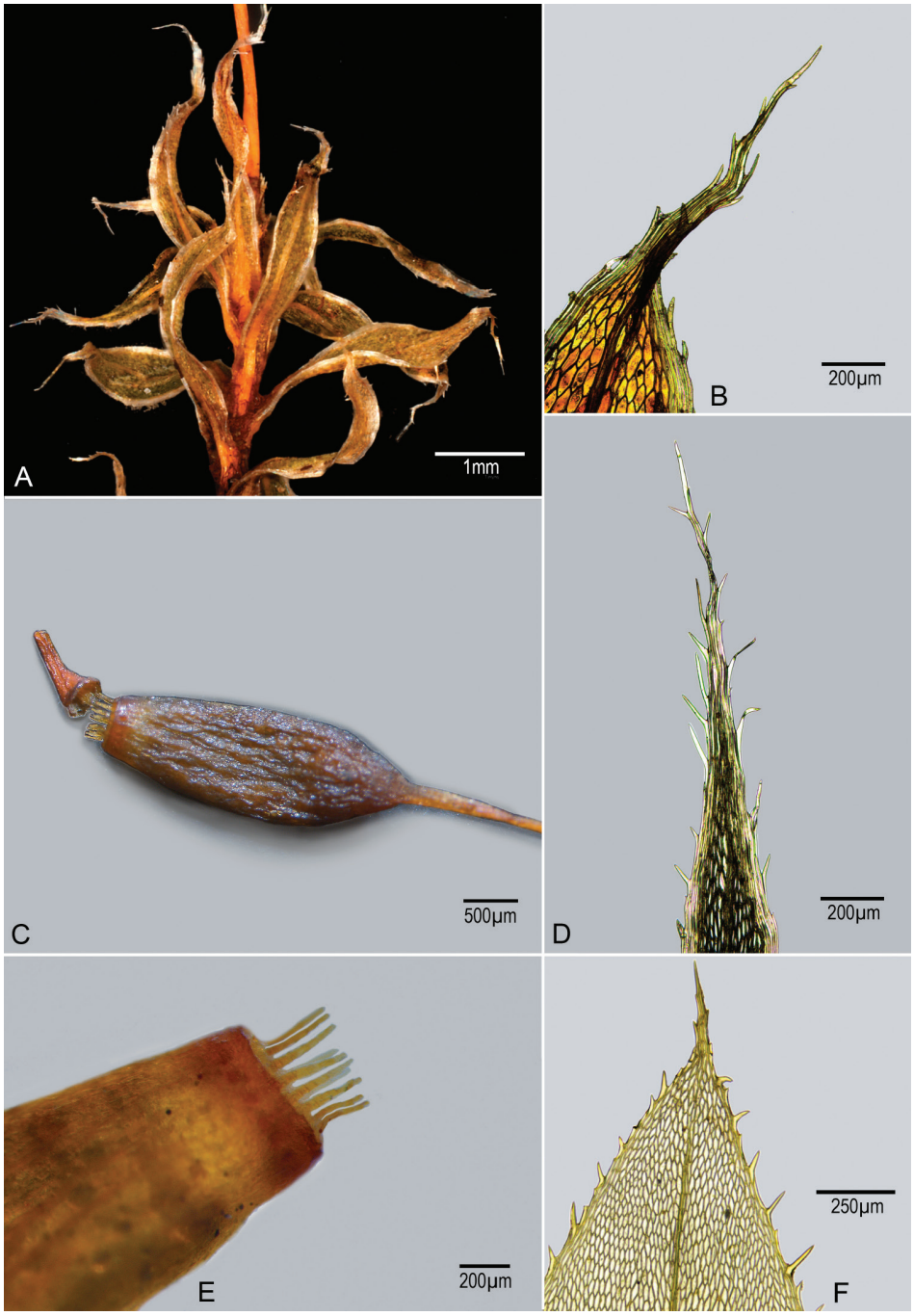

Figure 1. *Brachymenium ayangannensis* H.Rob. & G.K.Golinski. **A** Leafy stem showing distorted leaves **B** distal part of leaves, showing well-developed pale margin and spiniform teeth on both margin and long-acuminate tip **C** remoistened erect capsule showing partially detached short-rostrate operculum **D** *B. perspinidens* (Broth.) H.Rob. & Golinski, distal part of leaf of holotype (from H) **E** tip of capsule mounted in Hoyer's solution showing short exostome and lack of well-developed endostome. The photographs were taken using a Leica DM4B Compound microscope, using a 5× objective.

Brocchinia. Sporophytes green. On tree limb. *H.D. Clarke 9551* with *R. Williams*, *C. Perry*, *E. Tripp & J. Kelly* (US).

The peristome teeth of the new species have proven extremely fragile, possibly because of the radiation treatment.

The spiniform teeth of the leaf margin are distinctive, but the manner in which they occur on the acuminate apical extension is reminiscent of the illustration by Brotherus (1904: 557 fig. C; 1925: 367, figs C, D). This illustration has led to the comparison, but it proves to be somewhat inaccurate compared to the more recent illustration made from the type by Ochi (1972)

The African species is well illustrated by Ochi (1972), but the type from Helsinki has been borrowed not because of doubts of relationship so much as to insure that the two species are not the same. The principle difference is the absence of spinose teeth extending on to the apical acumination of the leaf. Nevertheless, there is no doubt the two are close, and the African species was placed in Bryum only because there was no sporophyte to indicate otherwise. A important point derived from the Ochi study is that none of the species in typical *Bryum* have spinose marginal teeth, all with such teeth are in what is now in the *Brachymenium*, *Rhodobryum* relationship. On the basis of the evident relationship between the African and Guyana species, the following transfer of the African species is provided.

Brachymenium perspinidens **(Broth.) H.Rob. & G.K.Golinski, comb. nov.**
Figure 1D

Bryum perspinidens Broth., Bot. Jahrb. Syst. 24: 246. 1897. Britische Ostafrika, Seengebiet: Ru– Nssóro, 3300–3600 m (Uganda: Ruwenzori, heather forest 10–12000'), *Scott Elliot 266*, Sterile. *Rhodobryum perspinidens* (Broth.) Pócs, in Bizot & Pócs, Acta Bot. Acad. Sci. Hungaricae 25: 257. 1979 [1980]. With record of species from Tanzania, also sterile. Ochi (1972) indicated the species was rather an oddity in *Bryum* Hedw. subgenus *Rhodobryum* Schimp. in which he placed it.

Notes. Placement of the new species in *Brachymenium* is based on the capsules being erect with an inner peristome being a low membrane lacking segments or cilia, the traditional distinctions of the genus. Recent DNA studies (Pedersen et al. 2003, Pedersen and Hedenas 2005; Cox and Hedderson 2003) indicate that species that have been placed in the genus *Brachymenium* are mostly in basal branches of the Bryaceae while *Bryum* species are more derived. According to such studies, the genus *Brachymenium* is more entangled phyletically with the genus *Rhodobryum* (Schimp.) Hampe, Linnaea 38: 663. 1874, a later established genus and *Osculatia* De Not., Mem. Reale Accad. Sci. Torino, ser 2, 18: 445. 1859 (Robinson 1965; Ochyra et al. 2018). A survey of the illustrations in Brotherus (1904, 1925) shows an additional trend in *Brachymenium* that is lacking in typical *Bryum*, conical to rostrate opercula such is seen in the new species. In fact, within the present definition of *Brachymenium*, fully rostrate opercula occur in another species recently collected in Guyana.

***Brachymenium speciosum* (Hook. & Wils.) Steere.**
Figure 2

Notes. The latter species has been collected on a mountain near Ayanganna as indicated below.

Mt. Wokomung, Little Ayanganna, upper slopes of highest point of Mount Wokomunga massif. 5°5'8"N, 59°50'32"W. elev. 1525 m. Tepui scrub forest on sandstone

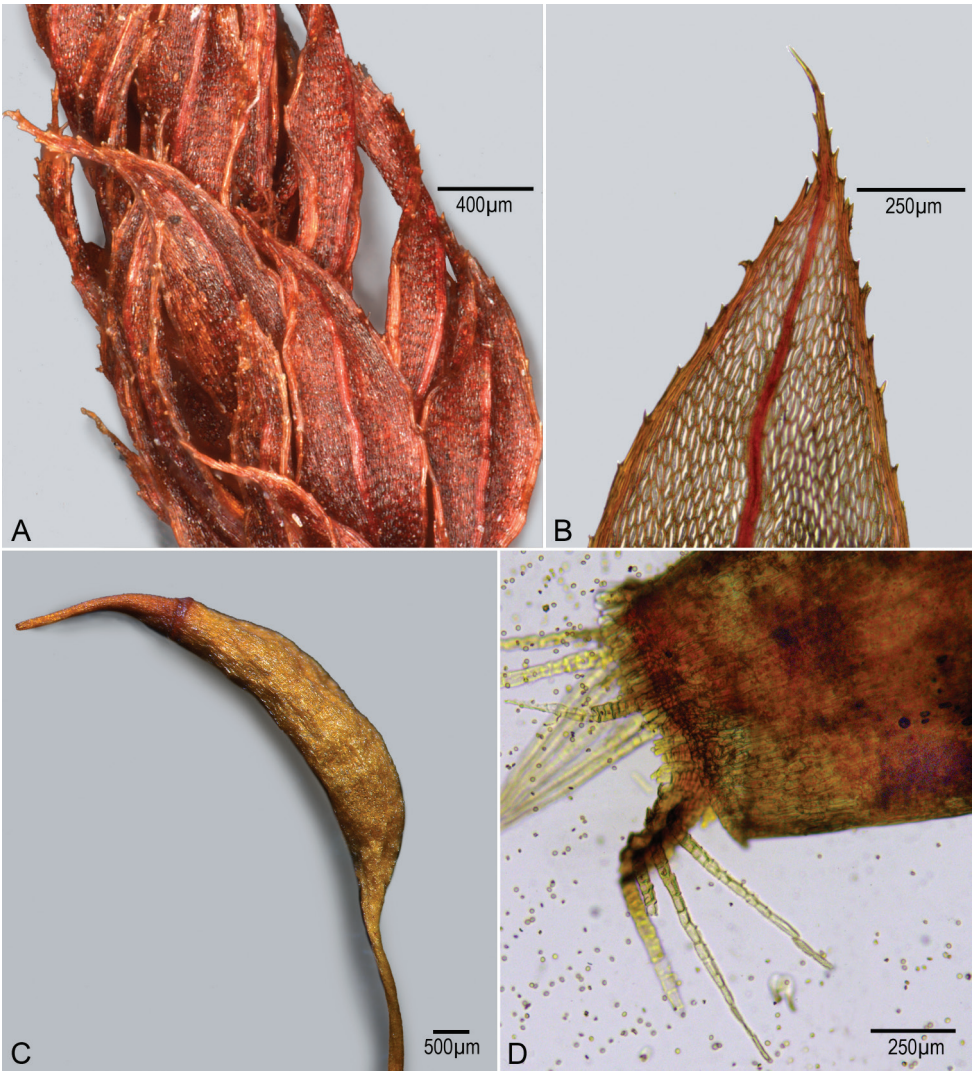

Figure 2. *Brachymenium speciosum* (Hook. & Wils.) Steere. **A** Part of leafy stem showing distorted leaves **B** tip of leaf showing thickened margin with teeth on margin and upper and lower surfaces, some of these appearing as double teeth **C** capsule showing rostrate operculum **D** peristome teeth mounted in Hoyer's solution, showing elongate exostome teeth erect on one half and reflexed on other half, the latter showing endostome lacking cilia and segments. The photographs were taken using a Leica DM4B Compound microscope, 5× objective.

and peat, with *Schefflera*, *Clusia* and *Guadua*. 5 July 2003, *H.D. Clarke 10550*, with *R. Williams*, *C. Perry*, *J. Kelly*, *D. Gittens*, *S. Stern*; Guiana. Mt. Wokomung, Little Ayanganna, upper slopes of highest point of Mount Wokomung massif. 5°5'8"N, 59°50'32"W. elev. 1525 m. Tepui scrub forest on sandstone and peat, with *Schefflera*, *Clusia* and *Guadua*, elev. 1525 m. 5 July 2003, *H.D. Clarke 10575*, with *R. Williams*, *C. Perry*, *J. Kelly*, *D. Gittens*, *S. Stern*. Guiana. Mt. Wokomung, Little Ayanganna, upper slopes of highest point of Mount Wokomung massif. 5°4'53.1"N, 59°50'26.1"W. elev. 1525 m. Tepui bog on sandstone and peat, with *Brocchinia*, *Bonnetia* and *Rapatea*, elev. 1660 m. 6 July 2003, *H.D. Clarke 10576*, with *R. Williams*, *C. Perry*, *J. Kelly*, *D. Gittens*, *S. Stern*. Mt. Wokomung, area above third of four escarpments, 1 km NE of Mt. Wokomung, 5°4'30"N, 59°51'15"W. elev. 1490 m. dense forest on laterite, with *Clusia*, *Euterpe* and *Licania*, elev. 1490 m. 8 July 2003, *H.D. Clarke 10802*, with *R. Williams*, *C. Perry*, *J. Kelly*, *D. Gittens*, *S. Stern*. The material shows the additional feature of the species, the multistratose leaf margin with teeth on the margin and upper and lower surfaces. The species is otherwise reported from Suriname, Ecuador, and supposedly described from Jamaica (Maracaibo, Venezuela?)(Allen 2013; Steere 1948).

Acknowledgements

We thank Eric Schuettpelz, Chair of the Department of Botany, NMNH, for generously allowing us to use his lab and for providing ongoing support of our work on the bryophytes. H. David Clarke collected the specimens of *Brachymenium ayanganna* and *B. speciosum* while exploring the mountaintops of Guyana, funded by grants from National Geographic (Grant #6622-990) and the Smithsonian Institution's Biodiversity of the Guiana Shield Program under the direction of Vicki Funk and Carol Kelloff. We appreciate the help of Sanna Laaka-Lindberg, Collection Coordinator of H Bryophyte Herbarium (Helsinki), for providing the type specimen of *Brachymenium perspinidens*, and Alice Tangerini, resident artist in the Department of Botany, NMNH, for expertly constructing the plates. Our manuscript greatly benefited from a thorough review by Blanka Aguero and an anonymous reviewer.

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PhytoKeys 154: 19–55 (2020)
doi: 10.3897/phytokeys.154.52790
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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A synopsis of the expanded *Rhaphiolepis* (Maleae, Rosaceae)

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Academic editor: A. Sennikov | Received 1 April 2020 | Accepted 6 June 2020 | Published 4 August 2020

Citation: Liu B-B, Wang Y-B, Hong D-Y, Wen J (2020) A synopsis of the expanded *Rhaphiolepis* (Maleae, Rosaceae). PhytoKeys 154: 19–55. https://doi.org/10.3897/phytokeys.154.52790

Abstract

As part of the integrative systematic studies on the tribe Maleae, a synopsis of the expanded *Rhaphiolepis* is presented, recognizing 45 species. Three new forms were validated: *R. bengalensis* f. *contracta* B.B.Liu & J.Wen, *R. bengalensis* f. *intermedia* B.B.Liu & J.Wen, and *R. bengalensis* f. *multinervata* B.B.Liu & J.Wen, and four new combinations are made here: *R. bengalensis* f. *angustifolia* (Cardot) B.B.Liu & J.Wen, *R. bengalensis* f. *gigantea* (J.E.Vidal) B.B.Liu & J.Wen, *R. laoshanica* (W.B.Liao, Q.Fan & S.F.Chen) B.B.Liu & J.Wen, and *R. latifolia* (Hook.f.) B.B.Liu & J.Wen. Furthermore, one new name, *Rhaphiolepis yui* B.B.Liu & J.Wen is proposed here, and three taxa were reduced as new synonyms. We also provide lectotypification for 13 names: *Crataegus bibas*, *Eriobotrya philippinensis*, *Mespilus spiralis*, *Opa integerrima*, *Photinia luzonensis*, *Rhaphiolepis brevipetiolata*, *R. ferruginea* var. *serrata*, *R. fragrans*, *R. gracilis*, *R. hainanensis*, *R. kerrii*, *R. indica* subsp. *umbellata* var. *liukiuensis*, and *R. parvibracteolata*.

Keywords

Eriobotrya, lectotype, new name, nomenclature, taxonomy, typification, validation

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Introduction

The three-subfamily classification system of Rosaceae, Amygdaloideae, Dryadoideae, and Rosoideae, has been accepted and stabilized with a series of molecular phylogenetic studies (Morgan et al. 1994; Potter et al. 2007; Xiang et al. 2017; Zhang et al. 2017). As one of the nine tribes in Amygdaloideae, the apple tribe Maleae consists of ca. 1000 species widely distributed throughout the Northern Hemisphere (Phipps et al. 1990). Some members in Maleae have shown great economic importance, especially as fruits, e.g. apples (*Malus domestica* (Suckow) Borkh.), pears (*Pyrus communis* L.), and loquats (*Rhaphiolepis bibas* (Lour.) Galasso & Banfi), as well as some ornamentals, e.g. chokeberries (*Aronia* Medik.), cotoneasters (*Cotoneaster* Medik.), firethorns (*Pyracantha* M.Roem.), hawthorns (*Crataegus* L.), photinias (*Photinia* Lindl.), rowans (*Sorbus* L.), and serviceberries (*Amelanchier* Medik.). Members of Maleae, therefore, have attracted the attention of many horticulturists, pomologists, and taxonomists.

A recent phylogenomic analysis of *Rhaphiolepis* Lindl. and *Eriobotrya* Lindl. in the framework of Maleae (Rosaceae) strongly supported the paraphyly of *Eriobotrya*, with *Rhaphiolepis* nested within it (Liu et al. 2020b). These two genera were thus considered to be congeneric and treated as *Rhaphiolepis*, which has the nomenclatural priority. The expanded *Rhaphiolepis* has two synapomorphies: the proportionally large seed with rounded or wide-elliptic cross-section and the absence of endosperm (Aldasoro et al. 2005; Liu et al. 2020b). Furthermore, frequent hybridizations may have occurred in the diversification of the expanded *Rhaphiolepis*, which may explain some of the reported topological incongruences between nuclear and chloroplast DNA data within the genus (Liu et al. 2020b). Hybridization events have been reported in several lineages of the apple tribe, such as *Micromeles* Decne., *Pseudocydonia* (C.K.Schneid.) C.K.Schneid. (Lo and Donoghue 2012), and *Phippsiomeles* B.B.Liu & J.Wen (Liu et al. 2019), as well as the *Amelanchier-Malacomeles* (Decne.) Decne.-*Peraphyllum* Nutt. clade (Liu et al. 2020a). It is also very common in many lineages of angiosperms, e.g. Gesneriaceae (Kleinkopf et al. 2019), Magnoliaceae (Wang et al. 2020), Vitaceae (Wen et al. 2018, 2020), and Wightiaceae (Xia et al. 2019).

Most of the species of the expanded *Rhaphiolepis* are trees and shrubs, distributed from subtropical East Asia to tropical Southeast Asia. The loquat species (*Rhaphiolepis bibas* = *Eriobotrya japonica* (Thunb.) Lindl.) belongs to this genus, and has been widely cultivated all over the world as fruits and ornamentals. Furthermore, several other species, such as *Rhaphiolepis indica* (L.) Lindl. and *R. umbellata* (Thunb.) Makino have been used as ornamentals with their abundant white flowers and persistent red fruits. Thunberg (1784) described the first species, i.e. the loquat, as *Mespilus japonica* Thunb., and since then nearly 242 names have been published in the last two centuries. Previous studies were primarily regional in scope along with floristic treatments, e.g., Flora of British India (Hooker 1878), Flora of Japan (Ohwi 1965), Flore du Cambodge, du Laos et du Vietnam (Vidal 1968), Flora of Thailand (Vidal 1970), Flora of Taiwan (Ohashi 1993), and Flora of China (Kuan and Yu 1974; Gu and Spongberg 2003). While these names have never been well evaluated comprehensively, and some of them

have been largely neglected since their description, such as *Rhaphiolepis crataegoides* M.Roem. and *R. laevis* Lodd. ex G.Don. Liu et al. (2020c) provided typifications for 23 names related to *Eriobotrya*. We herein evaluate all names published previously and provide a genus-wide synopsis of *Rhaphiolepis*, while the horticultural cultivars will not be in the scope of this study, such as *Eriobotrya japonica* f. *variegata* and × *Rhaphiobotrya* 'Coppertone' (Coombes and Robertson 2008). We hope the taxonomic framework presented here will stimulate in-depth evolutionary studies of this widely distributed Asian lineage of Maleae using collections-based tools (Wen et al. 2017; Funk 2018).

Materials and methods

We reviewed all names published previously, by checking all available online resources, such as Tropicos (2020: https://www.tropicos.org), IPNI (2020: https://www.ipni.org/), and the Plant List (2013: http://www.theplantlist.org/), furthermore, all the regional floras (e.g. Hooker 1878; Ohwi 1965; Vidal 1968, 1970; Ohashi 1993; Gu and Spongberg 2003) and related original literature of each taxon. We have followed the most recent taxonomic treatments in the regional floras, such as Flora of China (Gu and Spongberg 2003) and Flore du Cambodge, du Laos et du Vietnam (Vidal 1968), and the unresolved names were recognized temporarily herein. The rules governing the holotype and lectotype followed McNeill (2014), Turland et al. (2018), and Turland (2019). Thanks to the rapid digitization of plant specimens around the world, we checked the type specimens via JSTOR (2020) or personal communications with the herbaria. A total of 184 images of type specimens have been evaluated, and these specimens are from the following herbaria, A, B, BM, C, E, HBG, K, L, M, MO, MSC, NY, P, TCD, U, UPS, CNMN, and WU. We also visited some herbaria in China and USA for the type material, CDBI, HITBC, IBK, IBSC, KUN, PE, SN, SYS, SZ, US, and WUK. The herbarium code followed Index Herbariorum (2020).

Taxonomy

***Rhaphiolepis* Lindl. in Bot. Reg.: ad t. 468. 1 Jul 1820 ('*Raphiolepis*') (nom. & orth. cons.).**
Chinese name: 石斑木属

= *Eriobotrya* Lindl., Trans. Linn. Soc. London 13: 96, 102. 1821. Type: *Eriobotrya japonica* (Thunb.) Lindl. ≡ *Mespilus japonica* Thunb. (= *Rhaphiolepis bibas* (Lour.) Galasso & Banfi).
= *Opa* Lour., Fl. Cochinch.: 304, 308. Sep 1790. Type (vide McVaugh 1956): *Opa metrosideros* Lour. (= *Rhaphiolepis indica* (L.) Lindl.).
=× *Rhaphiobotrya* Coombes, Plantsman n.s., 7(3): 164. 2008 (*Eriobotrya* Lindl. × *Rhaphiolepis* Lindl.).

Type. *Rhaphiolepis indica* (L.) Lindl.≡*Crataegus indica* L.

Description. ***Trees, small trees, or shrubs***, 40–100[–200] dm. ***Stems*** ca. 1, erect; bark gray-brown; short shoots absent; unarmed; hairy. ***Leaves*** persistent, cauline, simple; stipules deciduous or ± persistent, free, on the extreme base of petiole, rarely intrapetiolarly connate, subulate, caducous, or subulate, small, margin entire; petiole present; blade ± elliptic to oblong-lanceolate, 2–40 cm, leathery, margins flat or reflex, serrate, dentate or entire, venation penninerved (craspedodromous or camptodromous). ***Inflorescences*** in terminal racemes, panicles, or compound racemes, many-flowered. ***Pedicels*** present, short, or nearly absent. ***Flowers*****:** perianth and androecium epigynous, 15–20 mm diam.; hypanthium campanulate, cupular, tubular, or obconical, the free part inside lined with an intrastaminal disk, open at the top; sepals 5, persistent or caducous; petals 5, white, yellow, or pink, obovate or orbicular, base clawed; stamens 15–20(-40); ovary inferior, carpels 2–5, ventrally and laterally connate (in upper part ventrally free), or completely connate with each other and dorsally adnate to the hypanthium, the hairy apex exposed; ovules normally 2 per carpel, rarely more; styles 2–5, connate at base and often pubescent; stigma truncate. ***Fruits*** a pome, yellowish, yellowish red, brown, dark purplish-brown, bluish, or purplish-black, subglobose, globose, or obovate, fleshy or dry, flesh mostly of hypanthial origin, sclereids absent or present, endocarp (core) thin, membranous. ***Seeds*** 1–3, large, with a thin but firm testa; endosperm absent, cotyledons thick. $2n = 34$.

About 45 species (Vidal 1965, 1968, 1970; Kalkman 1973, 2004; Gu and Spongberg 2003) in East & Southeast Asia and the Himalayas, south to Borneo and Sumatra.

1. *Rhaphiolepis angustissima* (Hook.f.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.

Chinese name: 条叶枇杷

≡ *Eriobotrya angustissima* Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 372. 1878. Type: India. Khasia. alt. 5000 ft., without date, *J.D. Hooker & T. Thomson s.n.* (lectotype, designated by Vidal 1965, pg. 574: K [barcode K000758406]! "type"; isolectotype: BM [barcode BM000602192]!, "isotype").

≡ *Pyrus angustissima* (Hook.f.) M.F.Fay & Christenh., Global Fl. 4: 95. 2018. Type: Based on *Eriobotrya angustissima*.

Distribution. India (Mt. Khasia) and Vietnam.

2. *Rhaphiolepis balgooyi* (K.M.Wong & Ent) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.

Chinese name: 基纳巴卢枇杷

≡ *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).

Distribution. Malaysia (Borneo on Mt. Kinabalu and Mt. Tambuyukon).

3. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 南亚枇杷

≡ *Mespilus bengalensis* Roxb., Fl. Ind. (ed. 1832) 2: 510. 1832. Type: India. 1824, *N. Wallich 668.2* (neotype, designated by Vidal 1965, pg. 567: K [barcode K001111550]!, "lectotype"; isoneotype: P [barcode P02143255]!), "isolectotype". cf. note in Liu et al. 2020c, pg. 113).
≡ *Eriobotrya bengalensis* Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 371. 1878. Type: Based on *Mespilus bengalensis*.

3a. *Rhaphiolepis bengalensis* f. *bengalensis*
Chinese name: 南亚枇杷(原变型)

= *Alsodeia grandis* Miq., Fl. Ned. Ind., Eerste Bijv. 3: 391. 1861. Type: Indonesia. "Sumatra orient. in regionibus interioribus prov. Palembang, prope Muara-enim", *s.coll. HB4023* (holotype: U [barcode U0005827]!).
= *Eriobotrya tinctoria* Kurz, Prelim. Rep. For. Veg. Pegu, App. B. 48. 1875, in clavi. Type: not designated.

Distribution. widely distributed from East Himalaya (Sikkim and Assam) through Bangladesh (Chittagong) to Myanmar, Laos, Cambodia, Vietnam, Malay Peninsula, Sumatra, and Borneo.

3b. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *angustifolia* (Cardot) B.B.Liu & J.Wen, comb. nov.
urn:lsid:ipni.org:names:77210691-1
Chinese name: 窄叶南亚枇杷

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. var. *angustifolia* Cardot, Notul. Syst. (Paris) 3: 371. 1918. Type: China. Yunnan: Hay-y près Lou-Lan, Pau Ngueou, 29 March 1907, *F. Ducloux 4719* (lectotype, designated by Liu et al. 2020c, pg. 103: P [barcode P02143256]!; isolectotype: P [barcode P02143257]!).

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *angustifolia* (Cardot) J.E.Vidal, Adansonia, n.s. 5: 569. 1965. Type: Based on *Eriobotrya bengalensis* var. *angustifolia*.

Distribution. China (Yunnan).

3c. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *contracta* B.B.Liu & J.Wen, f. nov.
urn:lsid:ipni.org:names:77210693-1
Chinese name: 聚花南亚枇杷

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *contracta* J.E.Vidal, Adansonia, n.s. 5: 569. 1965, *nom. inval.* Type: Vietnam. Annam: sommet du Nui Bach Ma, Station d'altitude un peu au Sud de Huê Alt. 1400–1500 m, Le 6 September 1938, *E. Poilane 27620* (holotype: P [barcode P03650248]!, isotype: P [barcode P03650249]!). Annam: Nui Bach Ma Station d'altitude de Huê 1400–1500 m, d'alt. Lé 12 December 1940, *E. Poilane 31104* (paratypes: P [barcode P03650258, P03650259]!). Bachma (Centre-Vietnam), 23 August 1943, *J.E. Vidal 36* (paratype: P [barcode P03650257]!). Annam: Col des nuages près Tourane Forêt 900 m, d'altitude Le 14 September 1923, *E. Poilane 7986* (paratypes: P [barcode P03650251, P03650253]!). Prov. Quang Nam: *E. Poilane 11* (syntype). Annam: Massif du Ngok Guga près de Dakto prov. du Kontum Le 25 February 1946, alt. 1000 m, *E. Poilane 35584* (paratypes: P [barcode P03650240, P03650241)!). S. Annam: massif du Hon Ba, 31 August 1918, *A. Chevalier 38718* (paratype: P [barcode P03650239]!). Sud. Annam: Prov. Nha Trang: Massif du Hon Ba, 1000–1100 m alt., 4 September 1918, *A. Chevalier 38832* (paratypes: P [barcode P03650246, P03650247]!). Prov. Nha Trang: Massif du Hon Ba, 1000–1500 m alt., 4 September 1918, *A. Chevalier 38892* (paratypes: P [barcode P03650233, P03650238, P03650245]). [Note A]

Distribution. Vietnam.

Note A. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *contracta* B.B.Liu & J.Wen, f. nov.** Vidal (1965) cited nine collections as syntypes in the protologue, but he did not indicate a single type. *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *multinervata* J.E.Vidal was thus invalidly published (Art. 40.1: Turland et al. 2018). We validated *Rhaphiolepis bengalensis* f. *multinervata* as a new form by reference to designating one duplicate (P03650248) of the first collections cited by Vidal (1965) as the holotype, and the diagnosis followed Vidal (1965).

3d. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *gigantea* (J.E.Vidal) B.B.Liu & J.Wen, comb. nov.
urn:lsid:ipni.org:names:77210695-1
Chinese name: 大叶南亚枇杷

** A forma typica differt inflorescentiis contractis, multo brevioribus (Vidal 1965).

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *gigantea* J.E.Vidal, Adansonia, n.s. 5: 569. 1965. Type: Myanmar. *Parkinson 314* (holotype: K)

Distribution. Myanmar.

3e. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *intermedia* B.B.Liu & J.Wen, f. nov.
urn:lsid:ipni.org:names:77210697-1
Chinese name: 四柱南亚枇杷

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *intermedia* J.E.Vidal, Adansonia, n.s. 5: 568. 1965, *nom. inval.* 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 Burmah", April 1919, *G. Forrest 17845* (holotype: E [barcode E00072976]!; isotypes: E [barcode E00072977]!, K). Région de Huê, "Bachma, Centre Vietnam, 1200 m", 21 January 1944, *J.E. Vidal 35A* (paratype: P [barcode P03650235]!); "Km. 13, Route de Bachma, Centre Vietnam, 1200 m", 12 March 1944, *J.E. Vidal 35B* (paratype: P [barcode P03650234]!); "Km. 12.5 Route de Bachma Centre Vietnam", 6 April 1944, *J.E. Vidal 35C* (paratype: P [barcode P03650231]!). [Note B]

Diagnosis. A forma typica differt stylis 4 frequentioribus (Vidal 1965).

Distribution. Myanmar.

Note B. Four gatherings were cited in the protologue by Vidal (1965), but none of them was not designated as type. *Eriobotrya bengalensis* f. *intermedia* was thus invalidly published (Art. 40.1: Turland et al. 2018) despite the lectotypification designated by Liu et al. (2020c) for this name. We validated *Rhaphiolepis bengalensis* f. *intermedia* as a new form by reference to designating one duplicate (E00072976) of the first gathering cited by Vidal (1965) as the holotype, and the diagnosis followed Vidal (1965).

3f. *Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen f. *multinervata* B.B.Liu & J.Wen, f. nov.
urn:lsid:ipni.org:names:77210699-1
Chinese name: 多脉南亚枇杷

≡ *Eriobotrya bengalensis* (Roxb.) Hook.f. f. *multinervata* J.E.Vidal, Adansonia, n.s. 5: 569. 1965, *nom. inval.* Type: Thailand. Siam, Chiang Mai, Doi Angka (now as Doi Inthanon), ca. 1400 m, 16 July 1922, *A.F.G. Kerr 6293* (holotype: P [barcode P03650228]!). Siam: Doi Pa Kao, ca. 1200 m, 7 May 1921, *A.F.G. Kerr 5372* (paratype: P [barcode P03650229]!). 1964, *B. Hansen et al. 10797* (paratypes: C, P [barcode P03650232]!). Siam. Kanchanaburi: Si Sawat, ca. 600 m, 17 January 1926, *A.F.G. Kerr 10235* (paratypes: K, P [barcode P03650230]!). [Note C]

Distribution. Thailand.

Diagnosis. A forma typica differt lamina venis utrinque 15–20 (Vidal 1965).

Note C. *Eriobotrya bengalensis* f. *multinervata* was invalidly published (Art. 40.1: Turland et al. 2018), because four gatherings were cited in the protologue by Vidal (1965), *A.F.G. Kerr 6293*, *A.F.G. Kerr 5372*, *A.F.G. Kerr 10235*, and *B. Hansen et al. 10797*. We herein validated *Rhaphiolepis bengalensis* f. *multinervata* as a new form by reference to designating *A.F.G. Kerr 6293* (P03650228) as the holotype which was in a better condition, and the diagnosis followed Vidal (1965).

4. *Rhaphiolepis bibas* (Lour.) Galasso & Banfi, Ital. Botanist 9: 66. 2020.
Chinese name: 枇杷

≡ *Crataegus bibas* Lour., Fl. Cochinch. 1: 319. 1790. Type: Plukenet, L. 1705. *Amaltheum botanicum* pag. 26. tab. 371. fig. 2. (**lectotype, designated here**). [Note D]
≡ *Pyrus bibas* (Lour.) M.F.Fay & Christenh., Global Fl. 4: 98. 2018. Type: Based on *Crataegus bibas*.
= *Mespilus japonica* Thunb., Fl. Jap. (Thunberg) 206. 1784. Type: Japan. *Thunberg* s.n. (holotype: UPS-THUNB accession no. 11908).
≡ *Eriobotrya japonica* (Thunb.) Lindl., Trans. Linn. Soc. London 13: 102. 1821. Type: Based on *Mespilus japonica*.
≡ *Photinia japonica* (Thunb.) Benth. & Hook.f. ex Asch. & Schweinf., Mém. Inst. Égypt. [Illustr. Fl. Egypt.]. Type: Based on *Mespilus japonica*.
≡ *Rhaphiolepis loquata* B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020. nom. illeg. Type: Based on *Mespilus japonica*.

Distribution. Native in Chongqing (Nanchuan) and Hubei (Yichang) of China. As an economically important fruit, this species has been widely cultivated in central & south China, as well as in Japan, Korea, India, and some countries in Southeast Asia.

Note D. Loureiro (1790) described *Crataegus bibas* Lour. in his "Flora Cochinchinensis" and cited one illustration (Fig. 1) published in Plukenet's book "Amaltheum botanicum" in the protologue. This is because Loureiro had his collections of specimens that may contain (or may have contained) specimens of this species. This illustration is thus designated as the lectotype of *C. bibas* herein.

5. *Rhaphiolepis brevipetiolata* J.E.Vidal, Fl. Cambodge, Laos & Vietnam Fasc. 6, 88. 1968, in adnot.
Chinese name: 短柄石斑木

Type. Vietnam. "Prov. de Khanh Hoa (Nha Trang): région de Nha Trang, 1600 m", 19 May 1922, *E. Poilane 3464* (**lectotype, designated here**: P [barcode P03206033]; isolectotype: P [barcode P03206032]). [Note E]

Distribution. Vietnam (Nha Trang).

Figure 1. Lectotype of *Crataegus bibas*.

Note E. Vidal (1968) described *Rhaphiolepis brevipetiolata* and cited the collection *E. Poilane 3464* deposited in herbarium P as type in the protologue, however, we found two duplicates in the herbarium P. A lectotype is needed to be chosen from these two duplicates (Turland et al. 2018: Art. 9.15). We herein designated the sheet (P03206033) that was annotated by Vidal as the lectotype. Furthermore, this species has never been well treated since its publication. Although we herein recognized this species, a further study will be needed to clarify the identity of *R. brevipetiolata*.

6. *Rhaphiolepis cavaleriei* (H.Lév.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.

Chinese name: 大花枇杷

≡ *Hiptage cavaleriei* H.Lév., Repert. Spec. Nov. Regni Veg. 10: 372. 15 March 1912. Type: China. Kouy-Tcheou (Guizhou): Pin-fa, montagne en pente, 20 May 1907, *J. Cavalerie 3220* (lectotype, designated by Liu et al. 2020c, pg. 112: E [barcode E00011330]!; isolectotypes: A [barcode 00055347]!, E [barcode E00284669]!, K [barcode K000758387]!, P [barcode P02143258, P02143259]!).

≡ *Eriobotrya cavaleriei* (H.Lév.) Rehder, J. Arnold Arbor. 13: 307. 1932. Type: Based on *Hiptage cavaleriei*.

≡ *Pyrus athenae* M.F.Fay & Christenh., Global Fl. 4: 96. 2018. Type: Based on *Hiptage cavaleriei*.

= *Eriobotrya grandiflora* Rehder & E.H.Wilson, Pl. Wilson. (Sargent) 1(2): 193. 30 April 1912. Type: China. Western Szech'uan (Sichuan): alt. 1600m, May 1904, *E.H. Wilson 3506* (lectotype, designated by Liu et al. 2020c, pg. 107: A [barcode 00026472]!; isolectotypes: A [barcode 00026473]!, BM [barcode BM000602187]!, HBG [barcode HBG511040]!, K [barcode K000758386]!, P [barcode P02143267]!).

≡ *Eriobotrya deflexa* (Hemsl.) Nakai var. *grandiflora* (Rehder & E.H.Wilson) Nakai, J. Arnold Arbor. 5(2): 72. 1924. Type: Based on *Eriobotrya grandiflora*.

= *Eriobotrya brackloi* Hand.-Mazz., Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 59: 102. 1922. Type: China. Kwangtung (Guangdong): In silva ad 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 by Liu et al. 2020c, pg. 104: WU [barcode WU0059394]!; isolectotype: A [barcode 00026469]!).

≡ *Eriobotrya cavaleriei* (H.Lév.) Rehder var. *brackloi* (Hand.-Mazz.) Rehder, J. Arnold Arbor. 13(3): 308. 1932. Type: Based on *Eriobotrya brackloi*.

= *Eriobotrya brackloi* Hand.-Mazz. var. *atrichophylla* Hand.-Mazz., Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 59: 103. 1922. 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 by Liu et al. 2020c, pg. 104: WU [barcode WU0059395]!; isolectotype: A [barcode 00026471]!).

Distribution. China (Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, and Sichuan) and North Vietnam (Hòa Bình and Lao Cai).

7. *Rhaphiolepis condaoensis* (X.F.Gao, Idrees & T.V.Do) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 昆岛枇杷

≡ *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!).

Distribution. Southeast Vietnam (Ba Ria-Vung Tau: Con Dao National Park).

8. *Rhaphiolepis* × *daduheensis* (H.Z.Zhang ex W.B.Liao, Q.Fan & M.Y.Ding) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 大渡河枇杷

≡ *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!).

Distribution. As a putative natural hybrid between *Rhaphiolepis bibas* (=*Eriobotrya japonica*) and *R. prinoides* (=*E. prinoides*), this species is restricted to Daduhe River Basin in Sichuan, China (Ding et al. 2015).

9. *Rhaphiolepis deflexa* (Hemsl.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 台湾枇杷

≡ *Photinia deflexa* Hemsl., Ann. Bot. 9: 153. 1895. Type: China. Formosa (Taiwan): Bankinsing, May 1894, *A. Henry 498* (lectotype, designated by Vidal 1965, pg. 566: K [barcode K000758389]! "type"; isolectotype: A [barcode 00026740]!, "isotype").
≡ *Eriobotrya deflexa* (Hemsl.) Nakai, Bot. Mag. (Tokyo) 30: 18, in adnot. 1916. Type: Based on *Photinia deflexa.*
= *Photinia buisanensis* Hayata, Icon. Pl. Formosan. 3: 100. 1913. Type: not designated.
≡ *Eriobotrya deflexa* (Hemsl.) Nakai f. *buisanensis* (Hayata) Nakai, Bot. Mag. (Tokyo) 30(349): 18. 1916. Type: Based on *Photinia buisanensis.*

≡ *Eriobotrya buisanensis* (Hayata) Kaneh., Formosan Trees 218. 1918. Type: Based on *Photinia buisanensis*.
≡ *Eriobotrya deflexa* Nakai var. *buisanensis* (Hayata) Hayata, Catal. Governm. Herb. Formos. 246. 1930. Type: Based on *Photinia buisanensis.*
≡ *Eriobotrya buisanensis* (Hayata) Makino & Nemoto, Fl. Japan., ed. 2 (Makino & Nemoto) 464. 1931. Type: Based on *Photinia buisanensis.*
= *Eriobotrya deflexa* Nakai var. *koshunensis* Kaneh. & Sasaki, Catal. Gov't Herb. Formosa 246. 1930. Type: not designated.
≡ *Eriobotrya deflexa* Nakai f. *koshunensis* (Kaneh. & Sasaki) H.L.Li, Lloydia 14(4): 232. 1951. Type: Based on *Eriobotrya deflexa* var. *koshunensis.*

Distribution. China (Guangdong, Hainan, and Taiwan) and Vietnam (Nha Trang).

10. *Rhaphiolepis dubia* (Lindl.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 喜马拉雅枇杷

≡ *Photinia dubia* Lindl., Trans. Linn. Soc. London 13(1): 104, t. 10. 1821. Type: Nepal. *N. Wallich 668.1* (neotype, designated by Liu et al. 2020c, pg. 113: K [barcode K001111549]!; isoneotypes: BM [barcode BM000521995]!, E [barcode E00011335]!).
≡ *Eriobotrya dubia* (Lindl.) Decne., in Nouv. Arch. Mus. Hist. Nat. Ser. I, x. 145. 1874. Type: Based on *Photinia dubia*.
= *Mespilus tinctoria* D.Don, Prodr. Fl. Nepal. 238. 1825. Type: not designated.

Distribution. Bhutan, India (Sikkim), Myanmar (Kachin, Mandalay, and Shan), and Nepal.

11. *Rhaphiolepis elliptica* (Lindl.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 椭圆枇杷

≡ *Eriobotrya elliptica* Lindl., Trans. Linn. Soc. London 13(1): 102. 1821. Type: Nepal. Narainhetty. 1 February 1803, *F. Buchanan-Hamilton s.n.* (holotype: BM [barcode BM000521994]!).
≡ *Cotoneaster ellipticus* (Lindl.) Loudon, Encyc. Pl. 1208. 1841. Type: Based on *Eriobotrya elliptica*.
≡ *Pyrus elliptica* (Lindl.) M.F.Fay & Christenh., Global Fl. 4: 102. 2018. Type: Based on *Eriobotrya elliptica*.

11a. *Rhaphiolepis elliptica* var. *elliptica*
Chinese name: 椭圆枇杷(原变种)

= *Mespilus cuila* Buch.-Ham. ex D.Don, Prodr. Fl. Nepal. 238. 1825, nom. nov. superfl. Type: Based on *Eriobotrya elliptica* Lindl.

Distribution. China (Tibet) and Nepal (Narainhetty).

11b. *Rhaphiolepis elliptica* (Lindl.) B.B.Liu & J.Wen var. *petelotii* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 老街椭圆枇杷

≡ *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 by Liu et al. 2020c, pg. 105: P [barcode P02143261]!; isolectotype: P [barcode P02143262]!).

Distribution. N Vietnam (Lao Cai).

12. *Rhaphiolepis ferruginea* F.P.Metcalf, Lingnan Sci. J. 18: 509. 1939, "*Raphiolepis*".
Chinese name: 锈毛石斑木

≡ *Pyrus sodomacea* M.F.Fay & Christenh., Global Fl. 4: 121. 2018. Type: China. Guangdong: Tapu District, Tung Koo Shan, 8–29 September 1932, *W.T. Tsang 21587* (holotype: A [barcode 00032516]!; isotypes: K [barcode K000758194]!, P [barcode P02143130]!).

12a. *Rhaphiolepis ferruginea* var. *ferruginea*
Chinese name: 锈毛石斑木(原变种)

Distribution. China (Fujian, Guangdong, Guangxi, and Hainan).

12b. *Rhaphiolepis ferruginea* F.P.Metcalf var. *serrata* F.P.Metcalf, Lingnan Sci. J. 18: 511. 1939, "*Raphiolepis*".
Chinese name: 齿叶锈毛石斑木

Type. China. Guangdong: Lung-tau Mt., near Iu Village, May 22-July 5, 1924, *To & Tsang 12546* (**lectotype, designated here**: A [barcode 00032518]!; isolectotype: A [barcode 00032517, 00032519]!). [Note F]

Distribution. China (Fujian, Guangdong, and Guangxi).

Note F. *To & Tsang 12546* was designated as the type in the protologue. We located three specimens in herbarium A, therefore, they are syntypes. A subsequent lectotypification is necessary. We designated the sheet (A00032518) in a better condition as the lectotype herein.

13. *Rhaphiolepis fulvicoma* (Chun ex W.B.Liao, F.F.Li & D.F.Cui) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 10. 2020.
Chinese name: 薄叶枇杷

≡ *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 IBK00060958, IBK00060976]!, IBSC [barcode 0298975]!, KUN [barcode 0116268]!, PE [barcode 00799336]!, SZ [barcode 00194329]!).

Distribution. China (Guangdong).

14. *Rhaphiolepis glabrescens* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 无毛枇杷

≡ *Eriobotrya glabrescens* J.E.Vidal, Adansonia sér. 2, 5: 554. 1965. Type: Myanmar. Kachin State: "N. Birmanie, Triangle, Hkinlum village, 2500 m, en fleurs", 4 April 1953, *F. Kingdon-Ward 20616* (lectotype, designated by Liu et al. 2020c, pg. 106: BM [barcode BM000602189]; isolectotypes: A [barcode 00026482]!, E [barcode E00011336]!).
≡ *Pyrus serpentae* M.F.Fay & Christenh., Global Fl. 4: 121. 2018. Type: Based on *Eriobotrya glabrescens*.

14a. *Rhaphiolepis glabrescens* var. *glabrescens*
Chinese name: 无毛枇杷(原变种)

Distribution. North Myanmar (Triangle, Centre Ouest, and Khai Yang).

14b. *Rhaphiolepis glabrescens* (J.E.Vidal) B.B.Liu & J.Wen var. *victoriensis* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 钝齿无毛枇杷

≡ *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 [barcode BM000602190]!).

Distribution. North Myanmar (Centre Ouest: Mt Victoria).

15. *Rhaphiolepis henryi* (Nakai) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 窄叶枇杷

≡ *Eriobotrya henryi* Nakai, J. Arnold Arbor. 5: 70. 1924. Type: China. Yunnan: Szemao (Simao), 1900, *A. Henry 13018* (lectotype, selected by Vidal 1965, pg. 562, first step "type"; second step, designated by Liu et al. 2020c, pg. 107: A [barcode 00026474]!; isolectotypes: K [barcode K000758388]!, NY [barcode 00436209]!).
≡ *Pyrus henryi* (Nakai) M.F.Fay & Christenh., Global Fl. 4:106. 2018. Type: Based on *Eriobotrya henryi*.

Distribution. China (Guizhou and Yunnan) and Myanmar (Pyin Oo Lwin).

16. *Rhaphiolepis hookeriana* (Decne.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 锡金枇杷

≡ *Eriobotrya hookeriana* Decne., Nouv. Arch. Mus. Hist. Nat. Ser. I 10:146. 1874. Type: India. Sikkim: Jongri, 13000–15000 ft., 10 August 1862, *T. Anderson 490* (lectotype, designated by Vidal 1965, pg. 563: P [barcode P02143268]!, "type"; isolectotype: GH [barcode 00026483]!, "isotype").
≡ *Pyrus hookeriana* (Decne.) M.F.Fay & Christenh., Global Fl. 4: 107. 2018. Type: Based on *Eriobotrya hookeriana*.

Distribution. Bhutan and India (Sikkim).

17. *Rhaphiolepis indica* (L.) Lindl., Bot. Reg. 6: t. 468. 1820.
Chinese name: 石斑木

≡ *Crataegus indica* L., Sp. Pl. 1: 477. 1753. Type: India. *s.coll. s.n.* (lectotype, designated by Vidal 1968, pg. 85: LINN [barcode LINN-HL643-11]! "type"). [Note G]

Note G. Vidal (1968) provided the lectotype for *Crataegus indica*, while he wrote it as type. Jarvis (2007) confirmed this typification and corrected it as lectotype.

17a. *Rhaphiolepis indica* var. *indica*
Chinese name: 石斑木(原变种)

= *Crataegus rubra* Lour., Fl. Cochinch. 1: 320. 1790. Type: China. Guangdong: "Habitat agrestis prope Cantone Sinarum", *J. Loureiro 320-3* (holotype: P [barcode P00150873]!).
≡ *Mespilus rubra* (Lour.) Stokes, Bot. Mat. Med. iii. 110. 1812. Type: Based on *Crataegus rubra*.
≡ *Rhaphiolepis rubra* (Lour.) Lindl., Coll. Bot. (Lindley) t. 3. 1821. Type: Based on *Crataegus rubra*.
= *Mespilus sinensis* Poir., Encyc. [J. Lamarck & al.] Suppl. 4. 70. 1816. Type: not designated.
≡ *Crataegus sinensis* (Poir.) Loisel., Herb. Amat. iv. t. 247. 1820. Type: Based on *Mespilus sinensis*.
≡ *Rhaphiolepis sinensis* (Poir.) M.Roem., Syn. Rosifl. 3: 114. 1847. Based on *Mespilus sinensis*.
= *Opa metrosideros* Lour., Fl. Cochinch. 1: 309. 1790. Type: "Cochinchina", *J. Loureiro s.n.* (holotype: BM [barcode BM000906022]!).
≡ *Syzygium metrosideros* (Lour.) DC., Prodr. [A. P. de Candolle] 3: 261. 1828. Type: Based on *Opa metrosideros*.
≡ *Eriobotrya metrosideros* (Lour.) A.Chev., Cat. Pl. Jard. Bot. Saigon 64. 1919. Type: Based on *Opa metrosideros*.
= *Rhaphiolepis crataegoides* M.Roem., Syn. Rosifl. 113. 1847. Type: not designated.
≡ *Rhaphiolepis indica* (L.) Lindl. var. *crataegoides* (M.Roem.) Nakai, J. Arnold Arbor. 5: 66. 1924. syn. nov. Type: Based on *Rhaphiolepis crataegoides*.
= *Rhaphiolepis fragrans* E.T.Geddes, Bull. Misc. Inform. Kew 1929(4): 108. 1929, "*Raphiolepis*". Type: Thailand. Kemarat, Ubon, Kan Kak, 100 m, 30 January 1924, *A.F.G. Kerr 8257A* (**lectotype, designated here:** K [barcode K000758246]!; isolectotypes: BM [barcode BM000602125]!, C [barcode C10017919]!, E [barcode E00011337]!). Siam: 100 m, January 1924, *A.F.G. Kerr 8257* (paratype: TCD [barcode TCD0016617]!) [Note H]
= *Rhaphiolepis gracilis* Nakai, J. Arnold Arbor. 5: 64. 1924. Type: China. Zhejiang: S. Yentang, 600 ft (ca. 183 m), August 26, 1920, *H.H. Hu 228* (**lectotype, designated here:** A [barcode 00032521]!). ibidem, 10 ft, August 24, 1920, *H.H. Hu 220* (syntype: A [barcode 00032520]!). [Note I]
= *Rhaphiolepis indica* (L.) Lindl. var. *latifolia* Cardot, Notul. Syst. (Paris) 3: 380. 1918. Type: not designated.
= *Rhaphiolepis indica* (L.) Lindl. var. *mekongensis* Cardot, Notul. Syst. (Paris) 3: 380. 1918. Type: Laos. "Bassin du Mékong: rivière Selamphao", 1876, *Harmand 202* (holotype: A [barcode 00032551]!).
≡ *Rhaphiolepis mekongensis* (Cardot) Tagane & H.Toyama, Acta Phytotax. Geobot. 66(2): 127. 2015. Type: Based on *Rhaphiolepis indica* var. *mekongensis*.

≡ *Pyrus mekongensis* (Cardot) M.F.Fay & Christenh., Global Fl. 4: 112. 2018. Type: Based on *Rhaphiolepis indica* var. *mekongensis*.

= *Rhaphiolepis kerrii* E.T.Geddes, Bull. Misc. Inform. Kew 4: 109. 1929, "*Raphiolepis*". Type: Thailand. Siam: "Kao Krading, 1200 m", 12 March 1924, *A.F.G. Kerr 8689* (**lectotype, designated here:** K [barcode K000758247]!; isolectotypes: BK (barcode BK257293)!, BM (barcode BM000602126)!). [Note J]

= *Rhaphiolepis loureiroi* Spreng., Syst. Veg., ed. 16 [Sprengel] 2: 508. 1825. Type: not designated.

= *Rhaphiolepis parvibracteolata* Merr., Philipp. J. Sci. 21: 344. 1922. Type: China. Hainan: Nodoa, roadside in wilderness, 250 m, 2 January 1922, *F.A. McClure 8015* (**lectotype, designated here:** US [barcode 00097487]!; isolectotypes: A [barcode 00032548, 00032549]!, NY [barcode 00415903]!). [Note K]

= *Rhaphiolepis rubra* (Lour.) Lindl. var. *foliosa* Nakai, J. Arnold Arbor. 5: 66. 1924. syn. nov. Type: not designated.

= *Rhaphiolepis rubra* (Lour.) Lindl. var. *lanceolata* Nakai, J. Arnold Arbor. 5: 67. 1924. syn. nov. Type: not designated.

= *Rhaphiolepis rugosa* Nakai, J. Arnold Arbor. 5: 62. 1924. Type: China. Jiangxi: Anfu County, Woo Kung Shan, 3500 ft, 20 April 1921, *H.H. Hu 711* (holotype: A [barcode 00032550]!).

Distribution. Cambodia, China, Indonesia, Japan, Laos, Thailand, and Vietnam.

Note H. Geddes (1929) described *Rhaphiolepis fragrans* and designated "*Kerr 8257A*" as the type. However, we located four sheets in four different herbaria (BM, C, E, K), all of which represent duplicates from a homogeneous collection. A lectotype is needed to be chosen from these four duplicates (Turland et al. 2018: Art. 9.15). We designated the duplicate in K (K000758246) in a better condition as the lectotype herein. It should be noted that Geddes (1930) described another name, *Pyrus fragrans* E.T.Geddes (in Bull. Misc. Inform. Kew 4: 161. 1930) with the same epithet.

Note I. Nakai (1924) described *Rhaphiolepis gracilis* and designated two collections as type, therefore, they are syntypes and a lectotype is necessary to be chosen from them (Art. 9.12: Turland et al. 2018). We designated the collection, *H.H. Hu 228* (A00032521) as the lectotype, as it is deposited in a better condition.

Note J. Geddes (1929) designated "*Kerr 8689*" as the type in his work "Contributions to the flora of Siam. Additamentum XXVI". We found three sheets of this collection in herbaria BK, BM, and K. According to Art. 9.15 (Turland et al. 2018), it is necessary for us to choose one of these three specimens as lectotype. We lectotypified the duplicate in K (K000758247) for *Rhaphiolepis kerrii*, as it was preserved in a better condition.

Note K. Merrill (1922) described *Rhaphiolepis parvibracteolata* and designated the collection, *F.A. McClure 8015*, as the type. However, we located four sheets in herbaria A, NY, and US, from which the lectotype could be chosen. As the duplicate deposited in the herbarium US (00097487) has the identification tag of ".....Rhaphiolepis parvibracteolata Merr. n. sp. ..... IDENTIFIED BY E. D. MERRILL .....", we herein designated this sheet as the lectotype.

17b. *Rhaphiolepis indica* (L.) Lindl. var. *phaeostemon* (Lindl.) Nakai, J. Arnold Arbor. 5: 65–66. 1924.
Chinese name: 长丝石斑木

≡ *Rhaphiolepis phaeostemon* Lindl., Coll. Bot. (Lindley) sub t. 3. 1821. Type. Not designated.

Distribution. China.

17c. *Rhaphiolepis indica* (L.) Lindl. var. *shilanensis* Yuen P.Yang & H.Y.Liu, Taiwania 47(2): 176. 2002.
Chinese name: 恒春石斑木

Type. China. Taiwan: Pingtung County, Nanjenshan, October 25, 1978, *K.S. Hsu & Y.P. Yang s.n.* (holotype: TAIF).

Distribution. China (Taiwan).

17d. *Rhaphiolepis indica* (L.) Lindl. var. *spiralis* (Blume) Nakai, J. Arnold Arbor. 4: 65. 1924.
Chinese name: 爪哇石斑木

≡ *Mespilus spiralis* Blume, Bijdr. Fl. Ned. Ind. 17: 1102, 1826. Type: Indonesia. Java: *C.L. Blume s.n.* (**lectotype, designated here:** L [barcode L0019710]!; isolectotypes: L [barcode L0019711, L0019712, L0019713]!, NY [barcode 00436082]!). [Note L]
≡ *Rhaphiolepis spiralis* (Blume) G.Don, Gen. Hist. 2: 602. 1832. Type: Based on *Mespilus spiralis*.
≡ *Crataegus spiralis* (Blume) Steud., Nomencl. Bot. [Steudel], ed. 2. i. 434. 1841. Type: Based on *Mespilus spiralis*.
≡ *Opa spiralis* (Blume) Seem., J. Bot. 1: 281. 1863. Type: Based on *Mespilus spiralis*.

Distribution. Indonesia (Java).

Note L. Blume (1826) described *Mespilus spiralis* in his book "Bijdragen tot de flora van Nederlandsch Indië", noting that the original material on which it was based was collected from a plant introduced from China in Java. We found five sheets representing the duplicates from one collection, four of them from herbarium L and one of them from herbarium NY. It will be necessary for us to choose one of them as the lectotype. According to Stafleu and Cowan (1976), Blume's original collections were deposited at L, second set at BO, and type mainly at L, but also at BO and P. One of the four duplicates deposited at L, therefore, will be a candidate for the lectotype. We designated the sheet (L0019710) in a better condition as the lectotype.

17e. *Rhaphiolepis indica* (L.) Lindl. var. *tashiroi* Hayata ex Matsum. & Hayata, J. Coll. Sci. Imp. Univ. Tokyo 22: 129. 1906.
Chinese name: 毛序石斑木

Type. Not designated.
Distribution. China (Taiwan).

17f. *Rhaphiolepis indica* (L.) Lindl. f. *impressivena* (Masam.) S.S.Ying, Coloured Illustr. Fl. Taiwan 1: 371. 1985.
Chinese name: 清水山石斑木

≡ *Rhaphiolepis impressivena* Masam., Trans. Nat. Hist. Soc. Formosa 30: 340. 1940. Type: China. Taiwan: "In rocky place between 1000–1200 m, Mt. Seisui-zan (Chingshui), Karengun, April 8, 1939", *T. Nakamura 365* (holotype: TI).

Distribution. China (Taiwan).

17g. *Rhaphiolepis indica* (L.) Lindl. f. *minor* (Makino) H.Ohashi, J. Jap. Bot. 63(1): 6. 1988.
Chinese name: 紧序石斑木

≡ *Rhaphiolepis umbellata* (Thunb.) Makino var. *minor* Makino, Bot. Mag. (Tokyo) 16: 14. 1902. Type: Japan. Prov. Mushashi: Tokyo, Bot. Gard. Koishikawa, cult. 19 May 1880, *T. Makino s.n.* (syntype: TI); 20 May 1890, T. Makino s.n. (syntype: TI); May 1896, *T. Makino s.n.* (syntype: TI).
≡ *Rhaphiolepis minor* (Makino) Koidz., Bot. Mag. (Tokyo) 23: 171. 1909. Type: Based on *Rhaphiolepis umbellata* var. *minor*.
≡ *Rhaphiolepis rubra* (Lour.) Lindl. var. *minor* (Makino) Nakai, J. Arnold Arbor. 5: 67. 1924. Type: Based on *Rhaphiolepis umbellata* var. *minor*.
≡ *Rhaphiolepis indica* (L.) Lindl. var. *minor* (Makino) Kitam., Acta Phytotax. Geobot. 26(1–2): 2. 1974. Type: Based on *Rhaphiolepis umbellata* var. *minor*.

Distribution. Japan (Tokyo).

18. *Rhaphiolepis integerrima* Hook. & Arn., Bot. Beechey Voy. 263. 1838.
Chinese name: 全缘石斑木

≡ *Opa integerrima* (Hook. & Arn.) Seem., J. Bot. 1: 281. 1863. Type: Japan. "Bonin [in] Loa Choo", *Beechey s.n.* (**lectotype, designated here:** K [barcode K000758198]!; isolectotypes: K [barcode K000758197, K000758199, K000758200]!).
≡ *Rhaphiolepis japonica* Siebold & Zucc. var. *integerrima* (Hook. & Arn.) Hook.f., Bot. Mag. 91: pl. 5510. 1865. Type: Based on *Opa integerrima*.

≡ *Rhaphiolepis integerrima* (Hook. & Arn.) Hort., ex Handl. Trees Kew Pt. i. [Polypet.] 217. 1894. Type: Based on *Opa integerrima*.
≡ *Rhaphiolepis umbellata* (Thunb.) Makino f. *integerrima* Rehder, Mitt. Deutsch. Dendrol. Ges. 24: 223. 1915. Type: Based on *Opa integerrima*.
≡ *Rhaphiolepis umbellata* (Thunb.) Makino var. *integerrima* (Hook. & Arn.) Masam., Sci. Rep. Kanazawa Univ. 3: 3. 1955. Type: Based on *Opa integerrima*.
≡ *Pyrus godiva* M.F.Fay & Christenh., Global Fl. 4: 105. 2018. Type: Based on *Opa integerrima*.
= *Rhaphiolepis mertensii* Siebold & Zucc., Fl. Jap. (Siebold) 1: 164. 1841. Type: not designated.
≡*Opa mertensii* (Siebold & Zucc.) Seem., J. Bot. 1: 281. 1863. Type: Based on *Rhaphiolepis mertensii*.
≡ *Rhaphiolepis umbellata* (Thunb.) Makino var. *mertensii* (Siebold & Zucc.) Makino, Bot. Mag. (Tokyo), 16(179): 14. 1902. Type: Based on *Rhaphiolepis mertensii*.
≡ *Rhaphiolepis integerrima* Hook. & Arn. var. *mertensii* (Siebold & Zucc.) Makino ex Koidz., J. Coll. Sci. Imp. Univ. Tokyo 34(2): 72. 1913. Type: Based on *Rhaphiolepis mertensii*.

Distribution. China (Taiwan) and Japan (Ryukyu Islands).

19. *Rhaphiolepis jiulongjiangensis* P.C.Huang & K.M.Li, J. Nanjing Forest. Univ. 13(4): 85. fig. IA, 1989, as '*Raphiolepis*'.
Chinese name: 九龙江石斑木

≡ *Pyrus jiulongjiangensis* (P.C.Huang & K.M.Li) M.F.Fay & Christenh., Global Fl. :4: 108. 2018. Type. China. Fujian: Hua'an County, Jiulongjiang, 120 m, April 1987, *K.M. Li 30439* (holotype: NJF).

Distribution. China (Fujian).

20. *Rhaphiolepis lanceolata* Hu, J. Arnold Arbor. 13: 335. 1932.
Chinese name: 细叶石斑木

≡ *Pyrus lanceolata* (Hu) M.F.Fay & Christenh., Global Fl. 4: 110. 2018. Type: China. Guangxi: "Seh-feng Dar-shan, S. Nanning, alt. 775 m", 21 Oct. 1928, *R.C. Ching 8060* (holotype: A [barcode 00032543]!; isotypes: A [barcode 00032544, 00032545]!, NY [barcode 00415902]!).
= *Rhaphiolepis hainanensis* F.P.Metcalf, Lingnan Sci. J. 18: 511. 1939. "*Raphiolepis*" Type: China. Hainan: Po-ting, 1300 ft, September 25, 1935, *F.C. How 73712* (**lectotype, designated here:** A [barcode 00032523]!). Dung Ka to Wen Fa Shi, 1700 ft, March 3, 1932, *N.K. Chun & C.L. Tso 43670* (syntypes: A [barcode

00032522]!, P [barcode P02143129]!). Yaichow, July 9, 1933, *H.Y. Liang 61989* (paratype). [Note M]

= *Rhaphiolepis indica* (L.) Lindl. var. *angustifolia* Cardot, Notul. Syst. (Paris) 3: 380. 1918. Type: Vietnam. "province de Quant-tri, vallée de haute rivière de Cu-Bi", *Eberhardt 2057* (holotype: P; isotypes: A [barcode 00032540]!).

Distribution. China (Guangdong?, Guangxi, and Hainan).

Note M. In the protologue of *Rhaphiolepis hainanensis*, two specimens was designated as types, they are *N.K. Chun & C.L. Tso 43670* as "type flower", and *F.C. How 73712* as "type fruit", which are therefore syntypes. Metcalf also cited the specimens *H.Y. Liang 61989* but without designating it as a type; it is, therefore, a paratype. It is necessary to choose one specimen as the lectotype from the two types; we, therefore, designated the "type fruit" specimen "*F.C. How 73712*" in a better condition as the lectotype herein.

21. *Rhaphiolepis laoshanica* (W.B.Liao, Q.Fan & S.F.Chen) B.B.Liu & J.Wen, comb. nov.

urn:lsid:ipni.org:names:77210700-1

Chinese name: 老山枇杷

≡ *Eriobotrya laoshanica* W.B.Liao, Q.Fan & S.F.Chen, PhytoKeys 146: 64 (2020). Type: China. Yunnan: Malipo County, Mount Laoshan, in thin forests on the slopes of limestone hills, 22°59.08'N, 104°50.48'E, 1160 m a.s.l., 14 October 2019, *Q. Fan 17570* (holotype: SYS; isotypes: IBSC, SYS).

Distribution. China (Yunnan).

22. *Rhaphiolepis latifolia* (Hook.f.) B.B.Liu & J.Wen, comb. nov. [Note N]

urn:lsid:ipni.org:names:77210701-1

Chinese name: 宽叶枇杷

≡ *Eriobotrya latifolia* Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. Type: Myanmar. Moalmayne, on Thoung Gyne, alt. 5000 ft., 1857, *T. Lobb s.n.* (holotype: K [barcode K000758400]!).

≡ *Pyrus herae* M.F.Fay & Christenh., Global Fl. 4: 106. 2018. Type: Based on *Eriobotrya latifolia*.

≡ *Rhaphiolepis herae* (M.F.Fay & Christenh.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020. Type: Based on *Eriobotrya latifolia*.

Distribution. Myanmar (Kayin and Taninthayi).

Note N. *Rhaphiolepis latifolia* Lodd. ex G.Don (in Hort. Brit. [Loudon] 202. 1830) was a naked name because this name has been published without descriptive statements in the protologue (Turland et al. 2018: Art. 38.1). *Rhaphiolepis latifolia* has

thus not been occupied. Although Liu et al. (2020b) made a new combination for this name as *R. herae* (M.F.Fay & Christenh.) B.B.Liu & J.Wen, the correct name of this taxon should be *R. latifolia*. We need to make another new combination as *Rhaphiolepis latifolia* (Hook.f.) B.B.Liu & J.Wen herein.

23. *Rhaphiolepis longifolia* (Decne.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 长叶枇杷

≡ *Photinia longifolia* Decne., Nouv. Arch. Mus. Hist. Nat. Ser. I 10: 142. 1874. Type: Bangladesh. East Bengal. Mishmi Hills, *W. Griffith 2093* (lectotype, designated by Liu et al. 2020c, pg. 113: P [barcode P02143220]!; isolectotype: K [barcode K000758398]!).
≡ *Eriobotrya longifolia* (Decne.) Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. Type: Based on *Photinia longifolia*.

Distribution. Bangladesh (East Bengal).

24. *Rhaphiolepis macrocarpa* (Kurz) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 大果枇杷

≡ *Eriobotrya macrocarpa* Kurz, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 41(4): 306. 1872. Type: not designated.

Distribution. Myanmar (Bago and Mandalay).

25. *Rhaphiolepis major* Cardot, Notul. Syst. (Paris) 3: 380. 1918.
Chinese name: 大叶石斑木

≡ *Pyrus major* (Cardot) M.F.Fay & Christenh., Global Fl. 4: 111. 2018. Type: China. Fujian: Wuyishan County, Kuantun (Guadun Village), April 1898, *M. de Latouche s.n.* (holotype: P [barcode P02143132]!; isotypes: A [barcode 00032547]!, K [barcode K000758196]!, P [barcode P02143133, P02143134]!)
= *Rhaphiolepis indica* (L.) Lindl. var. *grandifolia* Franch., Bull. Soc. Bot. France 46: 207. 1899. Type: not designated.

Distribution. China (Fujian, Jiangsu, Jiangxi, and Zhejiang).

26. *Rhaphiolepis malipoensis* (K.C.Kuan) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 麻栗坡枇杷

≡ *Eriobotrya malipoensis* K.C.Kuan, Acta Phytotax. Sin. 8(3): 231. 1963. 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]!).
≡ *Pyrus malipoensis* (K.C.Kuan) M.F.Fay & Christenh., Global Fl. 4: 111. 2018. Type: Based on *Eriobotrya malipoensis.*

Distribution. China (SE Yunnan).

27. *Rhaphiolepis merguiensis* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 丹老枇杷

≡ *Eriobotrya merguiensis* J.E.Vidal, Adansonia sér. 2, 5: 563. 1965. Type: Myanmar. "Birmanie, Mergui, Mout Myinmolekat, 1200 m, en fruits", 17 January 1930, *R.N. Parker 3098* (holotype: K [barcode K000758399]!).
≡ *Pyrus merguiensis* (J.E.Vidal) M.F.Fay & Christenh., Global Fl. 4: 112. 2018. Type: Based on *Eriobotrya merguiensis*.

Distribution. Myanmar (Mergui Archipelago and Taninthayi).

28. *Rhaphiolepis oblongifolia* (Merr. & Rolfe) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 矩圆叶枇杷

≡ *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 by Liu et al. 2020c, pg. 108: NY [barcode 00436215]!; isolectotype: US [barcode 00097490]!).

Distribution. Philippines (Mindanao).

29. *Rhaphiolepis obovata* (W.W.Sm.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 倒卵叶枇杷

≡ *Eriobotrya obovata* W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 10: 29. 1917. Type: China. Yunnan: in the vicinity of Yunnanfu, *E.E. Maire 2450* (holotype: E [barcode E00011331]!; isotypes: E [barcode E00284668]!, K [barcode K000758390]!).
≡ *Pyrus obovata* (W.W.Sm.) M.F.Fay & Christenh., Global Fl. 4: 114. 2018. Type: Based on *Eriobotrya obovata*.

Distribution. China (C Yunnan).

30. *Rhaphiolepis petiolata* (Hook.f.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 长柄枇杷

≡ *Eriobotrya petiolata* Hook.f., Fl. Brit. India [J. D. Hooker] 2(5): 370. 1878. Type: Sikkim, 9000 ft, *J.D. Hooker s.n.* (lectotype, designated by Liu et al. 2020c, pg. 109: K [barcode K000758394]).
≡ *Pyrus petiolata* (Hook.f.) M.F.Fay & Christenh., Global Fl. 4: 115. 2018. Type: Based on *Eriobotrya petiolata*.

Distribution. Bangladesh (Chittagong), Bhutan, India (Khasia and Sikkim), and Myanmar (Chin).

31. *Rhaphiolepis philippinensis* (S.Vidal) Kalkman, Blumea 21(2): 434. 1973.
Chinese name: 菲律宾石斑木

≡ *Eriobotrya philippinensis* S.Vidal, Revis. Pl. Vasc. Filip. 123. 1886. Type: Philippines. Luzon: "Santa Cruz, Pr. Zambales", *S. Vidal 1350* (**lectotype, designated here:** K [barcode K000758204]!, isolectotype: MA [barcode MA729287]!). "Infanta, Pr. Zambales", *S. Vidal 1353* (syntype: K [barcode K000758205]!, MA [barcode MA729288, MA729288-2]!). [Note O]
≡ *Pyrus philippinensis* (S.Vidal) M.F.Fay & Christenh., Global Fl. 4: 115. 2018. Type: Based on *Eriobotrya philippinensis*.
= *Photinia luzonensis* Merr., Publ. Bur. Sci. Gov. Lab. 17: 18. 1904. Type: Philippines. Luzon: Lamao River Mt. Mariveles, Provence of Bataan, Oct. 1903, *E.D. Merrill 3223* (**lectotype**, selected by Kalkman 1973, pg. 434, first step; **second step, designated here:** NY [barcode 00436125]!, isolectotypes: K [barcode K000758209]!, P [barcode P02143221]!). ibidem, January 1, 1904, *E.D. Merrill 3714* (syntypes: BM [barcode BM000602128]!, K [barcode K000758206]!). [Note P]
≡ *Eriobotrya luzonensis* (Merr.) Nakai, J. Arnold Arbor.5: 69. 1924. "luzoniensis". Type: Based on *Photinia luzonensis*.
= *Eriobotrya acuminatissima* Nakai, J. Arnold Arbor. 5: 71. 1924. Type: Philippines. Luzon: Panay Province, mt. Salibongbong Capiz, June 1919, *A. Martelino & G. Edano 35622* (lectotype, designated by Liu et al. 2020c, pg. 101: A [barcode

00026487]!; isolectotypes: BM [barcode BM000602127]!, L [barcode L0019714]!, P [barcode P02143260]).

Distribution. Philippines and Malaysia (Borneo: Sabah).

Note O. Vidal (1886) designated two collections as the type when he described *Eriobotrya philippinensis* in his work "Revision de Plantas Vasculares Filipinas", therefore, they are syntypes (Art. 9.6: Turland et al. 2018). We herein select the flowering specimen (*S. Vidal 1350*) as a candidate for the lectotype, however, two duplicates of this collection were located in herbaria K and MA. We must narrow the lectotype to a single sheet. In the 1870s Vidal took up posts in the forestry service of the Philippines, however, in 1883 he was back in Europe and visited the herbaria there including K (Vidal 1885). Therefore, we herein designate the sheet of *S. Vidal 1350* in K (barcode K000758204) as the lectotype.

Note P. Merrill (1904) described *Photinia luzonensis* and mentioned two collections (*E.D. Merrill 3223 & 3714*) in the protologue, and thus they are syntypes (Art. 9.6: Turland et al. 2018). Kalkman (1973) wrote as "Type: *Merrill 3223* (K, iso); paratype: *Merrill 3714* (BM, K)", which means that he designated *Merrill 3223* as the lectotype [first-step]. We located two duplicates in herbaria NY and K, respectively, and thus it is necessary to narrow the lectotype to one single specimen. 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 in NY (barcode 00436125) as the lectotype [second-step].

32. *Rhaphiolepis platyphylla* (Merr.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.

Chinese name: 克钦枇杷

≡ *Eriobotrya platyphylla* Merr., Brittonia 4(1): 80. 1941. Type: Myanmar. Upper Burma: hills east of Fort Hertz, 8 December 1931, *F. Kingdon-Ward 10205* (lectotype, designated by Liu et al. 2020c, pg. 109: A [barcode 00026485]!; isolectotypes: A [barcode 00026484]!, BM [barcode BM000602191]!).

≡ *Pyrus platyphylla* (Merr.) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: Based on *Eriobotrya platyphylla*.

Distribution. Myanmar (Kachin).

33. *Rhaphiolepis poilanei* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.

Chinese name: 越南枇杷

≡ *Eriobotrya poilanei* J.E.Vidal, Adansonia sér. 2, 5: 557. 1965. Type: Vietnam. Haut Donnai: Annam, Canton de Laouan Délégation de Djiriing, alt. 1200 m, 5 June 1933, *E. Poilane 22591* (lectotype, designated by Liu et al. 2020c, pg.

110: P [barcode P02143226]!; isolectotypes: C [barcode C10017885]!, L [barcode L0019414]!, P [barcode P02143227, P02143228]!).

≡ *Pyrus poilanei* (J.E.Vidal) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: Based on *Eriobotrya poilanei*.

Distribution. Vietnam (Haut-Donnai).

34. *Rhaphiolepis prinoides* (Rehder & E.H.Wilson) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 栎叶枇杷

≡ *Eriobotrya prinoides* Rehder & E.H.Wilson, Pl. Wilson. (Sargent) 1(2): 194. 1912. Type. China. Yunnan: Mengtze (Mengzi), alt. 1500 m, *A. Henry 9878* (lectotype, designated by Liu et al. 2020c, pg. 110: A [barcode 00026476]!; isolectotypes: A [barcode 00026478]!, B [barcode B 10 0295749]!, E [barcode E00011334]!, K [barcode K000758391, excluding the fruiting branch]!, MO [barcode MO-176739]!, NY [barcode 00436210, excluding the fruiting branch, 00436211, 00436212]!, US [barcode 00097491, excluding the fruiting branch]!).

≡ *Pyrus prinoides* (Rehder & E.H.Wilson) M.F.Fay & Christenh., Global Fl. 4: 116. 2018. Type: Based on *Eriobotrya prinoides*.

34a. *Rhaphiolepis prinoides* var. *prinoides*
Chinese name: 栎叶枇杷(原变种)

Distribution. China (Sichuan and Yunnan) and Laos.

34b. *Rhaphiolepis prinoides* (Rehder & E.H.Wilson) B.B.Liu & J.Wen var. *laotica* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 老挝栎叶枇杷

≡ *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, *E. Poilane 2243* (lectotype, designated by Liu et al. 2020c, pg. 110: P [barcode P02143229]!; isolectotypes: P [barcode P02143230, P02143231]!).

Distribution. Laos (Xièng Khouang).

35. *Rhaphiolepis salicifolia* Lindl., Coll. Bot. (Lindley) 1: sub t. 3. 1821.
Chinese name: 柳叶石斑木

≡ *Pyrus gomorrana* M.F.Fay & Christenh., Global Fl. 4: 105. 2018. Type: not designated.
= *Rhaphiolepis cheniana* F.P.Metcalf, Lingnan Sci. J. 18: 509. 1939. "*Raphiolepis*" Type: China. Fujian: Nanputo, Amoy, January 2, 1927, *H.H. Chung 5912* (holotype: A [barcode 00032513]!; isotype: A [barcode 00032514]!).
= *Rhaphiolepis kwangsiensis* Hu, J. Arnold Arbor. 13: 335. 1932. Type: China. Guangxi, Me-Kom, Seh-feng Dar-Shan, S. Nanning, 800m, *R.C. Ching 8360* (holotype: A [barcode 00032541]!, isotype: A [barcode 00032542]!).

Distribution. China (Fujian, Guangdong, and Guangxi) and Vietnam (Quang Tri and Thua Thiên).

36. *Rhaphiolepis salwinensis* (Hand.-Mazz.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 怒江枇杷

≡ *Eriobotrya salwinensis* Hand.-Mazz., Symb. Sin. Pt. 7(3): 475. 1933. 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 by Liu et al. 2020c, pg. 111: WU [barcode WU0059392]!; isolectotype: A [barcode 00026480]!).
≡ *Pyrus salwinensis* (Hand.-Mazz.) M.F.Fay & Christenh., Global Fl. 4: 120. 2018. Type: Based on *Eriobotrya salwinensis*.

Distribution. China (NE Yunnan and Tibet), India, and Myanmar.

37. *Rhaphiolepis seguinii* (H.Lév.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 11. 2020.
Chinese name: 小叶枇杷

≡ *Symplocos seguinii* H.Lév., Repert. Spec. Nov. Regni Veg. 10: 431. 1912. 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, pg. 575, first step "type"; second step, designated by Liu et al. 2020c, pg. 114: E [barcode E00011359]!; isolectotypes: P [barcode P02143232, P02143233]!).
≡ *Eriobotrya seguinii* (H.Lév.) Cardot ex Guillaumin, Bull. Soc. Bot. France 71: 287, in obs. 1924. Type: Based on *Symplocos seguinii*.

= *Eriobotrya pseudorhaphiolepis* Cardot, Notul. Syst. (Paris) 3: 371. 1918. nom. nov. superfl. Type: Based on *Symplocos seguinii* (Referring to the note Liu et al. 2020c, pg. 114).

Distribution. China (SW Guizhou and SE Yunnan).

38. *Rhaphiolepis serrata* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 齿叶枇杷

≡ *Eriobotrya serrata* J.E.Vidal, Adansonia sér. 2, 5: 558. 1965. Type: Laos. Xièng Khouang: Ban Na Poun, 1200 m, en fleurs, 19 November 1920, *E. Poilane 2345* (lectotype, designated by Liu et al. 2020c, pg. 111: P [barcode P02143235]!; isolectotypes: A [barcode 00026486]!, L [barcode L0019415]!, P [barcode P02143236, P02143237]!).
≡ *Pyrus serrata* (J.E.Vidal) M.F.Fay & Christenh., Global Fl. 4: 121. 2018. Type: Based on *Eriobotrya serrata*.

Distribution. China (Guangxi and Yunnan) and Laos (Xièng Khouang).

39. *Rhaphiolepis stipularis* (Craib) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 泰国枇杷

≡ *Eriobotrya stipularis* Craib, Bull. Misc. Inform. Kew 1929(4): 109. 1929. Type: Thailand [Siam]: Satul, Adang, 1500 m, on rocky ridge, 16 January 1928, *A.F.G. Kerr 14125* (lectotype, designated by Liu et al. 2020c, pg. 111: K [barcode K000758408]!; isolectotypes: ABD, BK [barcode BK257292]!, BM, K [barcode K000758408]!, TCD [barcode TCD0016606]!).
≡ *Pyrus stipularis* (Craib) M.F.Fay & Christenh., Global Fl. 4: 122. 2018. Type: Based on *Eriobotrya stipularis*.

Distribution. Cambodia and Thailand (Satun).

40. *Rhaphiolepis tengyuehensis* (W.W.Sm.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 腾越枇杷

≡ *Eriobotrya tengyuehensis* W.W.Sm., Notes Roy. Bot. Gard. Edinburgh 10: 30. 1917. 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 1965, pg. 571: E [barcode E00011333]!).
≡ *Pyrus tengyuehensis* (W.W.Sm.) M.F.Fay & Christenh., Global Fl. 4: 123. 2018. Type: Based on *Eriobotrya tengyuehensis*.

Distribution. China (NW Yunnan and Tibet) and Myanmar (Kachin).

41. *Rhaphiolepis umbellata* (Thunb.) Makino, Bot. Mag. (Tokyo) 16: 13. 1902.
Chinese name: 厚叶石斑木

≡ *Laurus umbellata* Thunb., Fl. Jap. (Thunberg) 175. 1784. Type: Japan. *Thunberg s.n.* (holotype: UPS-THUNB accession no. 9844).
≡ *Rhaphiolepis umbellata* C.K.Schneid., Ill. Handb. Laubholzk. i. 705. 1906. Type: Based on *Laurus umbellata*.
≡ *Rhaphiolepis indica* (L.) Lindl. subsp. *umbellata* (Thunb.) Hatus. 1970. Type: Based on *Laurus umbellata*.
≡ *Rhaphiolepis indica* (L.) Lindl. f. *umbellata* (Thunb.) Hatus., J. Geobot. 25(4): 126. 1978. Type: Based on *Laurus umbellata*.
≡ *Rhaphiolepis indica* (L.) Lindl. var. *umbellata* (Thunb.) H.Ohashi, J. Jap. Bot. 63(1): 4. 1988, pro parte. Type: Based on *Laurus umbellata*.

41a. *Rhaphiolepis umbellata* var. *umbellata*
Chinese name: 厚叶石斑木(原变种)

= *Mespilus sieboldii* Blume, Bijdr. Fl. Ned. Ind. 17: 1102. 1826. Type: not designated.
≡ *Photinia sieboldii* (Blume) G.Don, Gen. Hist. 2: 602. 1832. Type: Based on *Mespilus sieboldii*.
≡ *Rhaphiolepis sieboldii* (Blume) Hassk., Flora 25(2): 47. 1842. Type: Based on *Mespilus sieboldii*.
= *Rhaphiolepis japonica* Siebold & Zucc., Fl. Jap. (Siebold) 1: 162. 1841. Type: not designated.
≡ *Opa japonica* (Siebold & Zucc.) Seem., J. Bot. 1: 281. 1863. Type: Based on *Rhaphiolepis japonica*.
= *Rhaphiolepis ovata* Briot, Rev. Hort. [Paris]. 348. 1870–1871. Type: not designated.
≡ *Rhaphiolepis umbellata* (Thunb.) Makino f. *ovata* (Briot) C.K. Schneid., Ill. Handb. Laubholzk.1: 706. 1906. Type: Based on *Rhaphiolepis ovata*.
≡ *Rhaphiolepis mertensii* Siebold & Zucc. var. *ovata* (Briot) Nakai, Fl. Sylv. Kor. 6: 32. 1916. Type: Based on *Rhaphiolepis ovata*.

Distribution. China (Taiwan and Zhejiang), Korea, and Japan.

41b. *Rhaphiolepis umbellata* (Thunb.) Makino var. *liukiuensis* Koidz., J. Coll. Sci. Imp. Univ. Tokyo 34(2): 73. 1913.
Chinese name: 琉球厚叶石斑木

≡ *Rhaphiolepis indica* (L.) Lindl. subsp. *umbellata* (Thunb.) Hatus. var. *liukiuensis* Koidz., J. Coll. Sci. Imp. Univ. Tokyo 34 (2): 73. 1913. Type: South Korea. Jeju Island: "Quelpaert: in rupibus littoris", May 1907, *U. Faurie 1562* (**lectotype,** selected by Nakai 1924, pg. 64, first step "type"; **second step, designated here**: P [barcode P02143131]!; isolectotypes: A [barcode 00032546]!, B [barcode B 10 0278052]!). [Note Q]
≡ *Rhaphiolepis liukiuensis* (Koidz.) Nakai, J. Arnold Arbor. 5: 63. 1924. Type: Based on *Rhaphiolepis indica* subsp. *umbellata* var. *liukiuensis*.
≡ *Rhaphiolepis umbellata* (Thunb.) Makino subsp. *liukiuensis* (Koidz.) Masam. & Yanagih., Trans. Nat. Hist. Soc. Formosa XXXI: 274. 1941. Type: Based on *Rhaphiolepis indica* subsp. *umbellata* var. *liukiuensis*.
≡ *Rhaphiolepis indica* (L.) Lindl. var. *liukiuensis* (Koidz.) Kitam., Acta Phytotax. Geobot. 26(1–2): 2. 1974. Type: Based on *Rhaphiolepis indica* subsp. *umbellata* var. *liukiuensis.*

Distribution. China (Taiwan), Japan (Kyushu and Ryukyu), and Korea (Jeju Island).

Note Q. Koidzumi (1913) described *Rhaphiolepis umbellata* var. *liukiuensis* and did not mention any type material except the locality "Liukiu: Okinawasima; Korea: Quelpaert". Nakai designated the collection *U. Faurie 1562* as type, however, it should be lectotype [first-step] according to Art. 9.17 (Turland et al. 2018). This designation of the lectotype is found to refer to three sheets in herbaria A, B, and P, and needs to be further narrowed to a single one of these specimens by way of a subsequent lectotypification [second-step].

42. *Rhaphiolepis wardii* (C.E.C.Fisch.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 缅甸枇杷

≡ *Eriobotrya wardii* C.E.C.Fisch., Bull. Misc. Inform. Kew 1929(6): 205. 1929. 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).
≡ *Pyrus alabaster* M.F.Fay & Christenh., Global Fl. 4: 94. Feb. 2018. Type: Based on *Eriobotrya wardii*.
≡ *Pleiosorbus wardii* (C.E.C.Fisch.) Rushforth, Phytologia 100(4): 233. 21 Dec. 2018. Type: Based on *Eriobotrya wardii*.

Distribution. Myanmar (Kachin and North Triangle).

43. *Rhaphiolepis williamtelliana* (M.F.Fay & Christenh.) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 香花枇杷

≡ *Eriobotrya fragrans* Champ., Hooker's J. Bot. Kew Gard. Misc. 4: 80. 1852. Type: China. Hong Kong: Mt. Victoria, *J.G. Champion s.n.* (lectotype, designated by Vidal 1965, pg. 557: K [barcode K000758384]! "type").
≡ *Pyrus williamtelliana* M.F.Fay & Christenh., Global Fl. 4: 126. 2018. Type: Based on *Eriobotrya fragrans*.

43a. *Rhaphiolepis williamtelliana* var. *williamtelliana*
Chinese name: 香花枇杷(原变种)

Distribution. China (Guangdong, Guangxi, Hainan, Hongkong, and Tibet) and Vietnam.

43b. *Rhaphiolepis williamtelliana* (M.F.Fay & Christenh.) B.B.Liu & J.Wen var. *furfuracea* (J.E.Vidal) B.B.Liu & J.Wen, Front. Plant Sci. 10-1731: 12. 2020.
Chinese name: 粉叶香花枇杷

≡ *Eriobotrya fragrans* Champ. ex Benth. 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 by Liu et al. 2020c, pg. 106: P [barcode P02143263]!; isolectotypes: A [barcode 00026481]!, C [barcode C10017884]!, K [barcode K000758407]!, L [barcode L0019413]!, P [barcode P02143264, P02143265, P02143266]!).

Distribution. Vietnam (Nha Trang).

44. *Rhaphiolepis wuzhishanensis* W.B.Liao, R.H.Miao & Q.Fan, Novon 17(4): 429 (-431, fig. 1). 2007.
Chinese name: 五指山石斑木

Type. China. Hainan: Mt. Wuzhishan, 1830 m, 5 August 2005, *Q. Fan 6087* (holotype: SYS; isotype: MO).

Distribution. China (Hainan).

45. *Rhaphiolepis yui* B.B.Liu & J.Wen, nom. nov. [Note R]
urn:lsid:ipni.org:names:77210703-1
Chinese name: 广西枇杷

≡ *Eriobotrya kwangsiensis* Chun ex X.H.Yang & S.Q.Lin, Acta Hortic. 750: 221. 2007. Type: China. Guangxi: Xiangzhou County, Shangguchen, Wuzhishan, 18 June 1936, *C. Wang 39423* (holotype: IBK [barcode IBK00061038, herbarium accession number 35925]!; isotypes: PE [barcode 00799311]!, SZ [barcode 00194327]). [Note S]

Distribution. China (Guangxi).

Note R. The species epithet "kwangsiensis" has been pre-occupied by *Rhaphiolepis kwangsiensis* Hu, J. Arnold Arbor. 13: 335. 1932, thus a new name is needed for this taxon (Turland et al. 2018). The epithet is given in honor of the late Prof. Te-Tsun Yu (PE) for his great contributions to the taxonomy of Rosaceae.

Note S. Yang and Lin (2007) provided the following type information in the protologue, "Guangxi: Shangguchen. 1936. 6. *C. Wang 35925* (Holotypus, TBK)". According to the image of holotype provided in the protologue, the holotype is *C. Wang 39423*, which was deposited in the herbarium IBK rather than TBK (Fig. 2). The number "35925" cited in Yang and Lin (2007) was the herbarium accession number of the holotype.

Artificial hybrid species:

***Rhaphiolepis* × *delacourii* André, Rev. Hort. [Paris]. 72: 698. 1900.**

≡ *Pyrus* × *delacourii* (André) M.F.Fay & Christenh., Global Fl. 4: 101. 2018. Type: France. Golfe-Juan, May 1900, *s.coll. s.n.* (holotype: K [barcode K000758248]!). [Note T]

Note T. This hybrid species was produced by M. Delacour, a gardener of the Villa Allerton, in Cannes, and it was hybridized between *Rhaphiolepis indica* and *R. ovata* (= *R. umbellata*).

Doubtful names associated with *Rhaphiolepis*:

Photinia luzonensis Merr. var. *acuminatissima* Merr., nom. nud.

Rhaphiolepis crassifolia Hort. ex Voll & Brade, Rodriguésia i. No. 3, 61. 1935, nom. nud.

Rhaphiolepis hiiranensis Kaneh., Formosan Trees, ed. rev. 276. 1936, anglice et japonice. ≡ *Rhaphiolepis indica* (L.) Lindl. var. *hiiranensis* (Kaneh.) H.L.Li, Lloydia 4: 235.

Figure 2. Holotype of *Rhaphiolepis yui* (IBK [barcode IBK00061038]).

1952. ≡ *Rhaphiolepis umbellata* (Thunb.) Makino var. *hiiranensis* (Kaneh.) Hatus., Fl. Ryukyus 312. 1971. nom. nud.

Rhaphiolepis indica (L.) Lindl. var. *insularis* Hatus., Fl. Ryukyus 844. 1971. nom. illeg. & nom. nud.

Rhaphiolepis laevis Lodd. ex G.Don, Hort. Brit. [Loudon] 202. 1830, "*Raphiolepis*". nom. nud.

Rhaphiolepis latifolia Lodd. ex G.Don, Hort. Brit. [Loudon] 202. 1830, "*Raphiolepis*". nom. nud.

Rhaphiolepis pheostemonia St.-Lag., Ann. Soc. Bot. Lyon vii. 133. 1880. nom. nud.

Acknowledgments

We thank Everly Robin (US) for assistance in obtaining literature from other libraries, the reviewer Gerwin Kasperek (Frankfurt, Germany) and subject editor Alexander Sennikov for their constructive comments. We also thank Bing Liu (PE) and Yun-Fei Deng (IBSC) for their advice on the nomenclature, and Fang Wen (IBK) and Chun-Rui Lin (IBK) for providing the holotype image of *Rhaphiolepis yui*. This research is supported by the National Natural Science Foundation of China (Grant No. 31620103902).

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PhytoKeys 154: 57–102 (2020)
doi: 10.3897/phytokeys.154.49615
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Synopsis of *Schizanthus* Ruiz & Pav. (Solanaceae), a genus endemic to the southern Andes

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Academic editor: S. Knapp | Received 23 December 2019 | Accepted 5 May 2020 | Published 4 August 2020

Citation: Morales-Fierro V, Muñoz-Schick M, Moreira-Muñoz A (2020) Synopsis of *Schizanthus* Ruiz & Pav. (Solanaceae), a genus endemic to the southern Andes. PhytoKeys 154: 57–102. https://doi.org/10.3897/phytokeys.154.49615

Abstract

We present a taxonomic synopsis of the South American genus *Schizanthus* Ruiz & Pav. (Solanaceae), within which we recognise seventeen taxa (14 species with three infraspecific taxa). The genus is mainly distributed in Chile between the coast of the Atacama Desert and the southern temperate forests, while two species occur in the Argentinian Provinces of Mendoza and Neuquén. This taxonomic treatment is based on the analysis of herbarium specimens from 30 different herbaria. For each accepted species we provide details of type specimens and synonymy, key characters, habitat, distribution information and presence in public or private protected areas. We also incorporate a list of representative localities from examined material. We here described three new taxa: *Schizanthus porrigens* Graham ex Hook. subsp. *borealis* V.Morales & Muñoz-Schick, **subsp. nov.**, *Schizanthus carlomunozii* V.Morales & Muñoz-Schick, **sp. nov.** and its variety *Schizanthus carlomunozii* var. *dilutimaculatus* V.Morales & Muñoz-Schick, **var. nov.**, all of them from the coast of Coquimbo Region. We also recognise *Schizanthus litoralis* Phil. var. *humilis* (Lindl.) V.Morales & Muñoz-Schick, **comb. nov.**, as a new combination.

Keywords

Argentina, Andes, Chile, classification, endemism, Solanaceae, taxonomy

Introduction

The Chilean flora has been recognised as harbouring a remarkable endemism at all taxonomic levels. This is driven by the long biogeographic history as well as geologi-

cally relative recent isolation due to the Andean uplift and associated regional climate changes (Moreira-Muñoz 2011; Scherson et al. 2014). Endemism in the Chilean flora encompasses around 2,000 species, 80 genera and 5 families; and endemic species richness concentrates in Mediterranean Chile between 25°S and 37°S (Moreira-Muñoz 2014). In spite of the Andes acting as a driver of genetic isolation and allopatric speciation, taxa adapted to the harsh high-altitude environment reached the Argentinian eastern side of the Andes, showing a group of plants that can be considered as southern Andean endemics. One of the richest families showing high presence of endemism in the southern Andes is Solanaceae, including rich and subcosmopolitan genera like *Solanum* L. and *Lycium* L., neotropical genera like *Cestrum* L. and *Exodeconus* Raf., Chile-Peruvian genera like species-rich *Nolana* L.f., and southern Andes endemics like *Schizanthus* Ruiz & Pav., *Salpiglossis* Ruiz & Pav. and *Reyesia* Gay (Moreira-Muñoz 2011). Several neotropical groups within the Solanaceae have been recently revised (e.g. Knapp et al. 2019), but some southern Andean endemics such as *Schizanthus* are still lacking an up-to-date revision.

The genus *Schizanthus* was described by Spanish explorers and botanists Hipólito Ruiz and José Antonio Pavón in their Prodromus (Ruiz and Pavón 1794). It is known vernacularly as "*pajarito*" (little bird), "*flor del pajarito*" (little bird flower), "*mariposita*" (little butterfly) and "*orquídea del pobre*" (poorman's orchid). The first validly published species of the genus was *S. pinnatus* Ruiz & Pav., described in 1798 (Ruiz and Pavón 1798). During the early part of the 19th century, *Schizanthus* species were introduced to Europe for cultivation and several species were later described in Europe from these introductions: *S. porrigens* Graham ex Hook. (Hooker 1824), *S. hookeri* Gillies ex Graham (Graham 1830), *S. grahamii* Gillies ex Hook. (Hooker 1831a) and *S. retusus* Hook. (Hooker 1831b).

It is thought that South America is the ancestral area for all Solanaceae and its major clades (Dupin et al. 2017). Atypical characteristics of the genus *Schizanthus* within Solanaceae, such as bilateral floral symmetry, two fertile stamens and revolute (resupinate) flowers (Grau and Gronbach 1984) have led researchers to believe the genus forms its own monotypic subfamily: Schizanthoideae (Olmstead and Palmer 1992, Hunziker 2001). Molecular studies suggested that *Schizanthus* diverged early from the rest of the Solanaceae (Olmstead and Palmer 1992). The most recent molecular analyses place *Schizanthus* as an early branch and the sister clade of a group including *Duckeodendron* Kuhlm. (Brazil), *Reyesia* (southern Andes endemism) and the Goetzeoideae (a Pantropical group from the Caribbean, Brazil and Madagascar) (Olmstead et al. 2008; Särkinen et al. 2013; Dupin et al. 2017).

The extreme floral diversification in *Schizanthus* is thought to be the product of changes associated with adaptation to different groups of pollinators in Mediterranean and semi-desert habitats of Chile, and high Andean areas of Chile and adjacent Argentina (Pérez et al. 2006). Cocucci (1989) described two pollination syndromes: by bees and by moths. The bee pollination syndrome is the most common and is related to pink-purple corollas, with a nectariferous guide, lower lateral lobes extended as a platform, and explosive discharge of pollen. On the other hand, the moth pollination

syndrome is related to white flowers with long tubes, lateral lobes of the upper lip very divided and reflexed, the lower lip reduced, tube curved downwards, without a nectariferous guide, but depending on the moth touch in the lower lateral lobes. Pérez et al. (2006) made field observations of a third pollination syndrome, associated with hummingbirds related to *S. grahamii* and to a lesser extent to *S. hookeri*. High population differentiation is prevalent in populations of *S. grahamii* (Pérez 2011). According to Pérez et al. (2006), a few species with white corollas do not show, in the field, any apparent relation to pollinator; they propose that the floral morphology of *S. lacteus* and *S. candidus* represents an anachronistic character that is maintained despite the disappearance of the original pollinator. This could be due to the continuous aridification of the Atacama Desert, which would have decreased the presence of pollinators. Today these *Schizanthus* species would be dependent on self-pollination for their maintenance.

Currently most *Schizanthus* species occur at the core of Mediterranean Chile, and on the transition towards the Atacama Desert, due to the genus being a main component of the Central Chilean biodiversity hotspot (Moreira-Muñoz 2014). Nevertheless, a specific richness assessment for the genus hasn't been undertaken yet, and an up-to-date revision is pending. This seems to be crucial for informing biogeography as well as conservation and pollination research (Medel et al. 2018). A preliminary revision was published by Muñoz-Schick and Moreira-Muñoz (2008). The current synopsis is based on the study of all herbarium specimens available in the two main Chilean herbaria, personal collections and herbaria from Argentina, Europe and North America. This synopsis includes 17 taxa, including one new species comprising two varieties, one new subspecies and one new combination.

Materials and methods

For this taxonomic treatment, 1.612 herbarium records from 30 collections were reviewed (AMD, ASU, BA, BM, CONC, DES, E, F, GH, HAL, IND, K, L, LINN, LP, M, MA, MEL, MEXU, MO, P, S, SGO, SI, TDC, U, US, VT, WAG and the Private collection of Andrés Moreira-Muñoz [AMM]). Collections were examined personally at BA, CONC, LP, SGO, SI and AMM, while the specimens from other herbaria were seen through high resolution images, available via the websites of each herbarium and Global Plants JSTOR (http://plants.jstor.org).

For each taxon, we provide a complete list of synonymy and type specimens but only for accepted names or basionyms. Some of them were difficult to trace because they were described from living material in cultivation. Thanks to the digitisation of herbarium material, we have been able to trace duplicates or original materials. When we were able to check specimens personally or by using high resolution images, these have been marked with an exclamation mark (!). We mentioned the holotypes, lectotypes or neotypes of accepted names, even if these were inadvertent typifications in previous publications (Grau and Gronbach 1984). We have designated new lectotypes where it is necessary. In general, we have lectotypified names

with the best preserved, or in some cases the only herbarium sheets we have seen. Where there has been difficulty or where the choice may not be obvious, we explain our reasoning under the taxonomic notes. Type specimens are cited with their barcodes in square brackets and written in an identical way as they appear on the specimen. Sheet numbers are cited together with the barcodes if they exist (e.g. SGO000004532 acc. #143618).

Since the original description of the genus, many species have been incorrectly identified. For this reason, we provide notes about nomenclature and botanical history, after the citation of the type material. Our main aim is to clarify the correct name for each taxon, as most *Schizanthus* species have already been described but confused in many publications. We complement this work by adding a list of illustrations published in classic and widely available journals, giving the correct name for them (Appendix I).

Under key characters, we mention the morphological features that help to differentiate each taxon. Here we put much emphasis on the corolla colour and drawings, because the identification of sterile or fruiting specimens is very difficult due to similar leaf shape and size throughout the species. Measurements given in this section were made from dried herbarium material; other information like colour of the corolla and drawings were taken from herbarium specimens and images taken on fieldwork. The distributions of the recognised taxa were established by studying the localities on the labels from herbarium specimens and georeferenced photos from fieldwork. Using these data, distributional maps were constructed over the platform of the GIS ARCGIS 10.4 (ESRI 2015). Few samples had label coordinates, making it necessary to retrospectively georeference the collections; in these cases, we use the following sources of data: Instituto Geográfico Militar [Chile] (Instituto Geográfico Militar 1983), Diccionario Jeográfico de Chile (Risopatrón 1924) and GeoNames Database (https://www.geonames.org/). The label coordinates were also checked using the aforementioned sources. Habitat information was taken from herbarium specimen labels. As a proxy to conservation status, we list the names of the protected areas, public or private, where the presence of each taxon has been verified by herbarium specimens or photos published online. We have included protected areas cited by other publications although when we could not confirm the information. We cite geographically representative specimens to justify the distributional ranges mentioned on the text. The specimens have been alphabetically arranged by the corresponding country. Within each country the specimens are organized geographically from north to south, mentioning the second and third administrative units level, the last one between square brackets. At the end of the citation of each specimen we provide the herbarium code. The corresponding barcode or accession numbers are available from GBIF (https://doi.org/10.15468/82kgtm), which contains the list of specimens revised.

Names of publications where the species are described, and their authorities follow the International Plant Names Index (https://www.ipni.org/).

For newly described taxa, we provide a short diagnosis of the taxon, type material and a full description; here we cite all specimens examined. In this work, we have

described two types of infraspecific taxa when we distinguish morphological characters within a species. When a set of morphological characters combines with a disjunct distribution, we classify these taxa as subspecies. However, when we find morphological variability in the specimens, which is replicated in the same locations, we have treated these taxa as varieties (Beentje 2010).

Taxonomic treatment

The following description of the genus has been taken from Barboza et al. (2016) and modified according to our observations made from fieldwork and examination of herbarium specimens.

Schizanthus Ruiz & Pav., Fl. Peruv. Prodr.: 4. 1794

Type species. *Schizanthus pinnatus* Ruiz & Pav.

Annual or biennial herbs, sometimes woody at base, usually sticky, with non-glandular unicellular trichomes and glandular shaggy hairs. Leaves rarely entire or slightly serrate, mostly lobed, pinnatisect to bipinnatifid. Inflorescences terminal, paniculate. Flowers 5-merous; calyx tube almost absent, segments slightly unequal, linear-spathulate or lanceolate; corolla tube shorter to several times longer than the calyx, zygomorphic, papilionate; 10–34 mm long, 10–40 mm wide, the upper lip tripartite, with the middle lobe entire, retuse, bilobed or multilobed, lateral lobes bipartite, sometimes these lobes can be two or more times divided; the lower lip with the middle lobe forming a keel and the lateral lobes linear or spathulate, the latter arched inwards; stamens 4, two superior like staminodes and two fertile inferior, sometimes a third staminode is present; anthers dorsifixed, dehiscing explosively by means of pollinators; gynoecium 2-carpellate, ovary with annular nectary, style filiform, stigma inconspicuous, lacking papillae. Capsule septicidal, 2-valved. Seeds up to 40, ellipsoidal or reniform, compressed.

In our treatment we recognise 17 taxa, i.e. 14 species and three infraspecific taxa. The genus is mainly distributed in Chile, where all taxa occur, with three centres of species richness: in the coast of Coquimbo (ca. 30°S), Valparaíso (32–33°S), and Metropolitan Andes (ca. 33°S) (Fig. 1A, Appendix II). In Argentina there are only two species, shared with Chile, which are restricted to the Provinces of Mendoza and Neuquén (Zuloaga et al. 2008). Following the bioclimatic classification by Rivas-Martínez et al. (2011), the genus occurs in three macrobioclimates. The northern portion reaches the Tropical macrobioclimate (Hyperdesertic), while the southern limit of the distribution is extending until the Temperate macrobioclimate (Oceanic). The distribution of the genus (number of records and taxa) is mainly located in the Mediterranean macrobioclimate (Fig. 1B).

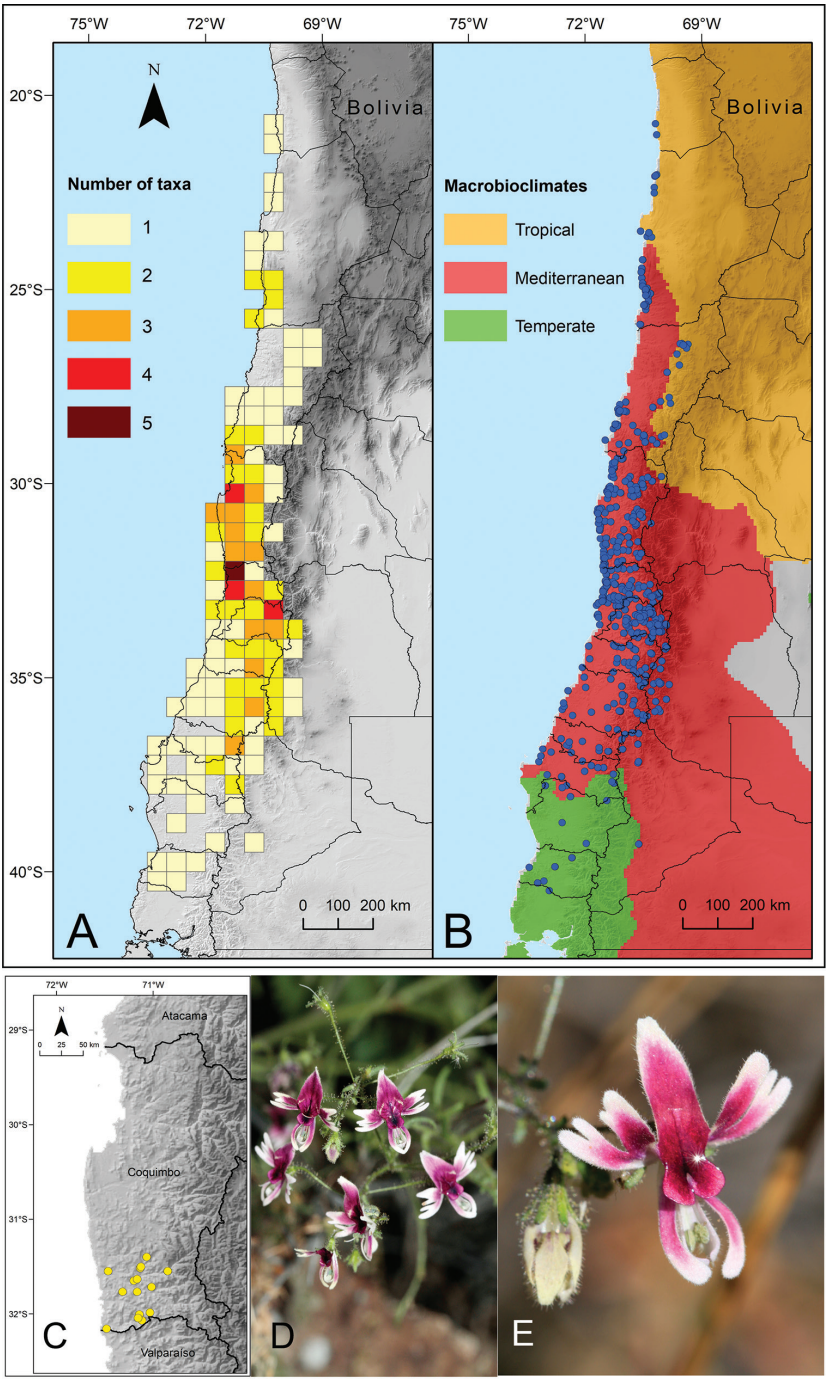

Figure 1. Distribution of the genus *Schizanthus* **A** number of taxa of *Schizanthus* by cells of 0.5 degree and administrative units **B** distribution of the genus by macrobioclimates and administrative units **C** distribution of *Schizanthus parvulus* **D, E** examples of *S. parvulus* in Las Chinchillas National Reserve. Photos by A. Moreira-Muñoz (**D, E**).

Artificial key to the species of *Schizanthus*

1 Corolla mostly burgundy, whitish only at the end of each lobe; upper middle lobe prolonged in its base in a distinctive bilobed and bright element; Coquimbo Region (Chile) ..... **1. *S. parvulus***

– Corolla not mostly burgundy but other colours; upper middle lobe not prolonged at its base in a different element **2**

2 Upper middle corolla lobe without a noticeable yellow area **3**

– Upper middle corolla lobe with a yellow area that covers 30–95% of its surface, always with segmented veins on it **9**

3 Upper lip of the corolla about three times longer than the lower lip; upper lateral lobes reflexed **4**

– Upper lip of the corolla about the same length as the lower lip, or shorter; upper lateral lobes not reflexed **7**

4 Corolla bluish to lilac with dark spots or veins (entire or segmented); Antofagasta Region (Chile) ..... **2. *S. lacteus***

– Corolla entirely white or with purple spots or veins **5**

5 Leaf margin deeply divided (pinnatisect), with narrow linear segments; Atacama Region (Chile) ..... **3. *S. candidus***

– Leaf margin lobed (pinnatifid) **6**

6 Corolla tube of equal or similar length to the calyx; Antofagasta Region (Chile) ..... **2. *S. lacteus***

– Corolla tube two or three times longer than the calyx; Atacama and Coquimbo Regions (Chile) ..... **4. *S. integrifolius***

7 Upper middle corolla lobe with the apex deeply bilobed; from Atacama to Valparaíso Region (Chile) ..... **5. *S. alpestris***

– Upper middle corolla lobe with the apex entire or slightly notched **8**

8 Lower lip of the corolla of similar length as the upper lip; upper lateral lobes without spots; Antofagasta Region (Chile) ..... **6. *S. laetus***

– Lower lip of the corolla 10–11 mm long, longer than the upper lip; upper lateral lobes with spots, sometimes faint; from Valparaíso to Los Lagos Regions (Chile) ..... **7. *S. pinnatus***

9 Upper middle corolla lobe rhomboid, apically attenuate and looks about two or three times wider than the lower middle lobe **10**

– Upper middle corolla lobe oblong or obovate, not apically attenuate and looks of similar width than the lower middle lobe **12**

10 Lower middle corolla lobe attenuated into two caudate apex; stamens long and protruding from the corolla tube; from Coquimbo to Biobío Regions (Chile) and Mendoza and Neuquén Provinces (Argentina) ..... **8. *S. hookeri***

– Lower middle corolla lobe attenuated into two short pointed apex; stamens short and barely protruding from the corolla tube **11**

11 Upper middle corolla lobe yellow, except at the base and the apex; this colour not extending to the upper lateral lobes; rarely when the corolla is mostly white; from Metropolitan to Biobío Regions (Chile) and Mendoza and Neuquén Provinces (Argentina) ..... **9. *S. grahamii***

– Upper middle corolla lobe completely yellow, this colour extending to the superior part of the upper lateral lobes; Metropolitan Region (Chile) ..... **10. *S. coccineus***

12 Lower lip of the corolla purple or burgundy, except at the base, markedly darker than the upper lip, which is whitish, pale pink or lilac **13**

– Lower lip of the corolla of the same colour as the upper lip **14**

13 Base of the upper lip of the corolla without or rarely with faint veins, but dotted with dark spots over the yellow area; Valparaíso Region (Chile) ..... **11a. *S. litoralis* var. *litoralis***

– Base of the upper lip of the corolla with purple veins, and dotted with dark spots over the yellow area; Valparaíso Region (Chile) ..... **11b. *S. litoralis* var. *humilis***

14 Upper lateral corolla lobes without spots **15**

– Upper lateral corolla lobes with spots, sometimes faint **16**

15 Corolla pink; peduncles up to 4 mm long; Coquimbo Region (Chile) ..... **12. *S. splendens***

– Corolla blue to lilac; peduncles from 4–25 mm long; Coquimbo Region (Chile) ..... **13b. *S. porrigens* subsp. *borealis***

16 Upper lateral corolla lobes each with a dark medium spot, these not reaching the upper margin **17**

– Upper lateral corolla lobes each with a large dark spot, reaching the upper margin **18**

17 Upper middle corolla lobe with two spots over the margin of the yellow area or a segmented line over it; from Coquimbo to O'Higgins Regions (Chile) ..... **13a. *S. porrigens* subsp. *porrigens***

– Upper middle corolla lobe without spots or lines outside the yellow area, but with a white halo over it; Coquimbo Region (Chile) ..... **13b. *S. porrigens* subsp. *borealis***

18 Upper middle corolla lobe with two lateral spots of dark colour and delimited edges, outside the yellow area; upper lateral lobes with delimited spots; Coquimbo Region (Chile) ..... **14a. *S. carlomunozii* var. *carlomunozii***

– Upper middle corolla lobe with a large spot of colour black to burgundy, fading towards the apex, outside the yellow area; upper lateral lobes with fading spots; from Coquimbo to Valparaíso Regions (Chile) ..... **14b. *S. carlomunozii* var. *dilutimaculatus***

1. *Schizanthus parvulus* Sudzuki, Agricultura Técnica, Chile 5(1): 33. 1945
Fig. 1C–E

Type. Chile. Coquimbo: Hacienda Illapel, Caren, frente a El Vato [Bato], ca. 900 m alt., 20–24 Oct 1941, *C. Muñoz & G.T. Johnson 2295* (holotype: SGO! [SGO000004532 acc. #143618]; isotype: SGO! [SGO000004534 acc. #148996]).

Taxonomic notes. In the protologue, the author indicates the holotype as being held at the national herbarium of the National Museum of Natural History, Santiago (SGO). At the same time, she mentions a duplicate at the herbarium of the Departamento de Genética y Fitotecnia del Ministerio de Agricultura. Today, both specimens can be found at SGO. In 2007, Mélica Muñoz identified one of the specimens as the holotype, as it has a label with the name of the species and the descriptor "*S. parvulus nov. sp. Sudzuki.*", while the second specimen lacks this information.

Key characters. Easily recognisable as having the smallest flower of the genus (10–14 mm long, 10–12 mm wide) and its conspicuous bilobed and brilliant element at the base of the upper middle corolla lobe, that exudes nectar. Corolla mostly burgundy and whitish only at the end of each acute lobe.

Distribution. Endemic to Chile, in the Region of Coquimbo (Province of Choapa, 31°20'–32°10' lat. S). 100–900 m a.s.l.

Habitat. *Schizanthus parvulus* grows in coastal hills and interior valleys of semiarid xerophytic scrub, including small trees of *Quillaja saponaria* Molina (Quillajaceae), shrubs such as *Spinoliva ilicifolia* (Hook. & Arn.) G.Sancho (Asteraceae), *Haplopappus pulchellus* DC. (Asteraceae), *Haplopappus velutinus* J.Rémy (Asteraceae), *Pleocarphus revolutus* D.Don (Asteraceae) and herbs such as *Loasa illapelina* Phil. (Loasaceae), *Calceolaria collina* Phil. (Calceolariaceae) and *Chaetanthera limbata* (D.Don) Less. (Asteraceae).

Conservation. Chile. Coquimbo: Las Chinchillas National Reserve, Cerro Santa Inés Natural Sanctuary.

Selected specimens examined. Chile. Coquimbo: [Choapa Province] Quebrada El Cobre, Parque Nacional Las Chinchillas, Auco, 31°31'S, 71°6'W, 567 m a.s.l., 1 Oct 2002, *L. Suárez s.n.* (CONC); Illapel, 24 km cruce Carretera Panamericana a Illapel, orillas de línea férrea, 21 Sep 1996, *M. Muñoz 3781* (SGO); Cuesta Guenchigualleco, a 60 km al Oeste de Illapel, ca. 100 m a.s.l., 20–24 Oct 1941, *C. Muñoz & G.T. Johnson 2273* (SGO); Vicinity of Illapel, 7 Oct 1914, *J.N. Rose 19273* (US).

2. *Schizanthus lacteus* Phil., Fl. Atacam.: 45. 1860
Fig. 2A–D

Schizanthus sanromanii Phil., Anal. Univ. Chile 91: 126. 1895, as "*san romani*".

Type. Chile. Antofagasta: In deserto Atacama ad Hueso Parado, Dec 1853, *R.A. Philippi s.n.* (holotype: SGO! [SGO000004524 acc. #055390]).

Key characters. In general, the corolla is entirely white, but it can vary from blue to lilac. Sometimes it has purple spots or veins on the upper lip or is purple throughout the corolla without any drawings. Leaves linear or lanceolate but lobed at margins. Like *S. integrifolius* and *S. candidus*, this species shows a reduced lower lip as compared to the upper lip.

Distribution. Endemic to Chile, in the coast of the Region of Antofagasta (Province of Antofagasta, 23°30'–26°0' lat. S). 20–900 m a.s.l.

Habitat. *Schizanthus lacteus* is part of the lomas vegetation and grows in the fog (camanchaca) zone, on steep hillsides and among rocks alongside watercourses; in gravel soil or coarse sand.

Conservation. Chile. Antofagasta: Morro Moreno National Park, La Chimba National Reserve, Paposo Norte Natural Monument.

Selected specimens examined. Chile. Antofagasta: [Antofagasta Province] Península Moreno, cerro al O de Juan López, 23°30'S, 70°34'W, 600 m a.s.l., 18 Oct 1992, *G. Baumann 25* (CONC, SGO); El Rincón, just north of Paposo, along trail to old Paranas Mine, 7 Dec 1925, *I.M. Johnston 5480* (F, US); Bajada a Caleta El Cobre, 24°15'S, 70°33'W, 1 Oct 1987, *S. Teillier 492* (CONC, SGO); Cachinal, quebrada frente a la playa, 25°10'S, 70°25'W, 80 m a.s.l., 14 Sep 1994, *L. Loyola 94-12* (CONC); Paposo, entrada a la Qda. Los Peralitos, 25°1'57"S, 70°26'30.3"W, 490 m a.s.l., 30 Sep 2005, *M. Muñoz 4608* (SGO).

3. *Schizanthus candidus* Lindl., Edwards's Bot. Reg. 29: tab. 45. 1843

Fig. 2E–G

Schizanthus albiflorus Phil., Anal. Univ. Chile 91: 124. 1895.

Type. Chile. Atacama: Coquimbo?, *T.C. Bridges 1356* (lectotype designated by Grau and Gronbach 1984, pg. 124 [as type]: K! [K00058348, photo at IND! [IND-0107170]]; isolectotypes: BM! [BM000995488, BM000995489], E! [E00089541], G [n.v., F! neg. 23090], P! [P00477035, P00477036]).

Taxonomic notes. There are several specimens collected by Bridges numbered as 1356, but only one of them was labelled with the complete original location ("*Hills near the valley of Huasco Prov. of Coquimbo*") [E00089541]. The handwriting on the other specimens only states "Coquimbo", which was (at that time) the name of the Province associated with the locality. In late 1843, the original Province of Coquimbo was divided into two new administrative units, the southern part maintained the name of the original Province (Coquimbo), while the northern section became the Province of Atacama (Pérez-Rosales 1857). Most of these territories are known today as the Regions of Coquimbo and Atacama; the area where the type material was collected corresponds to the latter. This situation can explain why some publications (Grau and Gronbach 1984; Rodríguez et al. 2018) have mentioned *S. candidus* as occurring in the actual Region of Coquimbo, where this species does not grow.

Key characters. This species has a white flower, the corolla tube can be longer or as long as the calyx; the lower lip of the corolla is reduced, compared to the upper part. Pinnatisect leaves with linear lobes.

Distribution. Endemic to Chile, in the coast and interior valleys of the Region of Atacama (Provinces of Copiapó and Huasco, 27°50'–29°0' lat. S). 20–200 m a.s.l.

Habitat. *Schizanthus candidus* grows abundantly among the rocks over fine sand, in dry places or in seasonally wet quebradas with scattered shrubs; it is rarely found along the roads in open areas. It has been found growing with *Leontochir ovallei* Phil.

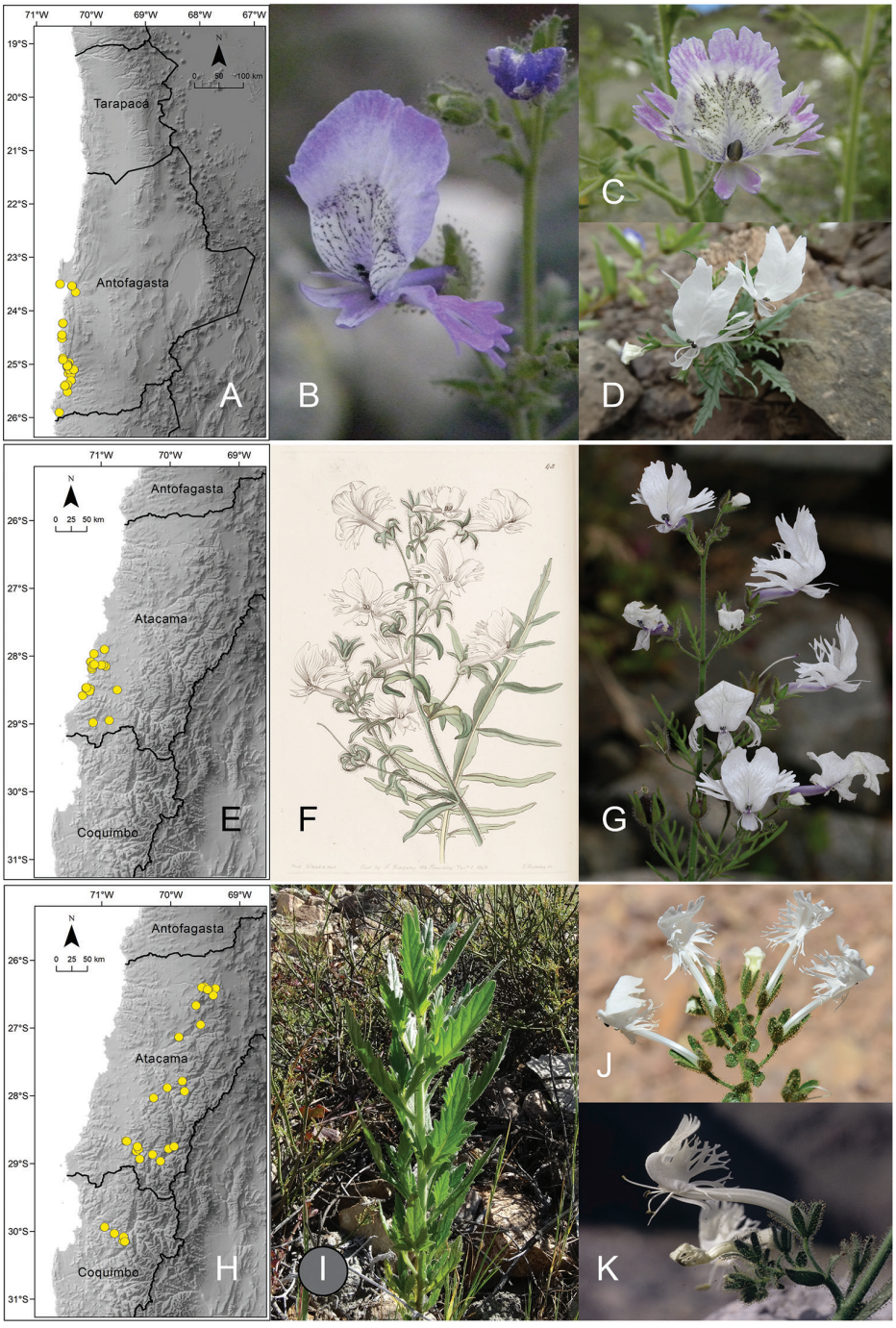

Figure 2. A distribution of *Schizanthus lacteus* **B** examples of *S. lacteus* in La Chimba National Reserve **C** Quebrada Peralito **D** Paposo **E** distribution of *Schizanthus candidus* **F** illustration of *S. candidus* published with the description of the species (Lindley 1843) **G** example of *S. candidus* in Quebrada de Carrizal **H** distribution of *Schizanthus integrifolius* **I** examples of *S. integrifolius* in Embalse Santa Juana **J** Río Cachitos **K** Alto del Carmen. Photos by M.T. Eyzaguirre (**B–D, I, J**), A. Moreira-Muñoz (**G**), S. Moreira (**K**).

(Alstroemeriaceae), *Cistanthe grandiflora* (Lindl.) Schltdl. (Montiaceae), *Chaetanthera limbata* (D.Don) Less. (Asteraceae) and *Senecio troncosii* Phil. (Asteraceae). Most abundant in rainy years associated to El Niño events, being a main element of the "blooming desert" (Muñoz-Schick 1985; Chávez et al. 2019).

Conservation. Chile. Atacama: Llanos de Challe National Park.

Selected specimens examined. Chile. Atacama: [Copiapó Province] Coastal road from Carrizal Bajo to Totoralillo, 27°57'56"S, 71°6'10"W, 179 m a.s.l., 27 Nov 2008, *R. Baines*, *M.F. Gardner*, *P. Hechenleitner*, *C. Morter & D. Rae 159* (E); **[Huasco Province]** Carrizal Bajo, Quebrada Oriente, 28°7'17"S, 71°5'57"W, 11 Oct 2002, *A. Moreira 738* (SGO); Quebrada angosta al lado norte de entrada a Aguada Tongoy, entre Huasco y Freirina, 28°30'S, 71°6'W, 90 m a.s.l., 10 Sep 2011, *M. Lazo & C. Stone 64* (CONC).

4. *Schizanthus integrifolius* Phil., Anal. Univ. Chile 43: 530. 1873

Fig. 2H–K

Type. Chile. Atacama: In andis Copiapo, Dec 1841, *C. Gay 1174 bis* (lectotype here designated: SGO! [SGO000004520 acc. #055382]).

Taxonomic notes. According to the protologue, the species was described using materials from two different collection: Andes de Copiapó by C. Gay (1174 bis) and Quebrada de Puquios by F. Geisse. Grau and Gronbach (1984: 123) selected as lectotype [as type] one of the specimens at SGO. However, they erroneously mixed data from two different specimens. They cited: "*en el interior de la provincia de Atacama*, *quebrada de Puquis*, *F. GEISSE* (*SGO 55382*)", but the SGO number 55382 corresponds to the specimen collected in the mountains of Copiapó by Gay. On the other hand, specimens from Quebrada de Puquios, gathered by Geisse have the numbers 55383 and 42901. Today, we cannot be sure if they selected the specimen from Puquios and annotated the number erroneously, or if they always wanted to lectotypify the specimen collected by Gay but did not realise it was from a different locality. In our opinion, the lectotypification by Grau and Gronbach (1984) is not valid, as the designated lectotype should be referred to a single collection (Turland et al. 2018; Art. 9.17). For this reason, we have chosen a new lectotype; this herbarium sheet shows the characters of the species more clearly.

The specimens from Quebrada de Puquios [SGO000004521 acc. #055383, SGO000004522 acc. #042901 pro parte] have labels written by R.A. Philippi stating they were collected in 1865, and not in 1861, the year mentioned in the protologue. Most likely, Philippi confused the date of collection in the protologue.

Key characters. This species has a reduced inferior lip, compared to the upper lip and white flowers with a very long corolla tube which is two or three times longer than the calyx. The basal leaves have entire or dentate and undulate margins.

Distribution. Endemic to Chile, in the Andean mountains and valleys from the Regions of Atacama (Province of Chañaral, 26°20' lat. S) to Coquimbo (Province of Elqui, 30°10' lat. S). 800–2800 m a.s.l.

Habitat. *Schizanthus integrifolius* is frequent in rocky areas on hillsides and in screes. It grows better in well-drained soils, like coarse sand, but is less abundant when growing in clay soils. Other species in the community include *Heliotropium sinuatum* (Miers) I.M.Johnst. (Heliotropiaceae), *Encelia canescens* Lam. (Asteraceae) and *Spinoliva ilicifolia* (Hook. & Arn.) G.Sancho (Asteraceae).

Conservation. Chile. Atacama: Los Huascoaltinos Private Natural Reserve (Peña-Gómez 2005).

Selected specimens examined. Chile. Atacama: [Chañaral Province] El Salvador, 26°23'42.53"S, 69°30'19.33"W, 2145 m a.s.l., 25 Nov 2011, *S. Teillier & A. Walkowiak 8128* (CONC); In Cachiyuyo, im Berraquilla-Tal, 800 m a.s.l., 21 Sep 1972, *O. Zoellner 6122* (L); Potrerillos, camino a la mina El Hueso, 31 Oct 1995, *S. Teillier 3697* (SGO); **[Copiapó Province]** Camino de Copiapó al Tranque Lautaro, 14 km antes del tranque, 26 Oct 1965, *M. Ricardi*, *C. Marticorena & O. Matthei 1494* (CONC); In Jorquera Tal, 1500 m a.s.l., 12 Jan 1970, *O. Zoellner 4258* (L); **[Huasco Province]** San Félix, al interior, 28°5'S, 70°28'W, 1250 m a.s.l., 11 Dec 2008, *M. Rosas 6142* (CONC); Vallenar, Alto del Carmen,, ca. 800 m a.s.l., Nov 1923, *E. Werdermann 151* (E, L, SI); Poco al W de El Tránsito, 3 Oct 1997, *M. Muñoz 3831* (SGO); **Coquimbo: [Elqui Province]** A unos 10 km al sur de Vicuña en el camino a Hurtado, 800 m a.s.l., 13 Oct 1940, *G. Looser 4305* (CONC, SGO); Camino entre Vicuña y Hurtado, Hacienda Pangui, 800 m a.s.l., 13 Oct 1940, *G. Looser 4305* (US).

5. *Schizanthus alpestris* Poepp., Not. Natur- Heilk. 23: 291. 1829

Fig. 3A–D

Schizanthus alpestris Poepp. ex Benth., Prodr. [A.P. de Candolle] 10: 202. 1846. nom. illeg. superfl.
Schizanthus alpestris var. *glanduliferus* Phil., Linnaea 33(2): 214. 1864, as "*glandulifera*".
Schizanthus angustifolius Phil., Anal. Univ. Chile 91: 119. 1895.
Schizanthus glanduliferus Phil., Anal. Univ. Chile 91: 120. 1895.
Schizanthus laciniosus Phil., Anal. Univ. Chile 91: 125. 1895.

Type. Chile. Valparaíso: Rarius in glareosis ad confluentes Rio Colorado et Rio Chille, Dec, *E. Poeppig 2* [12, Diar. 562] (lectotype designated here: HAL! [135744]; isolectotypes: B [destroyed, F! neg. 3057], P! [P00477033]).

Taxonomic notes. Grau and Gronbach (1984: 147) erroneously accepted as the first valid publication of this species that of Bentham (1846). Consequently, they chose as a type a specimen from G-DC, linking it to the original publication. Regarding this matter, it is important to say that we have not seen this specimen, as it is not available at Global Plants JSTOR (https://plants.jstor.org/) or at the herbarium catalogue of the institution (http://www.ville-ge.ch/musinfo/bd/cjb/chg/). *Schizanthus alpestris* was described and validly published almost 20 years earlier by Poeppig (1829). Hence, the type cited by Grau and Gronbach (1984) is not that of Poeppig's name.

Poeppig (1829) does not mention a type specimen or a specific area of collection, but the title of his work refers to collections made at Río Colorado in the Andes of Chile and being gathered by him on 24th of December of 1827. We have found two specimens that can be related to this trip, but none of them are part of the Poeppig herbaria at W or at B and LE, where his samples were distributed by G. Kunze (Stafleu and Cowan 1983). However, the sheets at HAL [135744] and P [P00477033] have a printed label, where the original publication is mentioned (Not. XXIII); these were distributed after Poeppig described the species. Hence, we think these samples are part of the material used in the description, and thus original material. As no holotype is mentioned in the description and we found two specimens referring to the same collection, a lectotypification is made here. Our selection of the lectotype was based on the best-preserved specimen that shows the morphological characters of the species and the full locality data. According to the printed label on the specimens, the material was collected at the confluence of the rivers Colorado and Chille. The latter corresponds to an old name for the Aconcagua River (Risopatrón 1924), area which agrees with the currently known distribution of the species.

A further two specimens collected by Poeppig were not considered as type material because of the following reasons: the locality cited on the specimen at P [P00477034] is insufficient to be linked to the protologue ("*Chile boreal. Andes.*"). On the other hand, the specimen at F [875198] has two labels: one of them contains the locality and date of collection ("*Andes de Sa. Rosa. Chile. 1828*"), data which do not agree the protologue. A second label refers to two different numbers given to the species on Poeppig's diary ("*N° 12. Schizanthus alpestris Pg. Diar. 562. A.*"). Those numbers are not to be associated to numbers of collection, which is different.

Key characters. Delicate small flowers (14–18 mm long, 14–16 mm wide), external portion of the corolla lavender or lilac, upper middle corolla lobe narrowly oblong, with a bilobed apex, sometimes these lobes a little divided.

Distribution. Endemic to Chile, between the Regions of Atacama (Province of Huasco, 28°50' lat. S) and Valparaíso (Province of Los Andes, 32°50' lat. S). 180–2800 m a.s.l.

Habitat. *Schizanthus alpestris* is abundant on stony hillsides, along railroads, roadsides, and watercourses; among rocks over loose soil. It has also been found in rocky areas, where it seems to be scarce. In these rocky areas, it grows with *Puya* sp. (Bromeliaceae), *Flourensia thurifera* DC. (Asteraceae), *Echinopsis chiloensis* (Colla) H.Friedrich and G.D.Rowley (Cactaceae) and *Proustia cuneifolia* D.Don (Asteraceae).

Conservation. Chile. Coquimbo: Las Chinchillas National Reserve.

Selected specimens examined. Chile. Atacama: [Huasco Province] Incahuasi, 25 kms al sur, 10 Oct 1958, *M. Ricardi & C. Marticorena 4902/1287* (CONC); Norte entrada de Los Cristales, cuesta ruta 5 entre Vallenar y llanos La Higuera, en ladera rocosa del cerro, 29°9'18.5"S, 70°59'57.9"W, 1010 m a.s.l., 8 Oct 2008, *M. Muñoz 5049* (SGO); **Coquimbo: [Elqui Province]** Camino Paihuano – Rivadavia, 840 m a.s.l., 28 Sep 1948, *F. Behn s.n.* (CONC); Camino de Marquesa a Condoriaco, 3 kms antes de Talcuna, 500 m a.s.l., 18 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1514* (F); Cuesta de Andacollo, en mitad de la cuesta, 16 Sep 1957, *C.*

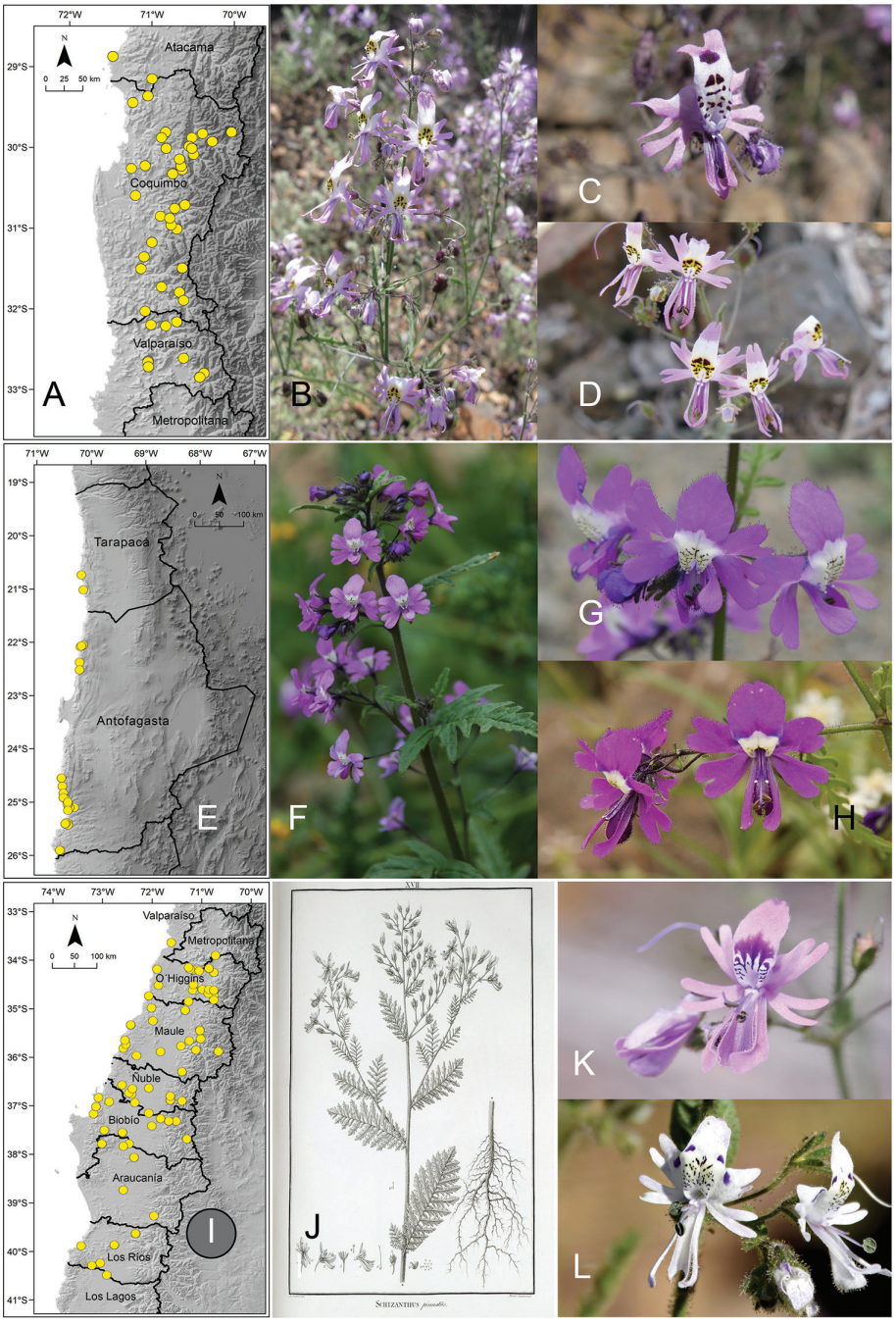

Figure 3. A distribution of *Schizanthus alpestris* **B** examples of *S. alpestris* in Cuesta Pajonales **C** Cordillera El Melón **D** Las Chinchillas National Reserve **E** distribution of *Schizanthus laetus* **F** examples of *S. laetus* in Quebrada Los Yales **G** Quebrada Peralito **H** Taltal **I** distribution of *Schizanthus pinnatus* **J** illustration of *S. pinnatus* published with the description of the species (Ruiz and Pavón 1798) **K** examples of *S. pinnatus* on road from Los Angeles to Antuco **L** Cerro Poqui. Photos by A Moreira-Muñoz (**B–D**), M.T. Eyzaguirre (**F, G, L**), M. Aldunate (**H**), S. Moreira (**K**).

Muñoz 4281 (SGO); **[Limarí Province]** Camino al Embalse de La Laguna, a 16 km del Embalse, 2500 m a.s.l., 5 Feb 1963, *M. Ricardi*, *C. Marticorena & O. Matthei 730* (CONC); Pulpica, 30°53'S, 70°46'W, 9 Mar 2008, *Fundación Philippi 366* (SGO); Combarbalá, 1000 m a.s.l., Sep 1936, *C. Grandjot s.n.* (SI); **[Choapa Province]** Cerro Gonzalo, cara N y W, 32°1'S, 71°6'W, 1740 m a.s.l., 5 Dec 2006, *M. Rosas & M. Acosta 4294* (CONC); Cuesta El Espino, 31°21'39.2"S, 71°5'51.7"W, 1260 m a.s.l., 9 Oct 2004, *M. Muñoz 4473* (SGO); **Valparaíso: [Petorca Province]** Petorca – Quebrada El Durazno, 32°12'7.58"S, 71°0'44.71"W, 1490 m a.s.l., 7 Nov 2017, *J. Macaya*, *S. Teillier*, *P. Novoa & O. Fernández 370* (CONC); In Chincolco, 1500 m a.s.l., 28 Dec 1972, *O. Zoellner 6741* (L); Las Tasas, Cajón del Pedernal, 23 Aug 1894, *P. Germain s.n.* (SGO); **[Quillota Province]** Cerro Caquis, ca. 15 km east of Melon, 1800 m a.s.l., 14 Dec 1938, *J.L. Morrison 16879* (SI); Cordillera El Melón, subida al cerro Mosco Verde, cerca cumbre, 32°39'6"S, 71°2'50"W, 2049 m a.s.l., 18 Jan 2011, *A. Moreira 1423* (SGO); **[San Felipe Province]** En el cerro Orolongo bei San Felipe, 2000 m a.s.l., 19 Nov 1972, *O. Zoellner 6210* (L); **[Los Andes Province]** Aconcagua, Los Maitenes (Río Colorado), 2000 m a.s.l., 18 Nov 1970, *O. Zoellner 4434* (CONC); In Maitenes bei Río Colorado, 2200 m a.s.l., 18 Nov 1970, *O. Zoellner 4462* (L).

6. *Schizanthus laetus* Phil., Fl. Atacam.: 45. 1860

Fig. 3E–H

Schizanthus fallax I.M.Johnst., Contr. Gray Herb. 85: 160. 1929.

Type. Chile. Antofagasta: Cachinal, *R.A. Philippi s.n.* (lectotype designated by Grau and Gronbach 1984, pg. 146 [as type]: SGO! [SGO000004526 acc. #055389]).

Taxonomic notes. Johnston (1929) characterised *S. fallax* as representing the northern-most distribution of the genus and having the upper lateral lobes of the corolla larger and not deeply lobed as in *S. laetus*. Grau and Gronbach (1984: 146) considered the characters of *S. fallax* as part of the variability and their broad concept of *S. laetus*, citing the name by Johnston (1929) as a synonym. We have revised the type material of *S. fallax* through Global Plants JSTOR (https://plants.jstor.org/) (Chile. Antofagasta: Tocopilla, steep hillside ca. 6 km. north of port and about opposite Caleta Duendes, 18 Oct 1925, *I.M. Johnston 3626* (holotype: GH! [00077406]; isotypes: F! [F0073042F acc. #625799], K! [K000585355, photo at IND! [IND-0107172]], S! [acc. #S04-3140], US! [00028096 acc. #1473978]). Some of these specimens suggest that *S. fallax* may represent a distinct species, but we do not have access to additional material and prefer to maintain the synonymy pending further study.

Key characters. Flowers dark violet or paler, upper middle lobe without a distinctive yellow area, but white and dotted with dark spots at the base. Lower lip of the corolla of similar length as the upper lip.

Distribution. Endemic to Chile, in the coast of the Regions of Tarapacá (Province of Iquique, 20°40' lat. S) and Antofagasta (Province of Antofagasta, 26°0' lat. S). 20–900 m a.s.l.

Habitat. *Schizanthus laetus* grows in the fog (camanchaca) zone, on steep hillsides, in watercourse and alluvial fans; between rocks and in sandy and gravel soil (coarse sand). Within these places, it prefers wet areas with organic material. Forms part of Lomas vegetation where it can be associated with *Echinopsis deserticola* (Werderm.) H.Friedrich and G.D.Rowley (Cactaceae) and *Euphorbia lactiflua* Phil. (Euphorbiaceae).

Conservation. Chile. Antofagasta: Paposo Norte Natural Monument, Pan de Azúcar National Park (Rundel et al. 1996).

Selected specimens examined. Chile. Tarapacá: [Iquique Province] Camino Iquique a Patillos, cumbres de los cerros frente al km 22, 17 Oct 1965, *M. Ricardi*, *C. Marticorena & O. Matthei 1343* (CONC); Alto Punta Lobos, 21°2'S, 70°9'W, 430 m a.s.l., 1 Nov 1997, *R. Pinto s.n.* (SGO); **Antofagasta: [Tocopilla Province]** Tocopilla, steep hillside ca. 6 km north of port and approximately opposite Caleta Duendes, 18 Oct 1925, *I.M. Johnston 3626* (F, GH, IND, K, US); 1 km al N de la Planta Mantos de La Luna, a lo largo de la ruta costanera, ca. 5 km al N de caleta Buena, 22°22'27"S, 70°13'73"W, 150–300 m a.s.l., 18 Oct 2002, *J.V. Schneider & M.L. Huertas 2851* (CONC); Cobija, Quebrada Aguada Cañas, 500–800 m a.s.l., 4 Dec 1949, *W. Biese 3080* (SGO); **[Antofagasta Province]** Quebrada de Miguel Díaz, en Punta Miguel Díaz, suelo arenoso, ca. 350 m a.s.l., 12 Oct 1941, *E. Pisano & R. Bravo 453* (CONC); Quebrada Miguel Díaz, en Punta Miguel Díaz, 350 m a.s.l., 12 Oct 1941, *E. Pisano & R. Bravo 453* (SGO); Quebrada Guanillo (10 km al N del Cachinal de la costa), 50–500 m a.s.l., 14 Dec 1949, *W. Biese 3303* (SGO); Paposo, entrada a la Qda. Los Peralitos, 25°1'57"S, 70°26'30.3"W, 490 m a.s.l., 30 Sep 2005, *M. Muñoz 4606* (SGO).

7. *Schizanthus pinnatus* Ruiz & Pav., Fl. Peruv. [Ruiz & Pavon] 1: 13. 1798

Fig. 3I–L

Schizanthus pinnatus β? *gracilis* Benth., Prodr. [A.P. de Candolle] 10: 202. 1846.
Schizanthus gracilis (Benth.) Clos, Fl. Chil. [Gay] 5(2): 153. 1849.
Schizanthus gayanus Phil., Linnaea 30(2): 198. 1859.
Schizanthus latifolius Phil., Linnaea 33(2): 214. 1864.
Eutoca pedunculosa Phil. Anal. Univ. Chile 65: 61. 1884.
Schizanthus humilis Phil., Anal. Univ. Chile 91: 118. 1895.
Schizanthus floribundus Phil., Anal. Univ. Chile 91: 119. 1895.

Type. Chile. Unknown: Chili, *J. Dombey s.n.* (lectotype designated by Grau and Gronbach 1984, pg. 139 [as type]: BM! [BM000992219]).

Taxonomic notes. This species was described on Ruiz and Pavón (1798) using the samples collected in Chile, during the botanical expedition to the Viceroyalty of Peru. The expedition to the Chilean territory was undertaken from 27th January of 1782

until October of 1783 with the participation of Hipólito Ruiz, José Pavón and Joseph Dombey (Marticorena 1995).

Regarding the type material, the protologue clearly states that the authors of the species had access to material from different collections: "*Esquadron*" [Escuadrón] located in the Municipality of Coronel and "*Araucanía*", referring to an area they visited. Therefore, the samples matching the protologue should be recognised as syntypes, requiring lectotypification.

We have found 11 herbarium sheets in five herbaria that correspond to this expedition (BM [BM000992219, BM000994723], F [V0126154F], MA [MA 815287, MA 815288, MA 815289], L [L.2881253], P [P00477581, P00477582, P00477583, P00675638]). Most of the sheets mentioned only the country of origin, except for the specimens at MA [MA 815287] and P [P00477583], which mentioned a more detailed locality: "*In Coronel juxta Concepcion*" and "*Concepcion*", respectively. The specimen at MA [MA 815287] gives a date (February) that agrees to the time when the collectors visited the localities mentioned in the protologue. It is also accompanied by the handwritten description and some drawings of the species. This specimen was identified as lectotype by F. Bellot in 1974 but he never appropriately published his findings. Later, the specimen at BM was cited as the lectotype of the species by Grau and Gronbach (1984: 139), as it matches the protologue and what is known about the possible collectors ("*Chili*, *Dombey*"). We are not designating any of the additional 10 specimens we have seen as isolectotypes, because the lack of data on their labels does not allow us to verify if any of them are duplicates of the lectotype.

We do not know why Grau and Gronbach (1984) chose the specimen at BM over the sheet at MA, where most of the types by Ruiz and Pavón are deposited (Stafleu and Cowan 1983). We have examined Turland et al. (2018, Art. 9.19.), without finding valid arguments for replacing the lectotypification made by Grau and Gronbach (1984).

Key characters. This species has small flowers (16–20 mm long, 14–15 mm wide), with the lower lip a little longer than the upper lip. Corolla colour from purple to white, upper middle lobe oblong, white or pale yellow at the base, this area dotted with dark spots and surrounded by a regular or irregular purple stripe (sometimes absent). The upper lateral lobes also have dark spots, which are sometimes faint.

Distribution. Endemic to Chile, between the Regions of Valparaíso (Province of San Antonio, 33°35' lat. S) and Los Lagos (Province of Osorno, 40°30' lat. S). 30–2000 m a.s.l.

Habitat. *Schizanthus pinnatus* can be found on dry hillsides and alluvial terraces of native forest and matorrals; in some areas it grows under plants of *Acacia caven* (Molina) Molina (Fabaceae). Abundantly in harvested plantation of *Pinus radiata* D.Don (Pinaceae).

Conservation. Chile. Metropolitana: Altos de Cantillana Natural Sanctuary; **O'Higgins:** Alto Huemul Natural Sanctuary; **Maule:** Radal Siete Tazas National Park, Altos de Lircay National Reserve, Bellotos del Melado National Reserve, Cajón del

Río Achibueno Natural Sanctuary (Bravo Monasterio et al. 2014), Humedal de Reloca Natural Sanctuary; **Ñuble**: Los Huemules de Niblinto National Reserve (Rodríguez et al. 2008); **Araucanía**: Nahuelbuta National Park.

Selected specimens examined. Chile. Valparaíso: [San Antonio Province] Rocas de Santo Domingo, Oct 1956, *G. Galingo s.n.* (CONC); **Metropolitana: [Maipo Province]** Cerro Challay, 2 Nov 1993, *R. Peña 840* (SGO); **O'Higgins: [Cachapoal Province]** Rancagua, old road to Termas de Cauquenes S of Río Cachapoal, ca. 12 km E of Hwy. 5 (Panamericana), 34°15'S, 70°45'W, 6 Oct 1993, *L.R. Landrum & S.S. Landrum 7900* (ASU); Cocalán (lad. exp. N), coord. UTM 300777E – 6213646N, 197 m a.s.l., 22 Nov 2005, *N. García, F. Romero & P. Contreras 2948* (CONC); Ex Laguna de Tagua-Tagua, Valle o Rinconada de Huinca, desde las casas hasta 200 m alt, 10 Nov 1967, *M. Muñoz 156* (SGO); **[Cardenal Caro Province]** El Espinillo, Poza El Encanto (ladera norte), coord. UTM 236051E – 6177258N, 33 m a.s.l., 29 Oct 2005, *N. García, F. Romero & P. Contreras 2368* (CONC); Tanumé, Quebrada Honda (ladera exposición norte), coord. UTM 232675E – 6213295N, 262 m a.s.l., 25 Oct 2005, *N. García, F. Romero & P. Contreras 2178* (CONC); **[Colchagua Province]** San Fernando, Fundo Los Alpes, Río Antivero, 26 Nov 1949, *T. Gutiérrez 54* (SGO); Yaquil (plano inclinado exp. S), coord. UTM 299844E – 6167762N, 277 m a.s.l., 18 Nov 2005, *N. García, F. Romero & P. Contreras 2740* (CONC); **Maule: [Curicó Province]** Reserva Nacional Radal Siete Tazas, 35°26'870"S, 71°2'298"W, 803 m a.s.l., 11 Dec 2004, *A. Marticorena*, *A. Jiménez & A. Pauchard 37* (CONC); **[Talca Province]** Alto de Vilches, Laguna El Alto, a orilla de la laguna, 35°37'S, 71°1'W, 2050 m a.s.l., 31 Jan 2000, *V. Finot & P. López 1886* (CONC); Constitución, 19 Oct 1942, *R. Silva 224* (SGO); **[Linares Province]** Tranque Bullileo, 600 m a.s.l., 11 Jan 1952, *P. Aravena 67* (SGO, US); [**Cauquenes Province**] Santuario Reloca, 35°39'S, 72°35'W, 40 m a.s.l., 1 Oct 1999, *M.T.K. Arroyo*, *J. Armesto*, *A.M. Humaña*, *F. Pérez*, *D. Rougier & R. Guevara 992712* (CONC); **Ñuble: [Diguillín Province]** Palomares, 36°34'4.23"S, 72°36'34.69"W, 57 m a.s.l., Nov 2008, *A. Marticorena s.n.* (CONC); Río Chillán, 36°38'S, 72°4'W, 120 m a.s.l., 2 Dec 2008, *N. García 4332* (CONC); **[Itata Province]** Huechupín, Mar 1864, *M. de Solís s.n.* (SGO); **Biobío: [Concepción Province]**, San Pedro, 18 Dec 1960, *C.S. Takayama s.n.* (CONC); **[Biobío Province]** Antuco, 21 Dec 1964, *G. Montero s.n.* (CONC); Los Ángeles, Antuco, 21 Dec 1964, *G. Montero 7052* (IND); Nacimiento, Fundo El Tambillo, 12 Nov 1950, *A. Pfister s.n.* (CONC); **[Arauco Province]** Laraquete, 15 Dec 1950, *A. Pfister & M. Ricardi s.n.* (CONC); Arauco, Dec 1927, *Bro. Claude-Joseph 5613* (US); **Araucanía: [Malleco Province]** Mininco, 10 Nov 1953, *H. Gunckel 2285* (CONC); Fuera del Parque Nacional Nahuelbuta, 1 Dec 1987, *I. Meza & E. Barrera 1651* (SGO); Fundo Solano, Los Alpes, Cordillera de Nahuelbuta, 1200 m a.s.l., 18 Jan 1958, *W.J. Eyerdam 10347* (US); **[Cautín Province]** Pucón – Lago Villarrica, Feb 1935, *A. Pfister s.n.* (CONC); **Los Ríos: [Valdivia Province]** Quinchilca, 70 m a.s.l., 20 Jan 1942, *A. Hollermayer 557* (SGO); Puñire [Panguipulli], ca. 200 m a.s.l., Feb 1925, *A. Hollermayer 694*

(CONC, E, F, L, SI, US); **[Del Ranco Province]** Daglipulli, Feb 1835, *C. Gay 176* (P); **Los Lagos: [Osorno Province]** In sepiis rarissimus Osorno, Mar 1835, *C. Gay 177* (P); Ad flumen Pilmaiquen, *D. Cueto s.n.* (SGO).

8. *Schizanthus hookeri* Gillies ex Graham, Edinb. N. Phil. Journ. 9: 176. 1830

Fig. 4A–D

Schizanthus calycosus Phil., Anal. Univ. Chile 43: 529. 1873.
Schizanthus hookeri var. *calycosus* (Phil.) Reiche, Anal. Univ. Chile 125: 480. 1909.

Type. Chile. Unknown: In various places on the Chilean side of the Cordillera of the Andes, 8000 ft alt., *J. Gillies s.n.* (neotype designated by Grau and Gronbach 1984, pg. 128 [as type]: K! [K000648571, photo at E! [E00089590], IND! [IND-0107179]]).

Taxonomic notes. According to the protologue, the species was described from samples grown at the private garden of Mr. Boog, in Portobello, close to Edinburgh (Scotland). These plants were raised from the seeds collected by Gillies "*in various places on the Chilian side of the Cordillera of the Andes*, *at an elevation of 8000 or 9000 feet above the level of the sea*" (Graham 1830: 177). At the very end of the description, Graham says that he received a letter by Gillies with a list of characteristic features of this new species and a specimen, but he does not mention the origin of the sample (from cultivation or from the wild).

During our search, we have not found cultivated samples of the species seen by Graham but one specimen at E [E00089582] collected by Gillies in "*Andes of Chile et Mendoza*". As in other cases, we cannot be sure if this sample was seen or used by Graham before or while he wrote the description. Therefore, we do not consider this specimen as original material.

Grau and Gronbach (1984), cited as type of *S. hookeri* a sample at K [K000648571], which exhibits the protologue information on the label (where the seeds were collected). In this case, it is possible that the data on the label could be copied from the protologue. Here we recognise this specimen as a neotype because we could not find original material. The same specimen at K has been cited as a holotype by Cosa (2013: 316), but given the previous reason, this should be considered incorrect.

Key characters. Delicate and slender flowers, corolla lilac to rose, with stamens protruding from the corolla tube. The lower middle lobe attenuated into two caudate apex.

Distribution. Southern Andean, endemic from Argentina and Chile. In the mountains of the Coastal range and the Andes. In Chile it grows from Coquimbo (Province of Limarí, 30°35' lat. S) to Biobío (Province of Biobío, 37°20' lat. S) and in Argentina it occurs in the Provinces of Mendoza and Neuquén. 900–3200 m a.s.l.

Cosa (2013: 317) rejects the presence of this species in the Argentinian Province of Mendoza, after checking specimens collected within the limits of this administrative

area. However, we have found one sample of this taxon in the Department of Malargüe (Mendoza) (see the selected specimens examined).

Habitat. *Schizanthus hookeri* is abundant in well-drained screes, along stream sides, slopes next to roads and moraines. Within these places, it grows in fine sandy soil, among rocks. It seems to be less frequent in open areas, including sunny banks or north-facing slopes. Regarding the vegetation, it can be seen in forest of *Nothofagus* Blume, arborescent scrub of *Chuquiraga oppositifolia* D.Don (Asteraceae), *Baccharis neaei* DC. (Asteraceae) and *Festuca acanthophylla* É.Desv. (Poaceae).

Conservation. Argentina. Neuquén: Epu-Lauquén Protected Natural Area.

Chile. Valparaíso: La Campana National Park, Río Blanco National Reserve, Serranía El Ciprés Natural Sanctuary, Juncal Andean Park; **Metropolitana**: El Morado Natural Monument, Cerro El Roble Natural Sanctuary, Yerba Loca Natural Sanctuary; **Maule**: Radal Siete Tazas National Park, Altos de Lircay National Reserve, Bellotos del Melado National Reserve; **Ñuble:** Los Huemules de Niblinto National Reserve (Rodríguez et al. 2008); **Biobío**: Laguna del Laja National Park.

Selected specimens examined. Argentina. Mendoza: [Malargüe Department] Trayecto desde Malargüe a Las Loicas, 1400–1750 m a.s.l., 29 Jan 1994, *C. Villagrán*, *F. Hinojosa & R. Villa 8108* (CONC); **Neuquén: [Huilliches Department]** Reserva Laguna de Epu-Lauquen, 36°49'3"S, 71°4'51"W, 1470 m a.s.l., 2 Dec 2012, *F.O. Zuloaga*, *L. Aagesen*, *M.V. Nicola & D.L. Salariato 15173* (SI);

Chile. Coquimbo: [Limarí Province] El Maitén, 90 km al oriente de Ovalle, 1340 m a.s.l., 13 Nov 1943, *R. Wagenknecht 149* (CONC, SGO, US); Cord. Ovalle, Cerro Loica, 2200 m a.s.l., 18 Dec 1965, *C. Jiles 4734* (CONC); Camino a Central Los Molles, km 13, 30°43'42.4"S, 70°31'28.6"W, 1700 m a.s.l., 21 Jan 2005, *M. Muñoz 4535* (SGO); **[Choapa Province]** Cerro Curimahuida, 10 km east of Matancilla and 15 km northeast of Sánchez mine, 2600–2800 m a.s.l., 23 Nov 1938, *C.R. Worth & J.L. Morrison 16671* (SI); Dpto. Illapel, La Polcura, 31°30'S, 70°40'W, 2400 m a.s.l., 16 Feb 1962, *C. Jiles 4255* (CONC); Las Mollacas, Cord. d. Illapel, Jan 1888, *Unknown s.n.* (SGO); **Valparaíso: [Quillota Province]** Between abandoned copper mine and bronze memorial plaque to Darwin, near summit of La Campana (Bell Mountain), 10 miles east of El Granizo, ca. 1750 m a.s.l., 15 Dec 1957, *W.J. Eyerdam 10087* (F, SGO, US); Above Ramayama copper mine, Cerro Las Vizcachas, 1860 m a.s.l., 7 Dec 1951, *P.C. Hutchinson 95* (F, US); Cerro La Campana, cerca de placa de Darwin, 1600 m a.s.l., 25 Nov 1962, *P. Weisser 390* (CONC); **[San Felipe Province]** Santuario Serranía El Ciprés, 32°39'12"S, 70°48'57"W, 1779 m a.s.l., 21 Dec 2013, *A. Madrid & J. Larraín 186* (CONC); **[Los Andes Province]** Portillo, Caracoles, 32°50'S, 70°7'W, 2580 m a.s.l., 14 Feb 1995, *K. Gengler 35* (CONC); Parque Andino Juncal, Sendero Las Canchitas, 32°55'17.5"S, 70°4'58.1"W, 2726 m a.s.l., 5 Mar 2011, *M.F. Gardner*, *C. Morter & G. Ovstebo 273* (E); Minera Andina, Saladillo, bajando desde túnel principal, 33°3'41.5"S, 70°14'54.6"W, 2900 m a.s.l., 16 Jan 2002, *M. Muñoz 4147* (SGO); **Metropolitana: [Chacabuco Province]** Altos de Chicauma, 33°12'S, 70°56'W,

2050 m a.s.l., 10 Jan 2003, *N. García 3799* (CONC); Camino a cerro El Roble, portezuelo hacia mina de cuarzo, 11 Jan 2004, *M. Muñoz 4413* (SGO); Estero Colina, en el lecho mayor del estero, 33°11'56.5"S, 70°35'30"W, 14 Nov 2009, *V. Morales & F. Cornejo 9* (SGO); **[Santiago Province]** Santuario de la Naturaleza Yerba Loca, ladera al NO del estero de La Yerba Loca, sector Qda. Agua Blanca, 33°17'S, 70°19'W, 2430 m a.s.l., 27 Feb 2000, *M.T.K. Arroyo*, *M. Mihoc & C. Valdivia 202026* (CONC); Valle Nevado, 3 Km del cruce con La Parva, 33°21'34.5"S, 70°17'34.2"W, 2380 m a.s.l., 25 Jan 2003, *M. Muñoz 4352* (SGO); Peñalolén, 1600–2300 m a.s.l., 30 Dec 1928, *G. Looser 914* (SI); **[Cordillera Province]** San José de Maipo, Cajón de Morales: entre Baños Morales y las Panimávidas, 33°48'S, 70°4'W, 1850 m a.s.l., 22 Dec 2001, *S. Teillier & C. Márquez 5255* (CONC); Bei Lo Valdés, 2500 m a.s.l., 2 Jan 1968, *O. Zoellner 2561* (L); Cajón del Yeso, Termas El Plomo, 3000 m a.s.l., 20 Jan 1995, *M. Muñoz*, *A. Moreira*, *I. Meza & J. Arriagada 3589* (SGO); **O'Higgins: [Cachapoal Province]** Camino de Caletones a Colón, km 2, 1700 m a.s.l., 17 Nov 1970, *C. Marticorena & E. Weldt 661* (CONC, F); Cajón del Río Claro, Rengo, 34°30'S, 70°41'W, 6 Nov 2003, *Fundación Philippi 97* (SGO); **[Colchagua Province]** Quebrada camino V. del Flaco, Huertecillas, 1100 m a.s.l., 8 Jan 1951, *M. Ricardi s.n.* (CONC); Alto Huemul, coord. UTM 345976E – 6137905N, 1645 m a.s.l., 3 Jan 2006, *L. Faúndez & B. Larraín 1289* (CONC); **Maule: [Curicó Province]** Hacienda Monte Grande, ca. 1700 m a.s.l., Dec 1924, *E. Werdermann 509* (CONC, E, F, SI, U, US); Molina, Área de Protección, Radal Siete Tazas, camino hacia cerro El Alto, 29 Dec 1989, *M. Muñoz 2514* (SGO): **[Talca Province]** Laguna del Maule, 36°1'S, 70°33'W, 2250 m a.s.l., 24 Jan 1990, *M.F. Gardner & S. Knees 4473* (E, SGO); Alto de Vilches, camino a Laguna El Alto, 35°36'S, 71°1'W, 1800 m a.s.l., 29 Jan 2000, *V. Finot & P. López 1732* (CONC); **[Linares Province]** Reserva Nacional Bellotos del Melado, 35°51'S, 71°5'W, 1330 m a.s.l., 19 Dec 1999, *M.T.K. Arroyo*, *P. MacPherson*, *M. Mihoc*, *A. Humaña & C. Valdivia 996027* (CONC, SGO); Cajón de Ibáñez, 19 Jan 1938, *Castellanos s.n.* (BA); **Ñuble: [Diguillín Province]** Termas de Chillán, 1800 m a.s.l., 5 Feb 1936, *A.L. Cabrera 3634* (F); Termas de Chillán, Sendero hacia fumarolas, sobre nivel del bosque, 6 Feb 1993, *M. Muñoz 3239* (SGO); Cord. de Chillán, Los Moscos, 1700 m a.s.l., Jan 1937, *C. Grandjot & G. Grandjot 2028* (CONC); **Biobío: [Biobío Province]** Orillas de la Laguna del Laja, 24 Jan 1969, *M. Ricardi & C. Marticorena 5816/1977* (CONC, F).

9. *Schizanthus grahamii* Gillies ex Hook., Bot. Mag. 58: tab. 3044. 1831

Fig. 4E–H

Schizanthus retusus Hook., Bot. Mag. 58: tab. 3045. 1831.
Schizanthus gilliesii Phil., Linnaea 29(1): 28. 1858.
Schizanthus araucanus Phil., Anal. Univ. Chile 91: 121. 1895.
Schizanthus diazii Phil., Anal. Univ. Chile 91: 122. 1895, as "*diazi*".
Schizanthus grahamii var. *araucanus* (Phil.) Reiche, Anal. Univ. Chile 125: 478. 1909.

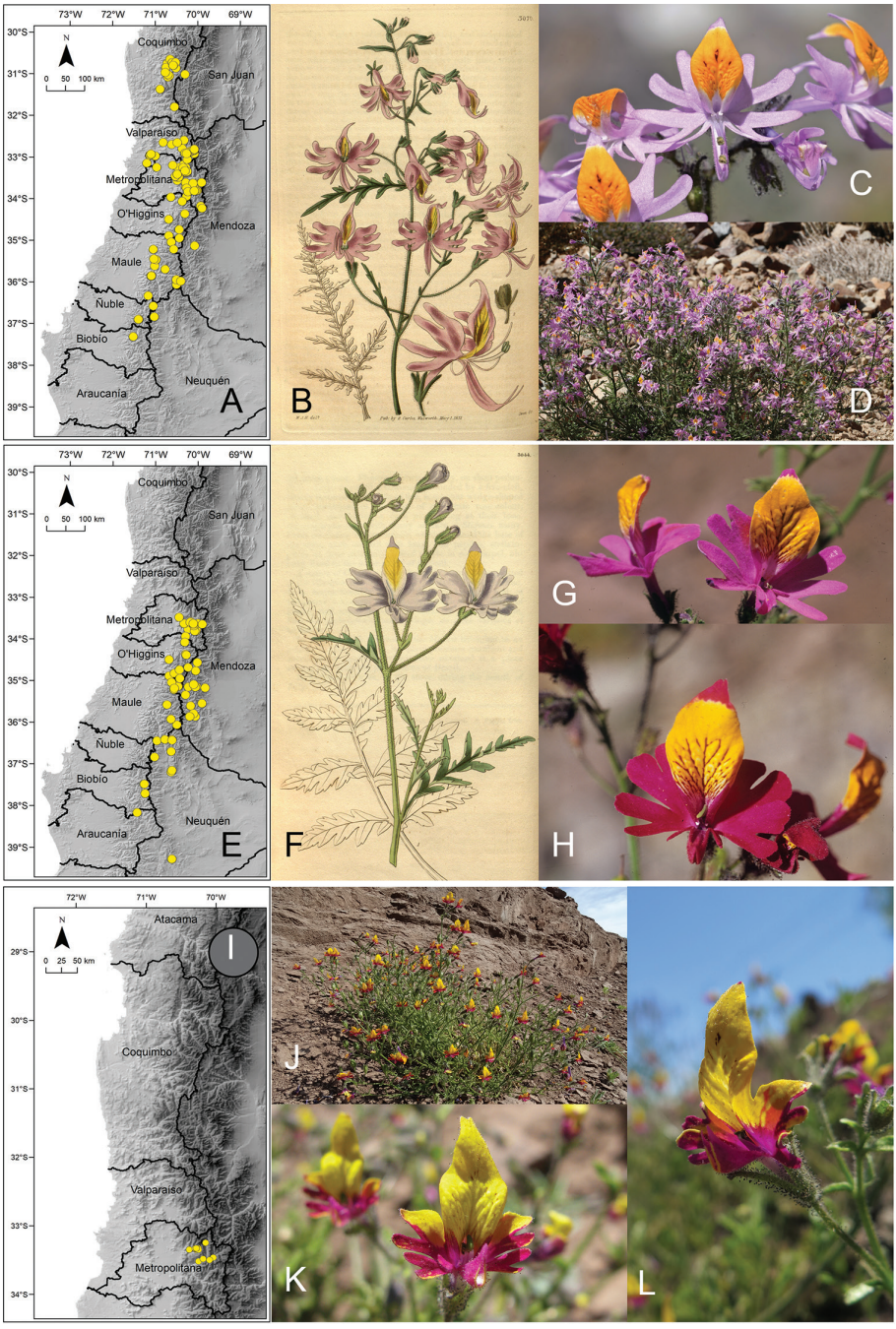

Figure 4. A distribution of *Schizanthus hookeri* **B** illustration of *S. hookeri* published with the description of the species (Graham 1830) **C** examples of *Schizanthus hookeri* in Juncal Andean Park **D** La Campana National Park **E** distribution of *Schizanthus grahamii* **F** illustration of *S. grahamii* published with the description of the species (Hooker 1831a) **G** examples of *S. grahamii* in Paso Vergara **H** Termas del Flaco **I** distribution of *Schizanthus coccineus* **J–L** examples of *S. coccineus* in La Parva (Metropolitan Region). Photos by M. Aldunate (**C**), A. Moreira-Muñoz (**D, K**), S. Moreira (**G, H**), C. Jirón (**J**), V. Morales (**L**).

Type. Argentina. Mendoza: On the Mendoza side of the cordillera of the Andes at an elevation of about 9000 feet, *J. Gillies s.n.* (neotype designated by Grau and Gronbach 1984, pg. 124 [as type]: K! [K000585353]).

Taxonomic notes. The original description mentions that the species was grown in the private garden of Mr. Boog in Portobello, raised from seeds collected by Gillies in Chile. Together with the description, an illustration by Dr. Greville was published.

The species was described and validly published by W.J. Hooker in 1831, while he was working as a professor of botany in Glasgow. Therefore, the material seen by him should be found at GL (now on permanent loan to E), although, some of his types were moved to K when he was appointed director of the Royal Botanic Gardens, Kew (Stafleu and Cowan 1979). We have searched for cultivated specimens of the species on these herbaria and we have not found specimens that could be linked to the protologue. However, we have found a cultivated specimen at GH [00077407], labelled at the top right corner as "*S. grahamii Gillies*". The smaller branch on the sheet, located at the right bottom corner says "*Mr. Boog's Garden Portobello 30th July 1830*". In this case, the place and date of flowering corresponds with the data given in the original description. The other three branches on the sheet were labelled as "*Native specimens from Dr. Gillies 26 Augt 1830*". We think this refers to the date of collection at Portobello, because Gillies was in South America until 1828. In our opinion, the specimen at GH cannot be considered as original material because we cannot be sure if it was seen by the author of the species.

Here we accept the inadvertent neotypification made by Grau and Gronbach (1984: 128), as they selected a specimen of the species that was collected by Gillies in the Andes of Mendoza [K000585353]. This selection does not look obvious as the protologue mentions Chile as the place where the seeds were collected. However, at the time when Gillies collected the material, Mendoza was associated with the administrative area called Corregimiento de Cuyo, controlled by the Capitanía General de Chile. In a previous publication, Cosa (2013: 316) cited the same sample at K as holotype of *S. grahamii*. We think this is not correct, as the holotype of the species corresponds to a cultivated sample.

Key characters. The upper middle corolla lobe is almost completely yellow, except for the apex and it looks bigger than the other segments of the corolla. Often confused with *S. hookeri*, because of its geographical distribution and the corolla form. However, the flower has short stamens, that barely protrude from the corolla tube and the lower middle lobe is attenuated into two short pointed apex.

Distribution. Southern Andean, endemic from Argentina and Chile. In Chile it grows from the Metropolitan Region (Province of Santiago, 33°25' lat. S) to Biobío, while on the Argentinian side it inhabits the Provinces of Mendoza and Neuquén (Department of Catan Lil, 39°20' lat. S). 1200–2900 m a.s.l.

Habitat. *Schizanthus grahamii* is abundant in areas close to watercourses, such as lakes, rivers or quebradas. It grows among rocks or in loose stony places, also located at the bases of hillsides, where it is common to find scree slopes and alluvial plains. It

seems to grow very well in shady places (south-facing slopes), dominated by *Acaena splendens* Hook. & Arn. (Rosaceae), *Calceolaria hypericina* Poepp. ex Benth. (Calceolariaceae), *Calceolaria dentata* Ruiz & Pav. (Calceolariaceae), *Glandularia berteroi* (Schauer) Muñoz-Schick (Verbenaceae) and in places by thickets of *Diostea juncea* (Gillies & Hook. ex Hook.) Miers (Verbenaceae) and among low shrubby vegetation.

Conservation. Argentina. Neuquén: Epu-Lauquén Protected Natural Area.

Chile. Metropolitana: Río Clarillo National Reserve, El Morado Natural Monument; **Biobío:** Laguna del Laja National Park (Rondanelli et al. 2000).

Selected specimens examined. Argentina. Mendoza: [Malargüe Department] De Ruta Nacional 40 a Valle de Las Leñas, 35°10'36"S, 69°49'60"W, 22 Nov 2010, *F.O. Zuloaga*, *D.L. Salariato*, *C.A. Zanotti & L. Zavala 12337* (SI); RP 226, de Las Loicas a termas del Azufre, camino hacia las termas, 35°20'56"S, 70°17'44"W, 2002 m a.s.l., 19 Jan 2018, *D.L. Salariato*, *L. Aagesen*, *J.M. Acosta & A. Martínez 100* (SI); **Neuquén: [Huiliches Department]** Lagunas de Epu-lauquén, 36°49'8"S, 71°3'10"W, 1520 m a.s.l., 26 Nov 2010, *F.O. Zuloaga*, *D.L. Salariato*, *C.A. Zanotti & L. Zavala 12517* (SI) **[Minas Department]** Laguna Varvarco Campos, 36°25'27"S, 70°37'9"W, 1959 m a.s.l., 15 Feb 2007, *J. Chiapella*, *G.E. Barbosa*, *F. Chiarini & M. Matesevach 1865* (SI);

Chile. Metropolitana: [Cordillera Province] Along the Embalse El Yeso, along the access road 4 km upstream from the dam, 33°35–40'S, 70°10–15'W, 2510 m a.s.l., 14 Jan 1993, *C.M. Taylor & R.E. Gereau 10927* (ASU, CONC, SGO); Río Volcán – Cajón del Morado, 33°46'41"S, 70°2'32"W, 2580 m a.s.l., 29 Jan 2009, *S. Teillier*, *F. Romero*, *I. Goic & X. Romero 5628A* (CONC); Laguna Negra ribera Este, 33°38'51"S, 70°6'46"W, 2916 m a.s.l., 5 Dec 2008, *A. Moreira 1107* (SGO); **O'Higgins: [Cachapoal Province]** El Teniente, rock-slides, near Río Coya, 2500–2700 m a.s.l., 26 Jan 1925, *W. Pennell 12282* (F, SGO); Cajón del Río Claro, Rengo, 34°30'S, 70°41'W, 6 Nov 2003, *Fundación Philippi 84* (SGO); **[Colchagua Province]** Las Huertecillas, entre la Pava y Qda. San Andrés, coord. UTM 368224E – 6154259N, 1724 m a.s.l., 31 Jan 2006, *N. García*, *F. Romero & P. Contreras 3427* (CONC); Termas del Flaco, inicio y base cerro Verde hacia huellas de dinosaurios, 34°57'7.5"S, 70°25'47"W, 1790 m a.s.l., 11 Jan 2006, *M. Muñoz 4752* (SGO); **Maule: [Curicó Province]** Alrededores de la Laguna de Teno, 35°10'S, 70°33'W, 2560 m a.s.l., 29 Mar 1973, *C. Marticorena*, *O. Matthei & R. Rodríguez 19* (CONC); Camino a Paso Vergara, pasado control policial, 35°8'45"S, 70°28'29"W, 1913 m a.s.l., 28 Jan 2003, *M. Muñoz 4370* (SGO); **[Talca Province]** Por ruta nacional n115, ca. 17 km de la Laguna de Maule, viniendo desde San Clemente, 35°55'39"S, 70°38'16"W, 1424 m a.s.l., 9 Feb 2007, *J. Chiapella*, *G.E. Barbosa*, *F. Chiarini & M. Matesevach 1660* (SI); SW del Descabezado del Maule, 1877, *E. Williams s.n.* (SGO); **[Linares Province]** Laguna Dial, 35°25'S, 70°55'W, 1520 m a.s.l., 25 Jan 1961, *F. Schlegel 3671* (CONC); **Ñuble: [Punilla Province]** Cord. "San Carlos", Feb 1925, *E. Barros s.n.* (CONC); **Biobío: [Biobío Province]** Los Pinos. Extremo sur de la Laguna Laja, 27 Feb 1951, *F. Behn s.n.* (CONC); Trapa-Trapa, Araucanía, 28 Jan 1887, *C. Rahmer s.n.* (SGO).

10. *Schizanthus coccineus* (Phil.) J.M.Watson, Pl. Altoandinas Fl. Silv. Chile: 140. 1998
Fig. 4I–L

Schizanthus grahamii var. *coccinea* Phil., Anal. Univ. Chile 91: 121. 1895.

Type. Chile. Metropolitana: Alfalfar, Dec 1887, *L. Kunze s.n.* (lectotype here designated: SGO! [SGO000004516 acc. #055328]; isolectotype: SGO! [SGO000004515 acc. #042891]).

Taxonomic notes. In this case, we have found two sheets of the same collection that agree with the data given in the protologue. For this reason, we have designated the best preserved specimen as the lectotype.

Key characters. Upper lip bi-coloured; yellow in the middle lobe and the upper half of the lateral lobes, while the lower half is mostly reddish, that continues to the lower lip. Upper middle lobe almost two times longer than the lateral lobes.

Distribution. Endemic to Chile, in the Andean mountains of the Metropolitan Region (Provinces of Santiago and Cordillera, 33°15'–33°30' lat. S). 2000–2900 m a.s.l.

Habitat. *Schizanthus coccineus* has been found growing over loose soil; mostly along roadsides and in wet or flooded areas (vegas).

Conservation. Chile. Metropolitana: Río Clarillo National Reserve (Teillier et al. (2005).

Selected specimens examined. Chile. Metropolitana: [Santiago Province] Valle de Mapocho, La Ermita, 33°20'S, 70°22'W, 2650 m a.s.l., 13 Mar 1992, *M.F. Gardner*, *A. Hoffmann & C. Page 5118* (E); La Parva, 33°19'48"S, 70°16'57"W, 2860 m a.s.l., 25 Jan 2008, *A. Moreira 1028* (SGO); **[Cordillera Province]** Tupungato, Río Colorado, Baños Salinillas, 1500 m a.s.l., 4 Jan 1930, *F. Behn s.n.* (CONC).

11. *Schizanthus litoralis* Phil., Anal. Univ. Chile 91: 118. 1895

11a. *Schizanthus litoralis* var. *litoralis*
Fig. 5A–D

Type. Chile. Valparaíso: Médanos Concon, 10 Dec 1884, *F. Philippi s.n.* (lectotype designated by Grau and Gronbach 1984, pg. 136 [as type]: SGO! [SGO000004531 acc. #055374]).

Taxonomic notes. For years, the name of this species was wrongly associated with the new species *S. carlomunozii* as growing from Coquimbo to Valparaíso (see notes under *S. carlomunozii*). The Fig. 5A–D depicts the true *S. litoralis* described by R.A. Philippi. In this case, the types of *S. litoralis* var. *litoralis* were especially important, as some flowers still show a darker colour on the lower lip, a character not mentioned by R.A. Philippi but that is distinctive of the species.

Most of the data on the lectotype matches other two specimens at SGO [SGO000004529 acc. #055325, SGO000004530 acc. #055326], except for the day and month of the collection (12th October). However, none of them can be discarded as type material, because the original description only mentions the year of collection (1884). The similarities between day and month (10 = October and 12 = December), make us think that the date could be erroneously swapped on the labels. Unfortunately, we cannot tell with certainty which was the true date of collection or if these specimens correspond to the same collection. Therefore, we decided to treat these two specimens as syntypes, conserving the lectotype chosen by Grau and Gronbach (1984).

Key characters. Delicate plant with flowers with noticeable dark purple to burgundy colour on the lower lip and faint or no spotting on any lobe, except on the yellow area of the upper middle lobe.

Distribution. Endemic to Chile, in the coast of the Region of Valparaíso (between the Provinces of Petorca and Valparaíso, 32°30'–33°10' lat. S). Photos in Fig. 5B–D correspond to cultivated specimens, which were grown from seeds collected in Dunas de Concón, growing upon the paleodune. The original population at Dunas de Concón, apparently no longer exists due to urban development. 10–100 m a.s.l.

Habitat. *Schizanthus litoralis* var. *litoralis* has been seen growing on sandy soil and between the fissures of the coastal rocks. Forms part of the coastal scrubland.

Conservation. Chile. Valparaíso: Dunas de Concón Natural Sanctuary (apparently locally extinct).

Selected specimens examined. Chile. Valparaíso: [Valparaíso Province] Dunas de Con Con, sobre las dunas a 100 m de la placa de Santuario mirando al mar, 32°56'36"S, 71°32'40"W, 30 m a.s.l., 7 Oct 2002, *A. Moreira 688* (SGO); Road along the coast, S. of Cachagua, N of Quintero, 32°36'35"S, 71°25'57"W, 100 m a.s.l., 10 Nov 2006, *E.J. Tepe*, *A. Marticorena & P.B. Pelser 1947* (CONC); N von Valparaíso, Oct 1967, *O. Zoellner 1856* (L).

11b. *Schizanthus litoralis* var. *humilis* (Lindl.) V.Morales & Muñoz-Schick, comb. nov.

urn:lsid:ipni.org:names:77210705-1
Fig. 5E–G

Schizanthus pinnatus var. *humilis* Lindl., Edwards's Bot. Reg. 18: T. 1562. 1833.
Schizanthus tricolor Grau & E.Gronbach. Mitt. Bot. Staatssamml. München 20: 143. 1984.

Type. Chile. Valparaíso: *H. Cuming 712* (lectotype designated by Grau and Gronbach 1984, pg. 143 [as type]: BM! [BM000994719]; isolectotypes: E! [E00089563, E00089564], MEL! [MEL-2449923 pro parte A]).

Taxonomic notes. This taxon was first described by Lindley (1833). He recognised that the specimens available exhibited two well-defined characters; the flowers grouped

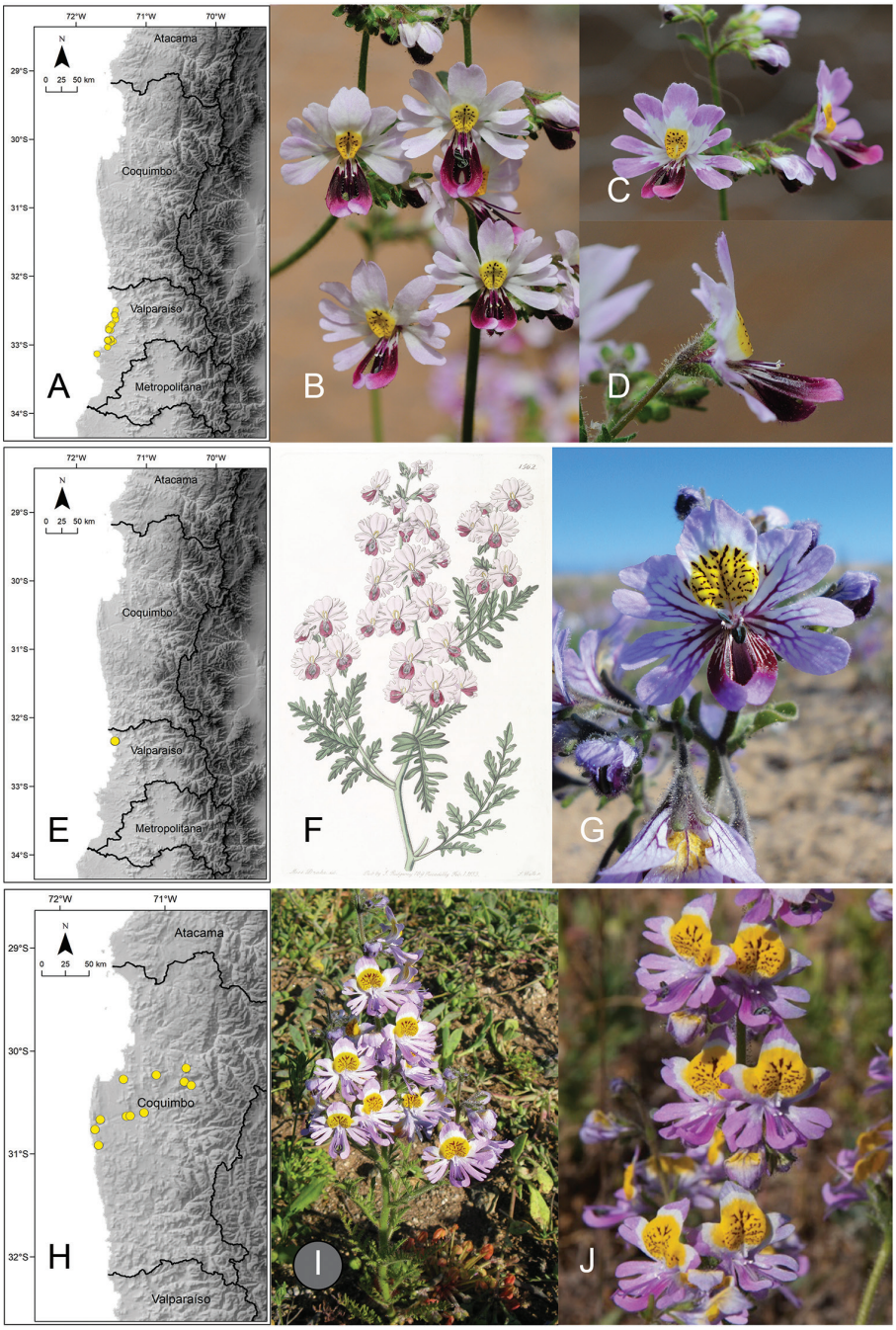

Figure 5. A distribution of *Schizanthus litoralis* var. *litoralis* **B–D** examples of *S. litoralis* var. *litoralis* in Colegio Sagrada Familia (Reñaca) **E** distribution of *Schizanthus litoralis* var. *humilis* **F** illustration of *S. litoralis* var. *humilis* published with the description of the species (Lindley 1833) **G** example of *S. litoralis* var. *humilis* in Pichicuy **H** distribution of *Schizanthus splendens* **I** examples of *S. splendens* in Hacienda El Tangue (south of Tongoy) **J** road Ovalle-Socos. Photos by S. Elórtegui (**B–D**), V. Morales (**G**), A de Trenqualye (**I**), M. Aldunate (**J**).

in congested racemes and the total height of the plants lower than those mentioned for *S. pinnatus*. The second character was used by Lindley to describe this taxon as a dwarf variety of *S. pinnatus*.

Regarding the type material, it appears that Lindley (1833) had access to cultivated material as well as material from the wild. First, he cites living material that flowered in June of 1832 at the private garden of the Comte de Vandes, at Bayswater (London). In the same paragraph, the author establishes that the plants were the product of seeds collected by Hugh Cuming. What is not clear is if Lindley had access to fresh or dried samples from the cultivated plants. In the following paragraph, he mentions some dried specimens collected in Chile by Cuming under the number 712. Therefore, the group of samples seen by Lindley should be treated as syntypes, thus requiring necessary lectotypification. We have not found herbarium sheets that agree with the data from cultivated material. Instead, we have found four specimens numbered as 712 by Cuming that match the characters of the species. One of them has been selected as lectotype of Lindley's name by Grau and Gronbach (1984: 143). This is a very poor sample of the species, that only shows the basal leaves of a single plant with a label saying "*Schizanthus*, *Cum 712*, *3898*". Of the specimens at E, one is the best-preserved sample [E00089563] and the other shows a more detailed locality (Valparaiso) [E00089564]. Here we recognise all the specimens collected by Cuming 712 as a single collection and as isolectotypes.

Key characters. It has a dark purple colour on the lower lip, but it differs from *S. litoralis* var. *litoralis* because of the distinct purple venation at the base of each corolla lobe.

Distribution. Endemic to Chile, along the coast of the Region of Valparaíso (Province of Petorca, 32°20'–32°35' lat. S). This variety has been reported from the Dunes in Pichicuy and also in Cachagua (Villagrán et al. 2007). However, only the population in Pichicuy has been observed during the last decade

Habitat. It grows within a narrow zone on the foredunes, associated with *Ambrosia chamissonis* Greene (Asteraceae), *Solanum coquimbense* J.R.Benn. (Solanaceae) and *Senecio bahioides* Hook. & Arn. (Asteraceae).

Conservation. Chile. Valparaíso: Humedal de Pichicuy Protected Area.

Selected specimens examined. Chile. Valparaíso: [Petorca Province] Final sur Playa Pichicuy, 32°20'24.1"S, 71°26'50.3"W, 10 m a.s.l., 12 Aug 2008, *M. Muñoz 5000* (SGO); Pichicuy, dunes behind beach, 32°20'35"S, 71°27'05"W, 2 m a.s.l., 9 Nov 2006, *E.J. Tepe*, *A. Marticorena & P.B. Pelser 1886* (CONC); Zapallar (médanos de Cachagua), 25 Sep 1909, *F. Johow s.n.* (CONC).

12. *Schizanthus splendens* Sudzuki, Agricultura Técnica, Chile 5(1): 33. 1945

Fig. 5H–J

Type. Chile. Coquimbo: Llano de Los Loros, 10 Sep 1942, C. Muñoz & E. Pisano 3349 (lectotype here designated: SGO! [SGO000004537 acc. #148994]; isolectotype: SGO! [SGO000004538 acc. #143619]).

Taxonomic notes. In the protologue, the author mentions the holotype as being held at the National Museum of Natural History, Santiago. Within the type col-

lection at SGO, we have found two sheets of this species, which are duplicates. In comparing the label data with the protologue, we identified some differences. In the description, the author cited Muñoz & Johnson as collectors of the specimens, but without giving a date of collection. This was an oversight because the herbarium specimens were collected by Carlos Muñoz & Edmundo Pisano and they clearly show the date of collection. This oversight could have occurred because Sudzuki had access to the specimens before they were mounted, in order that she could complete her thesis on the genus *Schizanthus*.

Grau and Gronbach (1984) did not recognise this name as an accepted species, citing it as synonym of *S. litoralis*. On page 136, the authors cited the type of *S. splendens* just giving the data from the protologue and without indicating the specimens as occurring at SGO. We are selecting as lectotype the specimen which has a label with the name of the species and the descriptor ("*S. splendens nov. sp. Sudzuki*"), while the second specimen was lacking this information.

Key characters. Flowers similar in form to *S. carlomunozii* var. *carlomunozii* as they exhibit a white halo around the yellow area but without any dark spots outside of it. The flowers are subsessile with peduncles up to 4 mm long, instead of 0.5–2.5 cm in *S. carlomunozii*.

Distribution. Endemic to Chile, in the Region of Coquimbo (Provinces of Elqui and Limarí, 30°10'–31°0' lat. S). 350–1800 m a.s.l.

Habitat. Along roadsides and in flat areas; over clayed soil.

Conservation. Chile. Coquimbo: Fray Jorge National Park.

Selected specimens examined. Chile. Coquimbo: [Elqui Province] Cordillera de Ovalle, Cerro Tololo, 1800 m a.s.l., 26 Oct 1971, *C. Jiles 6302* (CONC); Andacollo 5 km al sur, 33°15'S, 71°06'W, 1100–1200 m a.s.l., 1–6 Apr 2008, *M. Mihoc 325* (CONC); **[Limarí Province]** Salida S de Ovalle, planicies, 22 Aug 1991, *M. Muñoz 2566* (SGO); Carretera Panamericana, 19 km al norte de la Quebrada del Teniente, 16 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1440* (CONC, F).

13. *Schizanthus porrigens* Graham ex Hook., Exot. Fl. 2: tab. 86. 1824

13a. *Schizanthus porrigens* subsp. *porrigens*

Fig. 6A–E

Schizanthus porrigens Graham, Edinb. N. Phil. Journ. 11: 401. 1824.
Schizanthus tenuifolius Phil., Anal. Univ. Chile 91: 118. 1895.
Schizanthus tenuis Phil., Anal. Univ. Chile 91: 124. 1895.
Schizanthus heterophyllus Phil., Anal. Univ. Chile 91: 125. 1895.

Type. United Kingdom. Scotland: Hort. Edin. [cultivated material at the Royal Botanic Garden Edinburgh] (lectotype designated here: E! [E00089607]; isolectotype: E! E00089608]).

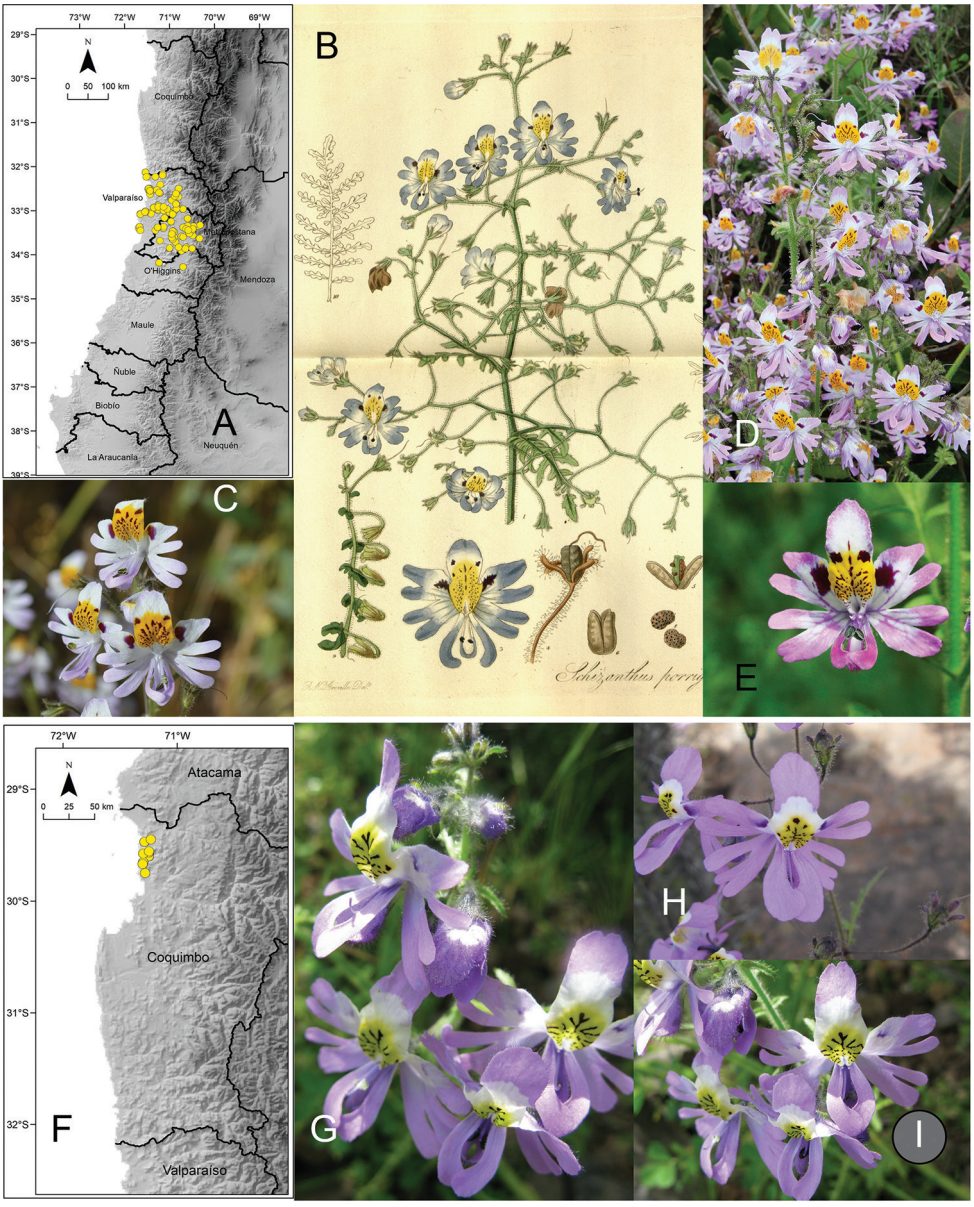

Figure 6. A distribution of *Schizanthus porrigens* **B** illustration of *S. porrigens* published with the description of the species (Hooker 1824) **C** examples of *S. porrigens* in Putaendo **D** Cerro La Huinca (Limache) **E** Los Molles (Valparaíso Region) **F** distribution of *Schizanthus porrigens* subsp. *borealis* **G–I** examples of *S. porrigens* subsp. *borealis* in Cuesta Buenos Aires (north of La Serena). Photos by A. Cádiz (**C**), A. Moreira-Muñoz (**D, E, G–I**).

Taxonomic notes. The name *Schizanthus porrigens* was first used by Graham (1824) when he listed this rare plant growing outside at the Royal Botanic Garden Edinburgh. Grau and Gronbach (1984: 134) accepted this name as being validly pub-

lished by Graham, but in our opinion, Graham's (1824) is not a valid publication of the name, as it only provides a short comparison to *S. pinnatus*, based on the smaller first emerging leaves ("*This species may be distinguished from S. pinnatus even in the seed bed, but the seminal leaves being shorter.*"). Hence, the specimen cited by Grau and Gronbach ("*s.n. Graham* (*E*)"), should be not considered as type of the name validly published by W.J. Hooker and illustrated by R.K. Greville.

Studying the original description, it is clear to us that the species was described based on cultivated material. Hooker (1824) stated that the plants at the Royal Botanic Garden Edinburgh were growing with individuals of another species, which was previously published by him (Hooker 1823) (as *S. pinnatus*, but represents *S. litoralis* var. *litoralis*). Hooker (1823) stated that the seeds were collected by Mr. Cruikshanks [Cruckshanks] and sent to Dr. Graham in Edinburgh. Hooker (1824) cited much information from Graham in his description of *S. porrigens*.

In trying to locate the type material, we searched for specimens at E and K, as these are the herbaria which hold most of the type specimens by W.J. Hooker (see Taxonomic notes under *S. grahamii*). At K, we could not find any specimens of *S. porrigens* but we found 15 samples at E (https://data.rbge.org.uk/search/herbarium/). Of these, only five were labelled as *S. porrigens* [E00089607, E00089608, E00089609, E00089610, E00089611]. The first two sheets were identified as possible types of the name *S. porrigens* Graham by Gronbach in 1983. We think these two specimens are part of the same collection, as both have Greville's handwriting and show complementary parts of an individual plant: the specimen E00089607 shows the inflorescence while E00089608 comprises a branch with several leaves. We think these specimens could have been used by Greville for illustrating the description. On the other hand, sheets E00089609, E00089610, E00089611 originated from GL and have the handwriting of W.J. Hooker (H. Noltie 2019, pers. comm.). Additionally, we found two herbarium sheets at P that can be related to the description [P00477566, P00477611]. The first one says "*Schizanthus porrigens Hook. Fl. Exot. E Chile* (*misit Hooker 1824*) *4733*". The second sheet has the same information, except for the name of the species "*Schizanthus pinnatus*". Both labels were handwritten by Hooker, except for the annotation "*misit Hooker 1824"*, which could have been added by E. Drake, former owner of the collection, meaning that the specimens were sent to him by Hooker in 1824 (H. Noltie 2019, pers. comm.). This data matches the year when Hooker described the species. Surely the specimens are duplicates and were part of an exchange of material between herbaria from the United Kingdom and France. We think specimens listed above should be treated as original material of the name *Schizanthus porrigens* Graham ex Hook. Following Turland et al. (2018: Art. 9.3.), we select the sheet E00089607 as lectotype and E00089608 as isolectotype, as they are considered duplicates and the only sheets that we can clearly relate to the description by Hooker (1824), even though it seems that all other specimens were seen by him.

Key characters. *Schizanthus porrigens* subsp. *porrigens* is a very variable species, especially in the colour of the flowers, which vary from intense rose and sometimes bluish to white. The spots are also variable; with two little ones at the sides of the up-

per middle lobe and two slightly larger at the upper lateral lobes (in the separation of the lateral and middle lobes). Sometimes, it has a purple irregular line above the yellow area. When the corolla is mostly white, the lower lip has a larger portion coloured light purple, but the same colour also occurs at the margin of the upper lateral lobes.

Distribution. Endemic to Chile, between the Regions of Coquimbo (Province of Choapa, 32°5' lat. S) and O'Higgins (Province of Cachapoal, 34°20' lat. S). 20–1800 m a.s.l.

Habitat. One of the most widespread species inhabiting from the coast to the cordillera, in different types of substrates; in shrubby and sclerophyllous communities.

Protected areas. Chile. Valparaíso: La Campana National Park, BioParque Puquén-Los Molles Private Reserve, Acantilados Federico Santa María Natural Sanctuary, Palmar El Salto Natural Sanctuary, Serranía El Ciprés Natural Sanctuary; **Metropolitana**: Río Clarillo National Reserve, Cerro El Roble Natural Sanctuary, Yerba Loca Natural Sanctuary, Altos de Cantillana Natural Sanctuary.

Selected specimens examined. Chile. Coquimbo: [Choapa Province] Pichidangui, 32°9'S, 71°31'W, 15 m a.s.l., 18 Nov 1960, *J. Petersen s.n.* (CONC); **Valparaíso: [Petorca Province]** 3 km al S de Papudo, 32°31'S, 71°28'W, 50 m a.s.l., 10 Nov 2001, *C. Aedo 6817* (CONC); Caleta Los Molles, inicio sendero al Puquén, 32°14'11.3"S, 71°30'59.7"W, 217 m a.s.l., 19 Oct 2008, *M. Muñoz 5070* (SGO); **[Quillota Province]** Cuesta El Melón, 32°40'S, 71°15'W, 500 m a.s.l., 10 Feb 1990, *C. von Bohlen 650* (CONC); Parque Nacional La Campana, sector Ocoa, sobre la cascada, 32°57'40.428"S, 71°3'13.86"W, 10 Dec 2000, *A. Moreira 487* (SGO); **[San Felipe Province]** Cuesta Las Chilcas, 32°51'1.5"S, 70°51'32.8"W, 508 m a.s.l., 19 Oct 2008, *M. Muñoz 5065* (SGO); Santuario Serranía El Ciprés, 32°41'12"S, 70°48'14"W, 1167 m a.s.l., 5 Oct 2013, *A. Madrid & J. Larraín 79* (CONC); **[Valparaíso Province]** Viña del Mar (El Salto) langs de weg, 11 Nov 1937, *C. Andreas 24* (L, U); Quilpué, Teniente Serrano – Poza Larga, coord. UTM 274802E – 6337967W, 19 Nov 2004, *O. Fernández 1092* (CONC); Cuesta Zapata, 300 m a.s.l., 27 Oct 1990, *C. von Bohlen 834* (SGO); **[San Antonio Province]** El Quisco, Nov 1976, *H. Gunckel & H. Vergara s.n.* (CONC); El Tabo, Quebrada de Córdoba, 33°25'S, 7 Oct 1980, *C. Villagrán 2878* (SGO); **Metropolitana: [Chacabuco Province]** Altos de Chicauma, sector Loma Blanca, 33°12'S, 70°56'W, 750 m a.s.l., 29 Sep 2002, *N. García*, *C. Valdivia & F. Salinas 3294* (CONC); Montenegro, UTM 19H 0327491-6351928, 12 Oct 2002, *M. Muñoz 4155* (SGO); **[Santiago Province]** Santuario de la Naturaleza Yerba Loca, laderas al borde del estero de la Yerba Loca, cerca de la confluencia con el río San Francisco, 33°19'S, 70°19'W, 1800 m a.s.l., 16 Dec 1999, *M.T.K. Arroyo*, *C. Valdivia & P. McPherson 994740* (CONC, SGO); **[Cordillera Province]** San José de Maipo, 12 Oct 1969, *A. Cid 13* (CONC); La Obra, 820 m a.s.l., 20 Nov 1927, *G. Montero 481* (F); **[Maipo Province]** Cerro Lo Chena, 780 m a.s.l., 26 Nov 1950, *H. Gunckel s.n.* (CONC); Fundo Cullipeumo, Cerro Cullipeumo, Champa, 21 Nov 1976, *I. Gallardo s.n.* (SGO); **[Melipilla Province]** Camino entre Chorombo y Casablanca, en la cuesta, 33°27'S, 71°19'W, 280 m a.s.l., 17 Sep 2009, *I. Escobar 202* (CONC); Alhué, lado del río, 18 Nov 2002, *A. Brinck s.n.* (SGO); Cuesta de Barriga, between Marrue-

cos and Los Cerrillos, 850 m a.s.l., 3 Nov 1948, *E.P. Killip & E. Pisano 39675* (US); **[Talagante Province]** Talagante, Sep 1969, J Salas s.n. (CONC); Mallarauco, 31 Oct 1988, *J.P. Schiappacase s.n.* (F); **O'Higgins: [Cachapoal Province]** Palmería Cocalán, 2 Sep 2004, *Fundación Philippi 89* (SGO); Angostura de Paine, 25 Oct 1969, *O. Zoellner 3461* (CONC); Camino de Rancagua a Caletones, km 14, 1000 m a.s.l., 17 Nov 1970, *C. Marticorena & E Weldt 639* (CONC).

13b. *Schizanthus porrigens* subsp. *borealis* V.Morales & Muñoz-Schick, subsp. nov.

urn:lsid:ipni.org:names:77210706-1
Fig. 6F–I

Diagnosis. Differs from subsp. *porrigens* in its uniform corolla colour, with or without one faint dark spot in the upper part of each lateral lobe (in the separation of the lateral and middle lobe). These spots do not reach the margin of the lobes. A white halo always surrounding the yellow area of the upper middle lobe.

Type. Chile. Coquimbo: norte La Serena-Cuesta Porotitos, N El Arrayán, 29°40'10.5"S, 71°18'17.6"W, 184 m alt., 7 Dec 2008, *M. Muñoz 5023* (holotype: SGO! [acc. #157830]).

Description. Annual plant, glandular-pilose, with one or several stems arising from the same root, up to 50 cm tall. Leaves bipinnatifid, the blade 5.5–7.5(9) cm long, 1.5–2(2.5) cm wide; segments irregularly divided (opposite or alternate), diagonal or perpendicular to the midrib. Inflorescence 9–24 cm long, with basal peduncles up to 10–25 mm long and apical peduncles 4–7 mm long. Calyx hirsute-glandular, the divisions linear-spathulate of 4–6 mm long, 1–1.5 mm wide. Corolla with the tube shorter than the calyx, up to 3 mm long; limb bluish to lilac, 22–28 mm long, 15–20 mm wide; upper middle lobe 12–16 mm long, 5–6 mm wide, oblanceolate, the apex obtuse or sometimes a little retuse, little dotted with dark spots over the yellow area and surrounded by a white halo; upper lateral lobes without spots or sometimes with a small spot in each side (in the separation of the lateral and middle lobes), these spots not reaching the upper margin of each lobe; lower middle lobe 7–9 mm long, 4–6 mm wide; lateral lobes 10–13 mm long, 2–3.5 mm wide, linear-spathulate, longer than the middle lobe. Stamens reaching half of the length of the lower middle lobe. Capsule as long as the calyx, glabrous.

Taxonomic notes. Grau and Gronbach (1984) considered this new taxon as part of the variability of *S. porrigens*. This can be seen in their drawings (Grau and Gronbach 1984: Abb. 22, 23), based on specimens collected between Playa Temblador and Cruz Grande, in the Coquimbo region.

We have named this taxon as subsp. *borealis*, meaning its populations have a more northern distribution than the typical subspecies.

Key characters. *Schizanthus porrigens* subsp. *borealis* has a bluish or lilac uniform corolla colour, without or with one faint dark spot in the upper part of each lateral lobe (in the separation of the lateral and middle lobe). These spots do not reach the margin of the lobes.

Distribution. Endemic to Chile, in the coast of the Region of Coquimbo (Province of Elqui, 29°25'–29°50' lat. S). 170–600 m a.s.l.

Habitat. Inhabits shady hillsides and ravines, rocky outcrops with large boulders. It can be found among dense vegetation dominated by *Heliotropium stenophyllum* Hook. & Arn. (Heliotropiaceae), *Senna cumingii* var. *coquimbensis* (Vogel) H.S.Irwin & Barneby (Fabaceae), *Ophryosporus triangularis* Meyen (Asteraceae) and *Lobelia polyphylla* Hook. & Arn. (Campanulaceae). Also present in grazed areas with a dominance of shrubby species of Asteraceae.

Conservation. Chile. Coquimbo: Santa Gracia Private Natural Reserve (N. Mercado, https://www.inaturalist.org/observations/8988561).

Specimens examined. Chile. Coquimbo: [Elqui Province] Road between La Serena and Vallenar, 4 Oct 1971, *K. Beckett*, *M. Cheese & J. Watson 4060* (SGO); About 45 km N of La Serena along coast and ca. 10 km NW of the Panamerican (hwy 5) on road to Totoralillo, 21 Sep 1991, *L.R. Landrum & S.S. Landrum 7514* (ASU, CONC); Env. 30 km au N de La Serena, montée vers mine El Tofo, 29°35'S, 71°15'W, 500 m a.s.l., 23 Oct 1991, *F. Billiet & B. Jadin 5320* (US); La Serena, 4,6 kms from Chungungo en route to El Temblador, 29°28'18.6"S, 71°17'19.8"W, 171 m a.s.l., 30 Nov 2004, *P. Baxter*, *M.F. Gardner*, *P. Hechenleitner*, *P.I. Thomas & E. Zamorano 1765* (E, SGO); Primera curva de bajada Cuesta Buenos Aires, 29°33'20.2"S, 71°14'53.6"W, 566 m a.s.l., 8 Oct 2008, *M. Muñoz 5053* (SGO); Cuesta de Buenos Aires, cerca del portezuelo, 550 m a.s.l., 20 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1586* (CONC, F); Al pié de la Cuesta de Buenos Aires, 18 Sep 1958, *E. Bailey s.n.* (CONC, SGO); Cuesta Buenos Aires, 29°34'S, 71°14'W, 500 m a.s.l., 31 Oct 1991, *R. Rodríguez 2786* (CONC); Subida S Cuesta Buenos Aires, 29°34'S, 71°20'W, 27 Oct 1991, *M. Muñoz*, *S. Teillier*, *I. Meza 2639* (SGO); Cuesta Buenos Aires a Playa Temblador, primeros kilómetros, 28 Sep 1997, *M. Muñoz 3808* (SGO); Quebrada Honda, 41 km N La Serena, 1km del mar, 40 m a.s.l., 26 Sep 1948, *R. Wagenknecht 323* (CONC); Quebrada Honda, falda occidental del Cerro Juan Soldado, 200–300 m a.s.l., 4 Nov 1949, *W. Biese* 3021 (SGO); Panamericana Norte, entre La Serena y Caleta Hornos, antes Puente Juan Soldado, 3 Oct 1991, *C. von Bohlen 1199* (SGO); *C. von Bohlen 1191* (SGO); Km 495 al norte Cuesta Porotitos, 11 Oct 1992, *M. Muñoz 3029* (SGO).

14. *Schizanthus carlomunozii* V.Morales & Muñoz-Schick, sp. nov.

urn:lsid:ipni.org:names:77210707-1

Diagnosis. Differs from all other species in the genus in its large flowers with a very distinctive pattern on the upper lip of the corolla, where distinct spots cover the margins of the middle and lateral lobes.

Type. Chile. Coquimbo: Carretera Panamericana, entre la Quebrada de El Teniente a Talinay, 21 Aug 1963, *C. Muñoz & E. Sierra s.n.* (holotype: SGO! [acc. #075670]; isotype: SGO! [acc. #075671]).

14a. *Schizanthus carlomunozii* var. *carlomunozii* V.Morales & Muñoz-Schick
Fig. 7A–D

Description. Annual plant, glandular-pilose, with one or several stems arising from the same root, up to 45 cm tall. Leaves bipinnatifid, the blade 6.5–9 cm long, 2–3.5 cm wide; segments irregularly divided (opposite or alternate) and perpendicular to the midrib. Inflorescence 15–28 cm long, with basal peduncles up to 30–40 mm long and apical peduncles 4–8 mm long. Calyx hirsute-glandular, the divisions 5–8 mm long, 1.5–3 mm wide, linear-spathulate. Corolla with the tube shorter than the calyx, up to 3 mm long; limb pale violet, sometimes whitish, 20–28(34) mm long, 18–30(40) mm wide; upper lip with distinct dark spots on the margins of the middle lobe and in the upper part of the lateral lobes (in the separation of the lateral and middle lobes); upper middle lobe 10–18 mm long, 7–9(12) mm wide, oblanceolate, the apex obtuse to retuse, dotted with dark spots over the yellow area, sometimes surrounded by a white halo; upper lateral lobes with the upper segments a little rounded downwards and wider than the lower segments; lower middle lobe 7–8 mm long by 4–6 mm wide; lateral lobes 10–12(17) mm long, 2(4) mm wide, linear-spathulate, longer than the middle lobe. Stamens almost reaching the length of the lower middle lobe. Capsule as long or little longer than the calyx, glabrous.

Taxonomic notes. Grau and Gronbach (1984), following Reiche (1909: 477), treated this species as part of their concept of *S. litoralis*. We consider their description and figures include two different taxa and none of them correspond to the true *S. litoralis*; the abb. 24–27 in Grau and Gronbach (1984), shows the variation which corresponds to *S. carlomunozii*. All these drawings were based on samples collected in the Region of Coquimbo. This area corresponds to the distribution of this new species.

The name of the species honours the highly regarded Chilean botanist Carlos Muñoz Pizarro, for he provided a complete description that includes an illustration of this taxon in "*Flores silvestres de Chile*" (Muñoz-Pizarro 1966), but erroneously naming it as *S. litoralis.* Variability of the corolla drawings leads us to recognise two varieties within the species; one with two distinct spots on the margins of the upper middle lobe, and another with a large spot of fading colour of the same width of the upper middle lobe, which we described as var. *dilutimaculatus*.

Key characters. *Schizanthus carlomunozii* var. *carlomunozii* differs from all other species in the genus in its large flowers (20–34 mm long, 18–40 mm wide) with a very distinctive pattern on the upper lip of the corolla, with one medium or large delimited spot in the upper part of each lateral lobe (in the separation of the lateral and middle lobes). These spots reaching the margin of the lobes. The upper middle lobe also with two small or medium dark spots on the margins of it.

Distribution. Endemic to Chile, along the coast of the Region of Coquimbo (Provinces of Elqui and Limarí, 29°35'–31°10' lat. S). 20–350 m a.s.l.

Habitat. It grows under the shade of shrubs close to the sea; and along roadsides, sandy slopes and dry fields.

Conservation. Chile. Coquimbo: Fray Jorge National Park.

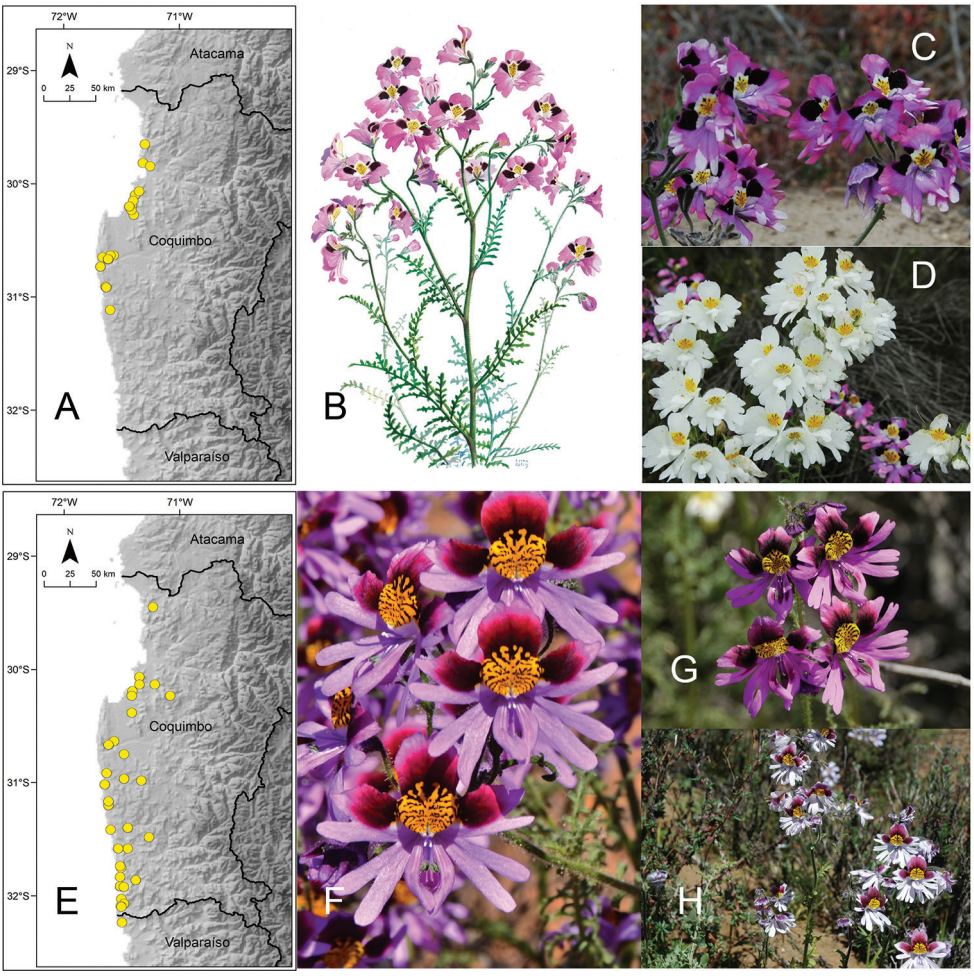

Figure 7. A distribution of *Schizanthus carlomunozii* var. *carlomunozii* **B** illustration of *S. carlomunozii* var. *carlomunozii* by S. Rafols (Muñoz-Pizarro 1966) **C, D** examples of *S. carlomunozii* var. *carlomunozii* in Fray Jorge National Park **E** distribution of *Schizanthus carlomunozii* var. *dilutimaculatus* **F** examples of *S. carlomunozii var. dilutimaculatus* in Amolanas **G** Las Majadas **H** El Ñague. Photos by M.T. Eyzaguirre (**C, D, G, H**), M. Aldunate (**F**).

Specimens examined. Chile. Coquimbo: [Elqui Province] Fundo Juan Soldado, 7 km al norte de La Serena, 1 Oct 1941, *R. Wagenknecht s.n.* (CONC); La Serena (Punta Teatinos), Sep 1898, *K. Reiche s.n.* (SGO); Norte de La Serena, frente Transportes Depetris, en arenales cerca línea de tren, 29°50'39.4"S, 71°15'16.6"W, 18 m a.s.l., 8 Oct 2008, *M. Muñoz 5057* (SGO); La Serena, Sep 1926, *E. Barros 2373* (CONC); Las Tacas, 8 Oct 2000, *A. Brinck s.n.* (SGO); Carretera entre Guanaqueros y La Serena, 18 Sep 1983, *M. Muñoz 1828* (SGO); Quebrada Tongoycillo, 19 Sep 1948, *C. Jiles 859* (CONC); Depto. Ovalle, Guanaqueros, 13 Sep 1965, *F. Behn s.n.* (CONC); Gua-

naqueros, 30 m a.s.l., Sep 1965, *C. Muñoz 5* (SGO); Camino interior Guanaqueros a Tongoy, primer km, 12 Oct 1989, *M. Muñoz 2418* (SGO); Dpto. Ovalle, Carretera Panamericana, frente a Tongoy, 30°15'S, 71°30'W, 30 m a.s.l., 20 Sep 1961, *F. Schlegel 3922* (CONC); **[Limarí Province]** Carretera Panamericana, 7 km al norte de la Quebrada Los Almendros, 17 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1468* (CONC, LP); Lagunillas, 21 Sep 1972, O. Zoellner 6198 (L); Prov. Elqui, Lagunillas, 30°6'S, 71°21'W, 100 m a.s.l., Sep 1987, *F. Squeo 87067* (CONC); Idem, *F. Squeo 87033* (CONC); Camino acceso Parque Nacional Fray Jorge, 30°38'1.4"S, 71°26'18"W, 305 m a.s.l., 11 Oct 2004, *M. Muñoz 4484* (SGO); Fundo Las Garzas, entre carretera Panamericana y el Bosque Fray Jorge, a 5 km al poniente, 14 Sep 1957, *C. Muñoz 4284* (SGO); Parque Nacional Fray Jorge, road between information center/gift shop and the Sendero interpretativo del Bosque Hidrófilo, 30°38'53"S, 71°40'0"W, 251 m a.s.l., 4 Nov 2006, *E.J. Tepe*, *A. Marticorena & P.B. Pelser 1724* (CONC); Dpto. Ovalle, Fray Jorge, parte baja, 20 Sep 1952, *M. Ricardi 2086* (CONC); Idem, *M. Ricardi 2095* (CONC); Fray Jorge, 18 Sep 1970, O. Zoellner 4388 (L); Estancia Frai Jorge, 215 m a.s.l., 13 Aug 1917, C. Skottsberg 742 (F); Fundo Fray Jorge, 100 m a.s.l., Sep 1934, *C. Grandjot & G. Grandjot 466a* (CONC); Dpto. Ovalle, Fray Jorge, cerca de las casas, 30°40'S, 71°40'W, 180 m a.s.l., 22 Aug 1948, *C. Jiles 751* (CONC); Dpto. Ovalle, Fray Jorge, 30°40'S, 71°40'W, 350 m a.s.l., Sep 1958, *J. Kummerow s.n.* (CONC); Dpto. Ovalle, Fray Jorge, 30°40'S, 71°40'W, 350 m a.s.l., 13 Sep 1961, *B. Behn s.n.* (CONC); Dep. Ovalle, Fray Jorge, ca. 300 m a.s.l., Nov 1925, *E. Werdermann 912* (E, F, SI, U, US); Monte de Fray Jorge, Sep 1904, *K. Reiche s.n.* (SGO); Fray Jorge, 26 Sep 1935, *C. Muñoz 268* (SGO); *C Muñoz 240* (SGO); *C. Muñoz 131* (SGO); Fray Jorge, 30 Oct 1956, *M. San Martín 650* (SGO); Depto. Ovalle, Fray Jorge, 8 Oct 1947, *B. Sparre 2903* (SGO); Ovalle, Fray Jorge, 15 Sep 1947, *Ibáñez & Kuschel s.n.* (SGO); Desembocadura Río Limarí, 12 Sep 1942, *C. Muñoz 3417* (SGO); Dpto. Ovalle, Estancia Talca, 30°54'S, 71°39'W, 300 m a.s.l., 19 Sep 1949, *C. Jiles 1435* (CONC); Faldeos del Cerro Talinay, 15 Sep 1957, *M. Ricardi & C. Marticorena 4284/669* (CONC); 122 km al N de Los Vilos, 19 Sep 1991, *C. Fernández & H. Niemeyer* (*91*)*183* (SGO); Más o menos al Sur de Mantos de Hornillos, alrededor del km 290, 21 Sep 1986, *M. Muñoz 2072* (SGO); **Unknown:** Coquimbo, La Rinconada, 17 Sep 1952, *E. Barros 10126* (CONC); Litoral de Coquimbo, Sep 1898, *K. Reiche s.n.* (SGO); Chili, 1828/1834, *C. Gay 176* (P).

14b. *Schizanthus carlomunozii* var. *dilutimaculatus* V.Morales & Muñoz-Schick, var. nov.

urn:lsid:ipni.org:names:77210708-1
Fig. 7E–H

Diagnosis. Similar to *S. carlomunozii* var. *carlomunozii* but differing in possessing three large and dark spots covering the distal portion of the upper lip. The colour of these spots fades from the bottom to the top.

Type. Chile. Coquimbo: 1 km S Los Vilos, 31°55'17"S, 71°29'03"W, 6 Oct 2008, *M. Muñoz 5020* (holotype: SGO! [acc. #157833]).

Description. Annual plant, glandular-pilose, with one or several stems arising from the same root, up to 70 cm tall. Leaves bipinnatifid, the blade 4.5–7.5(13) cm long, 1.5–3.5(4) cm wide; segments irregularly divided (opposite or alternate) and perpendicular to the midrib. Inflorescence 5–30 cm long, with basal peduncles up to 30–40 mm long and apical peduncles up to 4–14 mm long. Calyx hirsute-glandular, the divisions linear-spathulate of 5–9(12) mm long, 1–2 mm wide. Corolla with the tube shorter than the calyx, up to 3 mm long; limb pink, lavender or lilac, sometimes whitish, 20–28 mm long, 15–25 mm wide; upper lip with three large spots of colour black to burgundy, which fade from the bottom to top. One of these spots occupies the total width of the upper half of the middle lobe, while the others two occupy the upper part of the lateral lobes; upper middle lobe 12–15 mm long, 7–9 mm wide, oblanceolate, the apex obtuse to retuse, dotted with dark spots over the yellow area; upper lateral lobes with the upper segments a little rounded downwards and wider than the lower segments; lower middle lobe 6–9 mm long, 4–6 mm wide; lateral lobes 10–12 mm long, 2 mm wide, linear-spathulate, longer than the middle lobe. Stamens almost reaching the length of the lower middle lobe. Capsule shorter or little longer than the calyx, glabrous.

Taxonomic notes. The name selected to this variety refers to the coloured dark spots, which fade from the bottom to the top and cover the distal portion of the upper lip.

Key characters. Similar to *S. carlomunozii* var. *carlomunozii* in the size and corolla form but differing in possessing three large and dark spots covering the distal portion of the upper lip. The colour of these spots fade from the bottom to the top.

Distribution. Endemic to Chile, occurs along the coast between the Regions of Coquimbo (Province of Elqui, 29°25' lat. S) and Valparaíso (Province of Petorca, 32°20' lat. S). 20–350 m a.s.l.

Habitat. On dunes and in sandy soils, shady slopes and recently disturbed roadside verges. It grows under the shade of shrubs and is associated with *Centaurea chilensis* Bertero ex W.Bull (Asteraceae), *Myrcianthes coquimbensis* (Barnéoud) Landrum & Grifo (Myrtaceae) and *Heliotropium stenophyllum* Hook. & Arn. (Heliotropiaceae).

Conservation. Chile. Coquimbo: Fray Jorge National Park.

Specimens examined. Chile. Coquimbo: [Elqui Province] Panamericana, frente al Tofo, 9 Oct 1971, *E. Kausel 5458* (SGO); m/m 40 kms al sur de La Serena, 15 Sep 1957, *M. Ricardi & C. Marticorena 4330/715* (CONC); Carretera Panamericana, 40 km al S de La Serena, 15 Sep 1957, *A.L. Cabrera 12587* (LP, US); 20 km norte de Guanaqueros, lado carretera, ladera exp. Oeste, 11 Oct 1987, *C. von Bohlen 483* (SGO); Camino entre Guanaqueros y Coquimbo, 19 Sep 1980, *M. Muñoz 1662* (SGO); Entre Las Tacas hacia Totoralillo, al Sur de Coquimbo por la carretera panamericana,15 Sep 1957, *C. Muñoz 4168* (SGO); Idem, *C. Muñoz 4174* (SGO); Depto. Ovalle, Quebrada Tongoicillo, 30°10'S, 71°21'W, 250 m a.s.l., 19 Sep 1948, *C. Jiles 850* (CONC); Andacollo, Estación H/S Acueducto Andacollo, 750 m a.s.l., 12 Oct 1971, *A. Flores & M. Flores 24* (SGO); A 5 km de El Peñón camino hacia Andacollo, 30°12'S, 71°9'W, 500–600 m a.s.l., 1–6 Apr 2008, *M. Mihoc 438* (CONC); Camino Guanaqueros – Tongoy, 27 Sep 1997, *M. Muñoz 3801* (SGO); Depto. Ovalle, Estancia Camarones, 30°20'S, 71°25'W, 75 m a.s.l., 19 Oct 1961, *C. Jiles 3855* (CONC); **[Limarí Province]** Entre Panamericana y Fray Jorge (Coquimbo), 19 Oct 1963, *A. Garaventa s.n.* (CONC); Bosque Fray Jorge, Sep 1971, *O.*

Muñoz s.n. (CONC); Parque Nacional Fray Jorge, 18 Oct 2000, *N. Muñoz s.n.* (SGO); Sur de Socos, 22 Sep 1991, *I. Moreira 4* (SGO); Hacienda Talinay (Prov. de Coquimbo), 12 Oct 1961, *A. Garaventa s.n.* (CONC); Ovalle, El Parral, 500 m a.s.l., 4 Sep 1950, *C. Jiles 1853* (CONC); Dpto. Ovalle, Las Tunas, 11 Sep 1952, *C. Jiles 2152* (CONC); Dto. Ovalle, Quebrada Teniente, 19 Sep 1952, *M. Ricardi 2048* (CONC); Al norte de Mantos de Hornillos, 1 km antes de la Quebrada del Teniente, 13 Oct 1963, *C. Marticorena & O. Matthei 138* (CONC); Sur Bahía El Teniente, 270 m a.s.l., 22 Sep 1991, *M. Muñoz 2577* (SGO); Corral de Julio, exclusión La Rojadilla, 150 m a.s.l., 6 Nov 1976, *M. Muñoz 919* (F, SGO); Dpto. Ovalle, Quebrada Amolanas, 31°12'S, 71°36'W, 260 m a.s.l., 3 Oct 1948, *C. Jiles 985* (CONC); Idem, *C. Jiles 921* (CONC); **[Choapa Province]** Dpto. Illapel, Caleta Oscuro, 31°25'S, 71°35'W, 5–50 m a.s.l., 2 Nov 1974, *C. Marticorena*, *O. Matthei & R. Rodríguez 326* (CONC); Canela Baja, 11 Sep 1997, *O. Zoellner 21985* (CONC); Canela Baja a 11 km de la Carretera, 310 m a.s.l., 5 Oct 1997, *M. Muñoz 3846* (SGO); Salida camino Canela a Ruta 5 sur, 5 Oct 1997, *M. Muñoz 3850* (SGO); Dpto. Illapel, Carretera Panamericana, 10 km al norte de Huentelauquén, 16 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1417* (CONC); Dto. Illapel, Quillaicillo, 18 Sep 1952, *M. Ricardi 2019* (CONC); Altos Mincha-Illapel (Coquimvo), 17 Oct 1965, *J. Lazcano s.n.* (CONC); Dpto. Illapel, Huentelauquén, 31°35'S, 71°32'W, 75 m a.s.l., 20 Oct 1955, *C. Jiles 2812* (CONC); Huentelauquén, quebrada, 31°35'S, 71°32'W, 1 Oct 1957, *G. Monsalve 17* (SGO); Ruta 5N, N caleta Chigualoco Km 246, 31°44'15"S, 71°31'3"W, 113 m a.s.l., 9 Oct 2014, *A. Moreira 2272* (AMM); Dpto. Illapel. Carretera Panamericana, 14 km al norte de Los Vilos. Quebrada El Pangue, 16 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1392* (CONC); 7.3 km on Panamericana N of Turnoff from Panamericana to Los Vilos, between the road and the coast on top of the coastal rocks, 0–40 m a.s.l., 11 Nov 1991, *U. Eggli & B. Leuenberger 1673* (SGO); Más al Norte Quebrada Las Palmas, 18 Sep 1980, *M. Muñoz 1659* (SGO); Quebrada Las Palmas, 22 Sep 1961, *F. Behn s.n.* (CONC); Prov. Aconcagua, Las Palmas, Dec 1976, *R. Palma s.n.* (CONC); Al llegar a la Quebrada de Las Palmas, donde se ven tres palmeras al lado izquierdo del puente, 21 Sep 1980, *M. Muñoz 1686* (SGO); About 10 km north of town [Los Vilos], 31°55'S, 71°30'W, 20 m a.s.l., 3 Oct 1995, *M.F. Gardner & S. Knees 5905* (E); Los Vilos, ca. 20 m a.s.l., 8 Oct 1965, *G. Montero s.n.* (CONC); Los Vilos, ca. 20 m a.s.l., 8 Oct 1965, *G. Montero 7199* (IND); Los Vilos, Sep 1952, *L. Peña s.n.* (CONC); Los Vilos, 30 Oct 1976, *O. Zoellner 9346* (CONC); Los Vilos, 27 Oct 1991, *A. Brinck s.n.* (SGO); Los Vilos, quebrada, 31°55'S, 71°32'W, Oct 1957, *G. Monsalve 72* (SGO); Carretera panamericana, entre Pichidangui y Los Vilos, 12 Oct 1963, *C. Marticorena & O. Matthei 78* (CONC); Carretera Panamericana, 1 km al sur de paso superior Palo Colorado, 15 Oct 1971, *C. Marticorena*, *R. Rodríguez & E. Weldt 1352* (CONC, F); Norte de Pichidangui, 32°5'21.1"S, 71°30'31.4"W, 54 m a.s.l., 6 Oct 2008, *M. Muñoz 5019* (SGO); Peaje al norte de Pichidangui, 32°5'42.6"S, 71°30'19.2"W, 79 m a.s.l., 12 Sep 2008, *M. Muñoz 5001* (SGO); 23.6 km south of Los Vilos on the Panamerican Hwy., 85 m a.s.l., 1 Nov 1990, *T.G. Lammers*, *C.M. Baeza & P. Peñailillo 7678* (CONC); **Valparaíso: [Petorca Province]** Al Norte de Los Molles, 19 Oct 1984, *M. Muñoz 1882* (SGO); **Unknown:** Chile, Jul–Aug 1856, *W.H. Harvey 3898* (E); Chili, Jul 1912, *Unknown s.n.* (L); Without locality, *Unknown 597* (US).

Names (designations) not validly published

Designations are listed in alphabetic order.

Schizanthus cruikshanksii Kunze ex sched., Syn. Pl. Amer austr. Msc., nomen nudum = *S. litoralis* Phil. var. *litoralis*. Name only seen on the labels of three specimens collected by Poeppig (In arenos. ad ostia "Rio Aconcagua", Sep, *E. Poeppig 9* (F! [V0126168F], HAL! [HAL0135743], P! [P00477601])).

Schizanthus robustus Phil. ex sched., nomem nudum = *S. alpestris* Poepp. Name only seen on the label of herbarium specimens (Coquimbo, *Unknown s.n.* (B! [destroyed, photo at F! [FOB003062]], K! [000585347, photo at IND! [IND-0107169]], US! [02848562])). All these specimens are samples sent by R.A. Philippi to foreign herbaria.

Acknowledgments

We thank many people for help during the preparation of this synopsis; Sergio Moreira, María Teresa Eyzaguirre, Claudina Jirón, Sergio Elórtegui, Arón Cádiz and Margarita Aldunate kindly provided images of *Schizanthus* species; Mark Carine and Ranee Prakash (BM) and Leopoldo Medina (MA), sent photos of the requested material; Sue Frisby and Federico Fabriani (K), Henry Noltie and Martin Gardner (RBGE), helped us search for the type material of *S. hookeri* and *S. porrigens*; Alicia Marticorena (CONC), Gloria Rojas (SGO), Laura Iharlegui and Mariana Grossi (LP), Diego Gutiérrez (BA) and Amalia Suarez (SI), allowed access to the collections during our research; Nicolás García (EIF), Diego Gutiérrez (BA), John McNeill (RBGE) and Roberto Kiesling (MERL) helped to resolve nomenclatural issues; Martin Gardner and Sabina Knees (RBGE) carefully revised the text; Sandra Knapp, Iris Peralta and João Stehmann provided helpful comments on the submitted manuscript. We thank Proyecto Conicyt-Fondecyt 1180211 "*Rand Flora of Atacama*" for funding our field and herbarium work.

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Appendix I

List of classic iconographies

In the following text we list the publications that contain classic figures of the plants treated in this work. The publications are organised by year under each accepted species.

Schizanthus candidus Lindl.

Edwards's Bot. Reg. 29: tab. 45 (1843).

Schizanthus grahamii Gillies ex Hook.

Bot. Mag. 58: tab. 3044 (1831).
Bot. Mag. 58: tab. 3045 (1831) [as *S. retusus*].
Edwards's Bot. Reg. 18: tab. 1544 (1833) [as *S. retusus*].
Paxton's Mag. Bot. 1: 5, Plate before page 5 (1834) [as *S. retusus*].
Brit. fl. gard. ser. 2, 3: tab. 201 (1835) [as *S. retusus*].
Bot. Gard. 6: No. 521, T. 131 (1836) [as *S. retusus*].
Rev. Hort. [Paris]. ser. 2, 2: 529, Plate before page 529 (1844).
Rev. Hort. [Paris]. ser. 3, 5: 321, fig. 17 (1851) [as *S. retusus*].
Fl. Serres Jard. Eur. 7: 189, Pl. 712 (1852) [as *S. grahamii* var. *flore albo*].
Gartenflora 12: Taf. 385, fig. 2 y 3 (1863).
Favourite fl. 3: 423, Pl. 203B (1897) [as *S. retusus*].

Schizanthus hookeri Gillies ex Graham
Bot. Mag. 58: tab. 3070 (1831).

Schizanthus litoralis Phil. var. *litoralis*
Exot. Fl. 1: tab. 73 (1823) [as *S. pinnatus*].
Bot. Mag. 50: tab. 2404 (1823) [as *S. pinnatus*].
Brit. fl. gard. 1: tab. 63 (1823–1825) [as *S. pinnatus*].

Schizanthus litoralis Phil. var. *humilis* (Lindl.) V.Morales & Muñoz-Schick
Brit. fl. gard. ser. 2, 2: tab. 197 (1833) [as *S. pinnatus* var. *humilis*].
Edwards's Bot. Reg. 18: tab. 1562 (1833) [as *S. pinnatus* var. *humilis*].
Paxton's Mag. Bot. 2: 198, Plate before page 198 (1836) [as *S. pinnatus* var. *humilis*].

Schizanthus pinnatus Ruiz & Pav.
Fl. Peruv. [Ruiz & Pavon] 1: 13, lám. 17 (1798).
Favourite fl. 3: 422, Pl. 203A (1897).

Schizanthus porrigens Graham ex Hook. subsp. *porrigens*
Exot. Fl. 2(7): tab. 86 (1824).
Fl. Conspic.: tab 32 (1826).
Bot. Gard. 2: No. 126, T. 32 (1828).
Hist. Nat. Vég. (Spach) Atlas: 31, Pl. 77 (1847).

Schizanthus porrigens subsp. *porrigens* mixed with *Schizanthus litoralis* var. *litoralis* (see note below)
Bot. Mag. 51: tab. 2521 (1824).
Bot. Reg. 9: tab. 725 (1824) [as *S. pinnatus*].
Brit. fl. gard. 1: tab. 76 (1823–1825).

Note. These illustrations show mixed characters associated with the two species. On one hand, they show the lower lip of the flowers with a darker colour than the upper lip of the corolla (*S. litoralis*) and small spots on the upper lip (middle and lateral lobes) (S. *porrigens*). We think the first illustration can be mixing the characters of *S. litoralis* var. *litoralis* and *S. porrigens*, as they were growing together in different gardens during the introduction in the United Kingdom (Hooker 1824, Sweet 1823–1825). On the other hand, the illustrations at the "Botanical Register" and "The British flower garden" may be exaggerating the colour of the lower lip, as sometimes *S. porrigens* exhibits a larger portion of pink between the upper and lower lip.

Appendix II

Distributional ranges and presence of taxa for administrative units in Chile and Argentina.

Administrative units	Altitudinal range (a.s.l.)	Latitudinal range (lat.S)	Chile													Argentina	
Taxa			Tarapacá	Antofagasta	Atacama	Coquimbo	Valparaíso	Metropolitana	O'Higgins	Maule	Ñuble	Biobío	Araucanía	Los Ríos	Los Lagos	Mendoza	Neuquén
S. alpestris	180–2800 m	28°50'–32°50'			X	X	X										
S. candidus	20–200 m	27°50'–29°00'			X												
S. carlomunozii var. *carlomunozii*	20–350 m	29°35'–31°10'				X											
S. carlomunozii var. *dilutimaculatus*	20–350 m	29°25'–32°20'				X	X										
S. coccineus	2000–2900 m	33°15'–33°30'						X									
S. grahamii	1200–2900 m	33°25'–39°20'						X	X	X	X	X				X	X
S. hookeri	900–3200 m	30°35'–37°20'				X	X	X	X	X	X	X				X	X
S. integrifolius	800–2800 m	26°20'–30°10'			X	X											
S. lacteus	20–900 m	23°30'–26°00'		X													
S. laetus	20–900 m	20°40'–26°00'	X	X													
S. litoralis var. *litoralis*	10–100 m	32°30'–33°10'					X										
S. litoralis var. *humilis*	0–20 m	32°20'–32°35'					X										
S. parvulus	100–900 m	31°20'–32°10'				X											
S. pinnatus	30–2000 m	33°35'–40°30'					X	X	X	X	X	X	X	X	X		
S. porrigens subsp. *porrigens*	20–1800 m	29°25'–29°50'				X	X	X	X								
S. porrigens subsp. *borealis*	170–600 m	32°05'–34°20'				X											
S. splendens	350–1800 m	30°10'–31°00'				X											

PhytoKeys 154: 103–109 (2020)
doi: 10.3897/phytokeys.154.54042
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Taxonomic note on *Parnassia* (Celastraceae): the identity of *P. nubicola*

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Academic editor: Mark P. Simmons | Received 8 May 2020 | Accepted 22 June 2020 | Published 4 August 2020

Citation: Ma Y, Zhou H, Shu Y (2020) Taxonomic note on *Parnassia* (Celastraceae): the identity of *P. nubicola*. PhytoKeys 154: 103–109. https://doi.org/10.3897/phytokeys.154.54042

Abstract

Based on examination of herbarium specimens (including types) and living plants, as well as analysis of protologues and distributions, *Parnassia tibetana*, *P. nubicola* subsp. *occidentalis*, and *P. nubicola* var. *nana* are reduced to synonyms of *P. nubicola.*

Keywords

Flora Iranica, Himalaya, morphology, revision, staminode

Introduction

Parnassia Linnaeus (1753: 273), a morphologically distinguishable genus in the Celastraceae (APG IV 2016, Ball 2016), is distributed in the Northern Hemisphere, predominantly in temperate regions. The Pan-Himalaya region is the center of this genus' distribution as well as diversification (Phillips 1982, Ku and Hultgard 2001, Simmons 2004, Wu et al. 2004). All species of *Parnassia* are glabrous and rosulate perennial herbs, with solitary flowers borne on scapes. Flowers of all *Parnassia* species are pentamerous, actinomorphic or weakly zygomorphic, especially with the antipetalous staminodes. Morphologicaly, *Parnassia* is a rather homogeneous genus.

Parnassia nubicola Wall. ex Royle (1835: 227) is widely distributed in the mountainous regions of Himalayas; it is highly variable in some of its morphological char-

acters, especially some quantitative characters such as leaf blades length, petals length, and plant height (Schönbeck-Temesy 1966, Grierson 1987, Ku and Hultgard 2001).

In this study, herbarium sheets from BJFC, BM, BNU, E, GZU, K, KUN, L, NY, PE, QTPMB, U, and W (herbarium acronyms follow Thiers 2020, continuously updated) herbaria and two populations of living plants (voucher specimens were deposited in PE) were examined.

The typification of *Parnassia nubicola* has been discussed (Shu et al. 2017). This species was described based on *Wallich Cat. n. 1246*, without specifying the herbarium in which the specimen was deposited. However, specimens with this collection number were either obtained by Wallich from Gossain Than (*Wallich Cat. n. 1246a*), or by Blinkworth from Kumaon (*Wallich Cat. n. 1246b*). In addition, some individuals with fimbriate petals in these collections are more accurately identified as *P. wightiana* Wall. ex Wight et Arnott (1834: 35). A specimen of *Wall. 1246a* in W has been designated as the lectotype of *P. nubicola* (Schönbeck-Temesy 1966), and all the other duplicate specimens of *Wall. Cat. n. 1246a* are isolectotypes, except for the individuals with fimbriate petals that were determined to be *P. wightiana*.

Based on *Wall. Cat. n. 1246b* collected from Kumaon, Drude (1875) named the individuals with fimbriate petals and cordate leaves (actually *Parnassia wightiana*) as the new variety *P. nubicola* var. *cordata* Drude (1875: 316). This has been previously discussed by Shu et al. (2017).

Parnassia nubicola subsp. *occidentalis* Schönbeck-Temesy (1966: 2) was described with cordate leaf blades (vs. ovate-elliptic to ovate in *P. nubicola* subsp. *nubicola*), lanceolate or lanceolate-oblong sepals (vs. ovate to ovate-lanceolate), punctate petals (vs. not punctate), and entire or erose petal margins (vs. erose to short-fimbriate). Ku described a new variety, *P. nubicola* var. *nana* T.C. Ku (1991: 82), based on the size of the leaf blade (ca. 2×1.5 cm vs. 2.5–7.5 × 2–3.8 cm in *P. nubicola* var. *nubicola*) and plant height (5–13 cm vs. 13–40 cm). *P. nubicola* subsp. *occidentalis* and *P. nubicola* var. *nana* were recognized by a combination of these variable characters.

Our analysis of specimens from herbarium collections, including types of *P. nubicola*, *P. nubicola* subsp. *occidentalis*, and *P. nubicola* var. *nana*, suggested that these highly variable characters are continuous, and cannot be used to reliably separate these taxa (Table 1). Leaf blades from the holotype of *P. nubicola* subsp. *occidentalis* are ovate, rather than cordate. Extensive field observations and examination of herbarium specimens showed that petal punctation is always clearly visible in old herbarium specimens, whereas it is rarely observable in the living individuals or newly collected specimens. This phenomenon was also observed in *Parnassia* by Suksathan (2009), petal punctation speculated to be an artifact of preservation due to dessication.

Parnassia tibetana Z.P. Jien ex T.C. Ku (1987: 38), described on the basis of a single collection from Tibet, China, is found to be conspecific with *P. nubicola*. According to the original description, *P. tibetana* is morphologically similar to *P. nubicola*. The significant differences are that *P. tibetana* has yellow petals, shortly linear staminode lobes, which are rounded or truncate at the apex; in contrast, *P. nubicola* has white petals, and lanceolate or ovate-lanceolate staminode lobes, with the apex acute or rounded. We have examined the holotype of *P. tibetana* in PE and an isotype from N. When

Table 1. Comparison of key morphological characters of *Parnassia nubicola*, *P. nubicola* subsp. *occidentalis*, *P. nubicola* var. *nana*, and *P. tibetana*.

Characters	***P. nubicola* subsp. *nubicola****	***P. nubicola* subsp. *occidentalis*****	***P. nubicola* var. *nana*****	***P. tibetana****
height	10–40 cm	15–33 cm	5–20 cm	12–20 cm
basal leave shape and size	ovate or ovate-oblong, 1–9.5 × 0.8–5.2 cm	ovate-oblong or ovate, 1.5–3.5 × 0.7–2 cm	ovate, 1.2–2.5 × 0.8–2.5 cm	ovate-oblong, 1.5–2.3 × 1–1.4 cm
sepal shape and size	ovate-oblong or ovate-lanceolate, 5–8 × 2–3 mm	ovate-lanceolate, ca. 5 × 3 mm	ovate-lanceolate, 4–6 × 2–3 mm	ovate, ca. 6 × 3 mm
petal shape and size	ovate, oblong or obovate, 12–16 × 8–10 mm, margins entire, erose or short fimbriate at base	obovate, 12–15 × 5–7 mm, margins subentire	obovate, 12–13 × 7 mm, margins entire or erose at base	obovate or oblong, 8–10 × 5–6 mm, margins erose at base
staminode shape	3-lobed shallowly to half its length, apex acute or rounded	3-lobed shallowly, apex rounded	3-lobed for 1/4–1/2 its length, apex acute or rounded	3-lobed for 1/3 its length, apex rounded

*Description based on the Flora of China (Ku and Hultgard 2001), specimens from BJFC, BM, BNU, E, GZU, K, KUN, L, NY, PE, QTPMB, U, W, and observations of wild individuals from Yunnan and Tibet.
**Description based primarily on reexamination of holotypes as well as the original publication.

we compared these to various specimens of *P. nubicola*, as well as to wild individuals in Yunnan and Tibet, we found them to be part of the broader distribution of natural variation. In the flowering stage, *P. nubicola* petals are white (sometimes with yellow at the base), but the petals turn yellowish when the plant is in fruit, or when preserved as herbarium specimens. The delineated staminodes from some specimens, including type materials of *P. tibetana* and *P. nubicola* var. *nana*, show that staminode shape is highly variable (Fig. 1). The variation of staminodes in *P. mysorensis* Heyne ex Wight et Arnott (1834: 35), *P. wightiana*, and *P. delavayi* Franchet (1896: 267) has been discussed, suggesting that the diagnostic value of staminodes could have been overestimated (Suksathan 2009; Wang et al. 2018; Yu et al. 2018).

Since no significant differences were found among these four taxa, we propose reducing *Parnassia tibetana*, *P. nubicola* subsp. *occidentalis*, and *P. nubicola* var. *nana* to synonyms of *P. nubicola*.

Taxonomic treatment

Parnassia nubicola Wall. ex Royle, 1835: 227

=*Parnassia tibetana* Z.P. Jien ex T.C. Ku, 1987: 38. Syn. nov. Type: China. Tibet: 2 August 1959, *Exped. Zhufengensis 716* (holotype PE01863973!; isotype N117066161!).

=*Parnassia nubicola* subsp. *occidentalis* Schönbeck-Temesy, 1966: 2. Syn. nov. Type: Pakistan. Swat: Utror, 2500 m, 23 August 1962, *Rechinger 19590* (holotype W19680016319!; isotype G00388771!).

=*Parnassia nubicola* var. *nana* T.C. Ku, 1991: 82. Syn. nov. Type: China. Yunnan: Deqen, 25 August 1987, *Hengduanshan Exped. 3734* (holotype PE00866291!; isotypes PE00866288!, PE00866289!, PE00866290!).

Type. Nepal. Gossain-than (Gossain-kund), *Wallich Cat. n. 1246a* (lectotype W1889-0305721!, designated by Schönbeck-Temesy 1966: 2; isolectotypes BM000521923!, E00301174!, GZU000100103!, K000739482(except for the individual with fimbriate petals)!).

Description. Perennial herbs, glabrous. Rhizome sympodial, robust. Stems 1 to 5, 5–40 cm, with 1 proximal cauline leaf. Basal leaves 3–8; petiole 1–9 cm; blade ovate or ovate-oblong, 1–9.5 × 0.8–6 cm, base cordate to subtruncate, apex acute or shortly acuminate. Cauline leaf sessile, similar to basal ones but always smaller. Flowers 2.8–3.4 cm in diam., hypanthium campanulate. Sepals ovate to ovate-lanceolate, 4–8 × ca. 3 mm, margins entire, apex obtuse. Petals white, sometimes yellow at the base, obovate to ovate, 8–16 ×

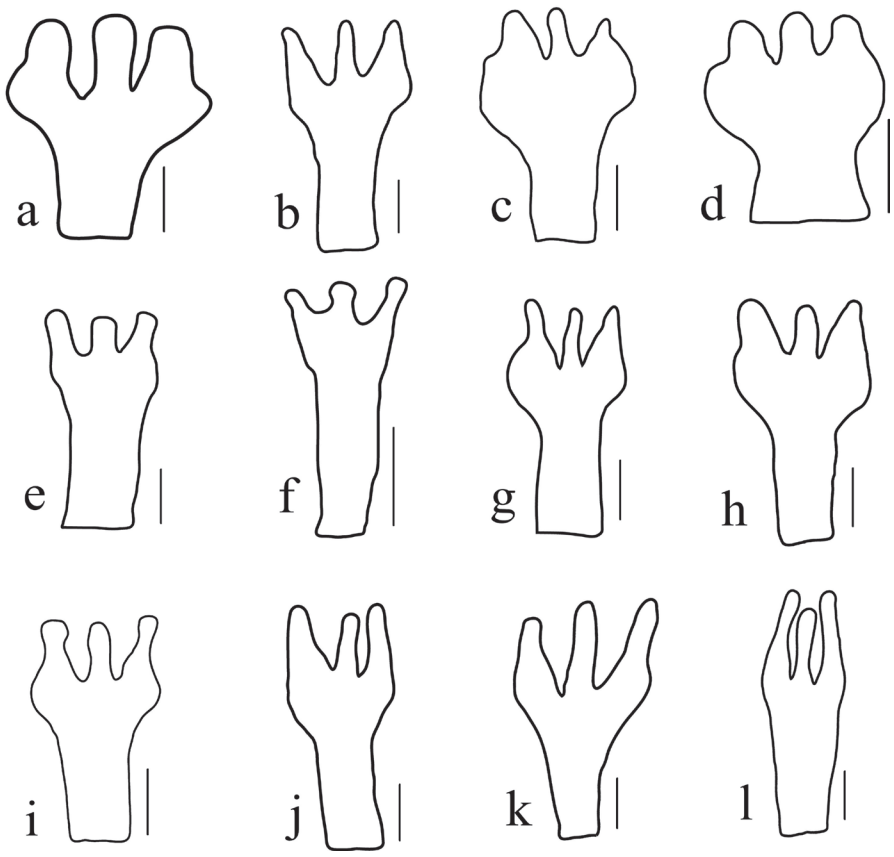

Figure 1. Staminodes variation of *P. tibetana* (**A**), *P. nubicola* var. *nana* (**B–D**) and *P. nubicola* var. *nubicola* (**E–L**). **A** delineated from *s.n. 716* (PE01863973) **B–D** delineated from *Hengduan Exp. 3734* (PE00866288 and PE00866291) **E–L** delineated from *Tibet herbs Exp. 1496* (PE00866275), *Plateau Exp. 14709* (PE00866299), *s.n. 6550* (PE01982606), and *Wang Qiwu 65371* (PE00866286). Scale bars: 1 mm. Illustrated by Shu Yumin.

5–10 mm, base contracted into a short claw, margins entire distally and erose to short-fimbriate proximally, apex rounded. Anthers ellipsoid, 0.8–1.1 mm; filaments ca. 4.5 mm; staminodes flat, 2.5–5 mm, shallowly to deeply 3-lobed, lobes up to half staminode length, apex acute or rounded. Ovary semi-inferior, ovoid; style ca. 2 mm; stigma 3(–4)-lobed. Capsule ovoid, 5–10 mm long, 3(–4) valved. Seeds minute, oblong, ca. 1 mm long.

Chromosome number. 2n =18 (Malla et al. 1979).

Flowering and fruiting. July to November.

Habitats. Margins of thickets, alpine meadows, 2600–4200 m.

Distribution. China, India, Nepal, and also recorded in Afghanistan, Bhutan, and Pakistan (Schönbeck-Temesy 1966, Grierson 1987).

Specimens examined. Herbarium barcode numbers are cited with herbaria acronyms if available.

China. Tibet, Bomi County: 11 August 2001, *Qin Haining et al. 337* (PE); 23 August 1983, *Cheng Shuzhi et al. 7062* (PE); 2900 m, 25 August 1975, *Anonymous 56* (SM706501104); 3000 m, 20 September 1973, *Zhang Jingwei 1485* (PE00866285); 3100 m, 20 September 1973, *Tibet Exped. 73-1453* (KUN0437389, KUN0437390, PE00866295, PE00866296); 25 July 1900, *Xia Guangcheng 599* (KUN0437701); **Chayu County:** 3996 m, 29 August 2009, *Gin Xiaohua et al. SET-ET 982* (PE); 3400 m, 9 August 1983, *Tibet Exped. 1334* (QTPMB38503, QTPMB86235); 3350 m, 13 September 1976, *Wu Zhengyi 5833* (KUN0437395, KUN0437398); 3500 m, 13 August 1973, *Anonymous 828* (PE01869747); 3900 m, 13 August 1973, *Tibet Exped. 73-1070* (KUN0437393, KUN0437394); 4100 m, 23 August 1973, *Tibet Exped. 73-1217* (KUN0437391, KUN0437392); **Cuona County:** 10 September 1975, *Tibet Exped. 751933* (PE00866302, QTPMB52545); **Jilong County:** 3977 m, 28 July 2015, *Wei Lai et Hao Jiachen 15338* (BNU0026890); 3544 m, 8 August 2010, *Tibet Exped. 348* (PE01877040); **Jiacha County:** 3500 m, 2 September 1972, *Tibet herbs Exped. 4563* (PE01982462, QTPMB33656, QTPMB82672); **Lang County:** 3239 m, 4 September 2010, *Luo Jian et al. L075* (KUN1237749); without date, *FLPH Tibet Exped. 12-1138* (PE); **Linzhi County:** 3060 m, 26 September 2008, *Gao Lianming et al. GLM-082000* (KUN1242252); 9 August 1983, *Li Bosheng et al. 6375* (PE); 4360 m, 2 August 1975, *Tibet Exped. 751124* (QTPMB51742); **Longzi County:** 10 August 2013, *Chen Yousheng et al. 13-0876* (PE01993054, PE01993055, PE01992603); **Milin County:** 3200 m, 30 July 2016, *Wei Lai et He Yi BNUXZ2016491* (BNU0027963); 3250 m, 21 September 1974, *Tibet Exped. 74-5338* (KUN0437387, KUN0437388, PE00866281, PE01982463); 3700 m, 16 July 1972, *Tibet herbs Exped. 3813* (PE00866276, PE00866277, QTPMB32867, QTPMB82577); **Motuo County:** 2800 m, 12 August 2010, *Jin Xiaohua et al. STET 2646* (PE); 3900 m, 5 September 1982, *Li Bosheng et al. 624* (PE00866297, PE00866298, PE01869745, PE01869746); 3700 m, 2 September 1980, *Plateau Exped. 14709* (PE00866299, PE00866300); **Nielamu County:** 3850 m, 17 July 2016, *Wei Lai et He Yi BNUXZ2016099* (BNU0027962); 3600 m, 2 August 2012, *Mu Xianyun 1174* (BJFC); 3015 m, 3 July 2012, *Gao Lianming et al. GLM-123685* (KUN1241906); 17 August 2011, *Yu Shengxiang et al. 5620* (PE); 18 August 2011, *Yu Shengxiang et al. 5690* (PE); 3970 m, 18 August 2010, *Tibet Exped. 1414* (PE01877046); 1 September 1981, *Ni Zhicheng et al. 1902* (PE); 3400 m, 26

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Acknowledgments

The authors thank the curators and staff members of BJFC, BNU, BM, E, GZU, K, KUN, L, NY, P, PE, QTPMB, SM, U, and W for welcoming us into their collections or providing images of specimens on their websites for this study. This work was financially supported by the Doctoral Scientific Research Foundation of China West Normal University (Grant no. 412679).

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PhytoKeys 154: 111–136 (2020)
doi: 10.3897/phytokeys.154.51454
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Welcome to the Czech Republic again! Rare northern mosses *Calliergon megalophyllum* and *Drepanocladus sordidus* (Amblystegiaceae) in South Bohemia in light of their European distribution and habitat preferences

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Academic editor: Matt von Konrat | Received 25 February 2020 | Accepted 19 June 2020 | Published 4 August 2020

Citation: Krajewski L, Adamec L, Saługa M, Bednarek-Ochyra H, Plášek V (2020) Welcome to the Czech Republic again! Rare northern mosses *Calliergon megalophyllum* and *Drepanocladus sordidus* (Amblystegiaceae) in South Bohemia in light of their European distribution and habitat preferences. PhytoKeys 154: 111–136. https://doi.org/10.3897/phytokeys.154.51454

Abstract

Two aquatic moss species, *Calliergon megalophyllum* and *Drepanocladus sordidus* (Amblystegiaceae, Bryophyta), which had been considered extinct in the Czech Republic, were found in the Třeboň Basin, South Bohemia, in 2016–2017. They co-occurred in extensive reed- and sedge-dominated fen pools with humic water on the shore of an old fishpond and the former species was also discovered in a small humic pool in an old shallow sand-pit. The new Czech sites of these rare boreal species represent one of the southernmost known outposts within their entire European range. Previously, the two species were only known from single records in the Czech Republic from the late 19th and early 20th centuries. To confirm our morphological observations, we used phylogenetic analyses of DNA sequence variation in four chloroplast loci (*atp*B-*rbc*L, *trn*L-*trn*F, *rpl*16, *trn*G) and one nuclear region, the internal transcribed spacers of ribosomal DNA (ITS). We found (1) monophyly of all *Calliergon megalophyllum* specimens tested; (2) based on chloroplast DNA sequences, monophyly among all *Drepanocladus sordidus* specimens and representatives of *Pseudocalliergon turgescens* and *P. lycopodioides* moss species; (3) based on nuclear ITS sequences, monophyly of all original *D. sordidus* specimens. These results corroborate morphological studies and thus confirm the existence of natural sites for the studied moss species in the Třeboň Basin, South Bohemia, Czech Republic.

Keywords
Aquatic mosses, *Drepanocladus tenuinervis*, glacial relicts, *Hypnum moldavicum*, southern distribution, threatening, Třeboň Basin

Introduction

During a botanical excursion in August 2016 to the Ptačí blato fishpond in the Třeboň Basin (South Bohemia, Czech Republic), the lead author found two interesting aquatic moss species, *Calliergon megalophyllum* Mikut. and *Drepanocladus sordidus* (Müll. Hal.) Hedenäs. They have recently been considered extinct in the Czech Republic (category RE; Kučera et al. 2012). This site was revisited in 2017 and both species were found again, with *C. megalophyllum* additionally discovered in a small humic pool in an old shallow sand-pit at Branná in that area.

Calliergon megalophyllum was recorded for the first time in Central Bohemia and the specimen was described as a new species, *Hypnum moldavicum* Velen. (Velenovský 1903), but this has fallen into oblivion (cf. Hedenäs et al. 1999). This was apparently because Mikutowicz (1908) described *Calliergon megalophyllum* from Latvia, which gained wide acceptance in Scandinavian literature (Jensen 1939; Tuomikoski 1940; Nyholm 1965; Tuomikoski and Koponen 1979; Hedenäs 1993a, b, 1997) since this species is widely distributed there.

Calliergon megalophyllum is a panholarctic, subarctic-boreal species having a strongly dissected geographical range (Fig. 1). It has the main centre of its occurrence in Fennoscandia (Norway, Sweden, Finland), mainly within the latitudinal limits of approximately 60–70°N. Outside Fennoscandia, the species is widely distributed but scattered in the northern regions of European and Asian Russia (Afonina and Czernyadjeva 1995; Ignatov et al. 2006) and very rarely in the Northwest Territories, the Yukon and Alaska in North America (Hedenäs 2014a). In Europe, *C. megalophyllum* has occasionally been found at isolated sites at lower latitudes: in Russia, Estonia, Latvia, Poland, Germany, Denmark and The Netherlands (Karczmarz and Touw 1973; Hedenäs 2003a; Ignatov and Ignatova 2004; Meinunger and Schröder 2007; Kooijman et al. 2015), reaching its southernmost site in the Czech Republic (Velenovský 1903).

In the Czech Republic, *Calliergon megalophyllum* was collected only once in 1896 in Štěchovice near Prague on the right bank of the Vltava river (German: Moldau) and described as *Hypnum moldavicum*. It has never been confirmed there since as this site was probably flooded by the dam reservoir and, accordingly, the species has been considered extinct (Váňa 2005a). Its Central European sites are relictual from the glacial period (Karczmarz 1971). Some of them no longer exist, for example in Germany, where it was reported at three sites in the northern part of the country (Meinunger and Schröder 2007). However, at least one German record is erroneous, because three specimens from Hagenmoor near Forst Klövensteen distributed by Bauer (1930) as No. 2092 in his *Musci Europaei et Americani Exsiccati* clearly represent *C. richardsonii* (Mitt.) Kindb. ex G. Roth (L. Hedenäs pers. com.). After many years, it has recently

Figure 1. Distribution of *Calliergon megalophyllum* in Europe. The new locations in the Czech Republic are marked by the triangle and the extinct type locality of *Hypnum moldavicum* (cf. Velenovský 1903) is marked by the asterisk.

been rediscovered in The Netherlands (Kooijman et al. 2015). In Poland, several sites have been known in northern and eastern regions (Lisowski 1960; Ochyra and Tomaszewicz 1982; Ochyra and Szmajda 1983).

Drepanocladus sordidus occurs in slightly mineral-rich to eutrophic habitats. It was recorded growing as a submerged or amphibious species in lakes, backwater pools and oxbows, terrestrial wetland habitats or fens. It is a panholarctic species having a strongly discontinuous geographical range in boreal and temperate zones (Fig. 2). It is most frequent in North America, ranging from Greenland, Nunavut and Alaska southwards to California, Oklahoma and Mexico (Hedenäs 2003b, 2014b), with some isolated sites in the West Indies and Central America and in the North and Central Andes in South America (Hedenäs 2003b). In Eurasia, it is mostly distributed in Sweden and Finland

Figure 2. Distribution of *Drepanocladus sordidus* in Europe. The new locations in the Czech Republic are marked by the triangle. Occurrence on the northern coast of Spitsbergen beyond the map is indicated by the arrow.

(Hedenäs 1993b) and very rarely in Iceland and Norway (Hedenäs 2003a), Karelia and in the Republic of Komi (Zheleznova 1994) and on Vaygach Island (Hedenäs, pers. com.) in north-eastern Europe, as well as in Taymyr Peninsula and Yakutia in Asia (Ignatov et al. 2006), extending as far north as Svalbard (Hedenäs 1998). In continental Europe, *D. sordidus* is very rare and scattered in the Netherlands (Hedenäs 1998), France (Hedenäs, pers. com.), Germany (Meinunger and Schröder 2007), Poland (Ochyra et al. 2003), Austria (Köckinger et al. 2008), Hungary (Erzberger and Papp 2004), Switzerland (Hedenäs and Bisang 2002), as well as Latvia (Āboliņa 2001) and Estonia (Ingerpuu et al. 1994). Additionally, *D. sordidus* was once recorded in the north-western part of the Czech Republic, in the Červený rybník fishpond near the village of Pihel close to the Česká Lípa town (Váňa 2005b). The moss was collected in

1910 by A. Schmidt and distributed by Bauer (1915) in his *Musci Europaei Exsiccati* as No. 1418 as *D. lycopodioides* (Brid.) Warnst. fo. *immersus* Mönk. The southernmost record of this species is in Turkey (Hedenäs 2003a). In general, *D. sordidus* has a somewhat wider range in Europe than *Calliergon megalophyllum* (Hedenäs 2003a), but the degree of threat to both species is similar (Hodgetts et al. 2019).

Although there are many known sites of the two aforementioned moss species, reliable data on biotic and abiotic habitat conditions are still scarce in the literature. In this paper, we characterise water chemistry and vegetation composition at both Czech sites. Also, we compare these characteristics with those at other European sites and discuss the phytogeographic particulars of both species in Europe. As the two species are rare and vanishing in the neighbouring countries (Hodgetts 2015), we briefly discuss the perspectives for their survival and their conservation concerns.

To investigate whether genetic data support species designation of individuals of *Calliergon megalophyllum* and *Drepanocladus sordidus* collected from the Třeboň Basin, Czech Republic, we sequenced the following DNA regions: nuclear ITS (internal transcribed spacers ITS1-5.8S-ITS2 of ribosomal DNA), and selected plastid DNA regions (intergenic spacer *atp*B-*rbc*L, intron of the *rpl*16 gene, intron of the $tRNA^{Gly}$ (UCC) gene *trn*G, and *trn*L gene plus the adjacent *trn*L-*trn*F (GAA) spacer together as a single amplicon). In the first step, our original data was compared to the available nucleotide sequences of reported moss species found in the GenBank database. Secondly, apart from collected individuals, additional herbarium specimens of *C. megalophyllum* and *D. sordidus* from Poland and Finland were used as a part of the molecular research. Finally, the taxonomic status of described species was resolved using two methods: maximum likelihood (ML) and Bayesian inference (BI) employed for the dataset consisting of our original sequences supplemented by the GenBank resources. Hence, we placed described species into the larger context of Amblystegiaceae taxonomy of their closely related taxa, e.g. *Calliergon* (Sull.) Kindb., *Loeskypnum* H. K. G. Paul, *Straminergon* Hedenäs, *Warnstorfia* Loeske in the case of *C. megalophyllum*, and *Cratoneuropsis* (Broth.) M. Fleisch., *Drepanocladus* (Müll. Hal.) G. Roth, *Pseudocalliergon* (Limpr.) Loeske concerning *D. sordidus*. Lastly, we checked the morphological identification of these species with their clustering in phylogenetic trees based on nuclear and plastid DNA.

Materials and methods

Description of the mosses and the nomenclature

The nomenclature of mosses follows Kučera et al. (2012), algae Caisová and Gąbka (2009), vascular plants Danihelka et al. (2012), and syntaxonomy Chytrý (2011). The herbarium materials have been deposited in the Bryological Herbarium of the W. Szafer Institute of Botany of the Polish Academy of Sciences in Kraków (KRAM), University of Ostrava (OSTR), and Medical University of Silesia, Department of Pharmaceutical Sciences in Sosnowiec (SOSN).

Description of the sites and field work

Calliergon megalophyllum and *Drepanocladus sordidus* were firstly found in the 1st fen pool (as counted from the north) on the eastern shore of Ptačí blato fishpond, ca. 4 km west of Lomnice nad Lužnicí, Třeboň Basin Biosphere Reserve, South Bohemia, Czech Republic, in August 2016 (for details of the site, see Adamec 1999; Adamec and Lev 1999; Adamec and Kovářová 2006). The Ptačí blato fishpond is a hypertrophic fishpond with an irregular water inflow. It is regularly emptied at 2-yearly intervals in October and its normal water level is reached again in February-April. During the 2014–2019 seasons, it suffered from summer drought and its summer water level was usually 10–30 cm lower than expected. Its whole SE shoreline is adjacent to a partly afforested fen meadow. In the 1970s, ca. 12 shallow fen pools of 0.04–0.1 ha in size attached to the fishpond were excavated in the fen soil. Up to now, they have had various connections with the fishpond body and have been subject to various botanical successions (Adamec 1999; Adamec and Kovářová 2006). A rare aquatic carnivorous plant *Aldrovanda vesiculosa* L. (Droseraceae) was successfully introduced to some pools in 1995 and a stable and abundant population has arisen there (Adamec and Lev 1999; Adamec and Kovářová 2006). On 28 June 2017, a detailed search for both moss species was conducted in the first 10 fen pools. The water level in the dominant parts of the moss stands was <6 cm.

On 12 October 2017, *Calliergon megalophyllum* was also found in a small shallow humic pool (area ca. 70 m^2, depth 3–50 cm) in an old sand-pit complex near Branná, ca. 4 km SE from Třeboň (Adamec 2009, 2010; Adamec and Kučerová 2013). To characterise the microsites for either of the rare moss species, we conducted a floristic survey (vegetation dominants) and measured basic parameters of water chemistry (pH, electrical conductivity) in typical microhabitats of both species by portable meters.

In July 2017, *Calliergon megalophyllum* was searched for comparison in NE Poland, in three historically known sites in Suwałki Landscape Park (cf. Ochyra and Tomaszewicz 1982), but was found only at one site near Błaskowizna on 17 July 2017. A very wet mire on thick peat deposits is developed there in a depression, surrounded by parallel, arched and prominent ridges of moraines (glacial curvilineations created by catastrophic megafloods during last glaciation; Weckwerth et al. 2019). The vegetation represents *Pinus-Betula* swamp forests, peatbogs and fens, with many relic species (most notable: *Eriophorum gracile* W. D. J. Koch ex Roth, *Baeothryon alpinum* T. V. Egorova, *Pseudocalliergon trifarium* (F. Weber & D. Mohr) Loeske and *Scorpidium scorpioides* (Hedw.) Limpr.) occurring, but *C. megalophyllum* was found there in an old peat hollow. Subsequently, water chemistry measurements were repeated on 27th July 2017 (Elmetron CPC-401).

Other potential sites of the two moss species checked in the Třeboň Basin

To specify the occurrence of both rare moss species at potential, humic mesotrophic sites within the Třeboň Basin, an extensive search for both species was conducted at

44 sites in this region in the 2017 and 2018 seasons (see the list in the Suppl. material 1). The potential sites were selected based on similarity with those (micro)sites of both mosses at Ptačí blato and Branná according to the following criteria: shallow standing humic water, loose reed- or sedge-dominated wetland vegetation, highly organic bottom sediment consisting of reed or sedge litter or fen, partial shading by adjacent vegetation, proximity to eutrophic fishponds but evidently low levels of nutrients (N and P). As both rare moss species were found at both Czech sites where aquatic carnivorous plants also grow (both naturally spread and introduced; see Adamec and Kučerová 2013), it is possible to suggest that the ecological requirements for the rare mosses and aquatic carnivorous plants *Aldrovanda vesiculosa*, *Utricularia australis* R. Br., *U. bremii* Heer, *U. ochroleuca* R.W. Hartm. *s. str.* greatly overlap. Therefore, the potential sites were also selected according to the occurrence of any of these aquatic carnivorous species. Moreover, in the past, many of these sites were used for ecophysiological studies on this plant group and some data on water chemistry are available (Adamec 1999, 2008, 2009, 2010; Adamec and Lev 1999; Adamec and Kovářová 2006). The distance between any of these selected sites and those of the rare mosses never extended beyond 20 km.

Determination of the mosses

Calliergon megalophyllum is a stenotypic species which exhibits a narrow range of morphological variability and is easily distinguishable from other congeners. It is usually a very robust moss, usually growing submerged and often floating, in somewhat nutrient-rich lakes, oxbow lakes and other small water bodies. The plants are green, brownish or yellowish, with shoots 15–30 cm long (exceptionally to almost 1 m in Sweden, L. Hedenäs pers. com.), radially, slightly pinnately or irregularly branched. The stem leaves are erect-spreading, concave, broadly rounded or rounded-ovate to rounded ovate-cordate, 3.5–5.0(–6.0) mm long, 2.5–3.0(–4.5) mm wide, broadly rounded at the apex and abruptly narrowed into a short blunt point. The costa is single, unbranched, 40–80(–105) μm wide at the base, ceasing just below the leaf apex. The alar cells are large, hyaline and thin-walled, forming a large pellucid group sharply separated from the adjacent laminal cells and occupying nearly two third or less the leaf base. *Calliergon megalophyllum* is closely related to *C. richardsonii*, but the latter differs in its shorter costa, ending far below the apex which is branched or spurred below and usually forked at the apex. The costa of *C. megalophyllum* is clearly thinner than that of *C. giganteum*, in which it is strong or very strong, 90–280 μm near the base, but it is also unbranched and extends to the leaf apex. The alar cells of *Calliergon cordifolium* (Hedw.) Kindb. form also a large group, reaching almost the costa but it is diffusely delimited and they transform gradually into laminal cells. Finally, a good differentiating character between *C. megalophyllum* and *C. richardsonii* is found in the relative length of the distal cell of the axillary hairs (more elongate in *C. richardsonii*). Since such hairs are abundant and large in *Calliergon* s.str., this is a useful character, especially when the identity of specimens is doubtful (L. Hedenäs pers. com.).

Drepanocladus sordidus belongs to the *D. sendtneri*-group species characterised by the presence of rounded-triangular groups of alar cells reaching from the leaf margin one third to two thirds of the distance to the costa. This character immediately distinguishes it from the *D. aduncus* group in which the alar cells form much larger, triangular groups reaching the costa. *Drepanocladus sordidus* is closely related to *D. sendtneri*, but it has a relatively weak costa, 30–75 µm wide near the base which vanishes far below the leaf apex and thin-walled alar cells. In contrast, *D. sendtneri* has a strong costa, (50-)70–100 µm wide near the base, ending in the leaf acumen near the apex and the alar cells have mostly incrassate walls. According to Hedenäs (2003a) the crucial difference between the two species is the ratio of the length of leaf cells (µm) to leaf length (mm). In *D. sordidus* this ratio is 23.3–36.5, whilst in *D. sendtneri* it is 17.9–24.4. The two species differ also in their ecological requirements. *Drepanocladus sordidus* prefers less mineralised waters (electrical conductivity only 0.1–2.4 mS/m, n = 45), whereas *D. sendtneri* prefers much harder waters (conductivity 14.0–96.0 mS/m, n = 19) (Hedenäs 1998, 2003a). Thus, the former usually occurs in oligotrophic and dystrophic habitats (e.g., *Lobelia* lakes), while the latter grows typically in alkaline fens (Rydin et al. 1999).

Preparation of outdoor culture

To keep living material of the two exceedingly rare moss species available for any study purpose, a simple outdoor culture of them originating from 2–3 specimens collected from Ptačí blato (first pool) has been established in the collection of aquatic and wetland plants in the Institute of Botany CAS at Třeboň (CZ 0 HBT 2017.03851; CZ 0 HBT 2017.03802). The cultivation mimicked the natural conditions of both species in humic water and was the same as that used for growing aquatic temperate *Utricularia* species (e.g., Sirová et al. 2003). Each moss species was grown in a 3 litres shaded aquarium floating in an outdoor 1 m^2 plastic container for cooling. A litter of robust sedges and a small amount of fen soil were used as a substrate which rendered the water humic (pH was ca. 6.6–7.0). Both moss species have grown vigorously in this culture and have formed a substantial biomass, but older parts of their shoots were covered by filamentous algae.

Materials, DNA extraction, PCR amplification and DNA sequencing

One sample of *Calliergon megalophyllum* and *Drepanocladus sordidus* was collected in the field (Třeboň Basin, Czech Republic), with voucher specimens deposited in the Bryophyte Herbarium at the W. Szafer Institute of Botany of the Polish Academy of Sciences (KRAM) under the following vouchers: *C. megalophyllum* (KRAM B-249804), and *D. sordidus* (KRAM B-249802). Tissue samples of the above mentioned specimens in the form of leafy gametophyte fragments were stored in silica gel until genetic analysis was performed. The sampling was completed using four her-

barium specimens from the KRAM collection: two individuals of *C. megalophyllum* (Poland, KRAM B-177615 and KRAM B-249803) and two individuals of *D. sordidus* (Finland, KRAM B-55364; Poland, KRAM B-75950). All specimens were morphologically verified before genetic analysis.

Gametophyte fragments of weight equal to 12 mg of both herbarium and fresh samples were used for DNA extraction. Total genomic DNA was isolated from six individuals with the Isolate II Plant DNA Kit (Bioline, Meridian Life Science, Memphis, USA) following the manufacturer's guidelines. We amplified and sequenced five DNA regions that were previously used to analyse the phylogenetic relationships in these genera. Accordingly, the internal transcribed spacers (ITS1-5.8S-ITS2) of nuclear DNA, and the following plastid regions: *atp*B-*rbc*L, *trn*L-*trn*F, *trn*G, and *rpl*16 were used on three individuals of *C. megalophyllum*. The internal transcribed spacers (ITS1-5.8S-ITS2) of nuclear DNA, and plastid *atp*B-*rbc*L, *trn*L-*trn*F regions were tested on three individuals of *D. sordidus*. The analysed DNA fragments were amplified with primers according to PCR conditions described in Saługa et al. (2018). Negative controls were added to all PCR reactions. PCR products were sequenced in both directions with an AB3500 sequencer. Resulting chromatograms were edited and contigs were assembled using Geneious v.10.1.3 (Biomatters Ltd.). All nucleotide sequences reported in this study have been deposited in GenBank with accession numbers given in Suppl. material 3. DNA extracts are deposited in the Laboratory of Molecular Analyses at the W. Szafer Institute of Botany of the Polish Academy of Sciences.

Phylogenetic analyses

To evaluate the genetic designation of described species we combined the sequences newly obtained in this study with the previously published sequences collected from BLAST searches of the GenBank database. In the first step, our original sequences were compared to molecular data of *Calliergon megalophyllum* (Sweden, MAC B88612), and *Drepanocladus sordidus* (USA, S B39576) specimens. Afterwards, selected molecular data published by Hedenäs et al. (2005) and Hedenäs (2006) was used to construct *C. megalophyllum* phylogeny. Original DNA sequences generated from *D. sordidus* specimens were analysed along with selected sequences published by Hedenäs and Rosborg (2008), and Saługa et al. (2018) (see Suppl. material 3). Sequence alignments were conducted in Geneious v.10.1.3 (Biomatters Ltd.) using the Geneious Alignment option. Final editing was done using BioEdit Sequence Alignment Editor v7.2.5 (Hall 1999). For each of the alignments, the programme jModelTest 2.0 v.0.1.1 (Guindon and Gascuel 2003; Darriba et al. 2012) was used to determine the model of sequence evolution. For the *C. megalophyllum* phylogeny, model selection using the Akaike Information Criterion (AIC), resulted in the GTR+I+G (ITS), TPM1uf+I (*atp*B-*rbc*L, *rpl*16), TPM3uf+I (*trn*G), and HKY+I (*trn*L-*trn*F) models of sequence evolution. The following evolutionary models were selected for the *D. sordidus* phylogeny: HKY+G (ITS), TPM1uf (*atp*B-*rbc*L), and TIM1+G (*trn*L-*trn*F). For both species, nuclear and

plastid sequences were analysed separately, except that all plastid sequences were combined into a single data matrix. The SeaView v.4 (Gouy et al. 2009) was used to concatenate all analysed plastid sequences. To infer phylogenetic trees, we applied two approaches: Bayesian inference (BI) in MrBayes v.3.2.6 (Ronquist et al. 2012) and Maximum Likelihood (ML) in RAxML v.7.2.4 (Stamatakis 2006; Stamatakis et al. 2008). One thousand non-parametric rapid bootstrap replications were used to generate ML trees. All ML analyses performed for *C. megalophyllum* phylogeny were conducted using the GTR GAMMAI model of sequence evolution (GTR + I + G). This is due to the fact that Stamatakis (2006) has only implemented the proportion of invariable sites parameter (I) along with gamma distributed variable sites (G) in RAxML. With regard to *D. sordidus* analyses, we used the GTR GAMMA sequence evolution model. As a starting tree for full ML searches, every fifth bootstrap tree was used. The resulting trees with the highest ML scores were chosen.

In the BI analyses, each target plastid region was treated as a separate partition during the analyses. Here, two independent runs starting from random trees were applied, each using four Markov chains. All analyses were run for 10,000,000 generations with sampling trees every 100 generations. In the final analysis 25 per cent, burn-in trees were discarded and the remaining trees and their associated parameter values were saved. The convergence of the chains was determined by examining the plot of all parameters values and the -lnL against generation time using the programme Tracer v.1.5, as recommended by Drummond and Rambaut (2007) to analyse MrBayes and BEAST output files.

Results

Distribution

A list of (micro)sites where the mosses were recently recorded.

Calliergon megalophyllum

Czech Republic:

1a) 3.5 km WNW of Lomnice nad Lužnicí town, Ptačí blato fishpond, NE part, loc. Zátoka 1, 49°5.45'N, 14°40.183'E, and nearby fen meadow, 49°5.4184'N, 14°40.2793'E, 434 m a.s.l., leg. Ł. Krajewski, 20 Aug 2016 (KRAM B-249804), leg. R. Ochyra with V. Plášek, H. Bednarek-Ochyra, Ł. Krajewski and L. Adamec, 28 June 2017 (KRAM B-250940, B-250945, B-250946, SOSN 67668).

1b) 3.5 km WNW of Lomnice nad Lužnicí town, Ptačí blato fishpond, NE part and nearby fen meadow, loc. Zátoka 2, 49°5.4106'N, 14°40.2562'E, 434 m a.s.l., leg. R. Ochyra with V. Plášek, H. Bednarek-Ochyra, Ł. Krajewski and L. Adamec, 28 June 2017 (KRAM B-250948).

1c) 3.5 km WNW of Lomnice nad Lužnicí town, Ptačí blato fishpond, NE part and nearby fen meadow, loc. Zátoka 4, 49°5.3873'N, 14°40.231'E, 434 m a.s.l., leg.

R. Ochyra with V. Plášek, H. Bednarek-Ochyra, Ł. Krajewski and L. Adamec, 28 June 2017 (KRAM B-250950).

2) 4 km SE of Třeboň town, sand-pit near Branná village, small humic pool in the complex on the margin of a forest, 48°58.428'N, 14°47.813'E, 440 m a.s.l., leg. V. Plášek, 12 Oct 2017 (OSTR B-7253, KRAM B-253888).

Poland:

3) 1 km NE of Błaskowizna, mire E of Boczniel Lake (E of Hańcza Lake), hollow in peat, 54°15.458'N, 22°49.433'E, 230 m a.s.l., leg. Ł. Krajewski, 17 Jul 2017 (KRAM B-249803, SOSN 67667).

Drepanocladus sordidus

Czech Republic:

1a) 3.5 km WNW of Lomnice nad Lužnicí town, Ptačí blato fishpond, NE part, loc. Zátoka 1, 49°5.45'N, 14°40.183'E, 434 m a.s.l., leg. Ł. Krajewski, 20 Aug 2016 (KRAM B-249802), leg. R. Ochyra with V. Plášek, H. Bednarek-Ochyra, Ł. Krajewski and L. Adamec, 28 June 2017 (KRAM B-250941, B-250942, B-250943, B-250944, B-250947).

1b) 3.5 km WNW of Lomnice nad Lužnicí town, Ptačí blato fishpond, loc. Zátoka 3, 49°5.3993'N, 14°40.183'E, 434 m a.s.l., leg. R. Ochyra with V. Plášek, H. Bednarek-Ochyra, Ł. Krajewski and L. Adamec, 28 June 2017 (KRAM B-250949).

Specimens of *Calliergon megalophyllum* recorded in Ptačí blato fen pools in 2016 were relatively small (shoots 10–20 cm long, leaves up to 4 mm long and 3.5 mm wide) overgrown with periphyton, dark green-brown, with leaves protruding at right angles and distant, just like *C. megalophyllum* var. *natans* Karczm. (Karczmarz 1971; Karczmarz and Touw 1973), but branching out. Despite the smaller size, the shape, the strongly concave leaves, the size and location of the alar cell groups were typical for the species. In 2017, the species grew in much shallower water, occasionally almost as a terrestrial plant.

Specimens of *Drepanocladus sordidus* from Ptačí blato pools in 2016 were strongly overgrown with periphyton, usually dark and dying in the opaque, humic water. The alar cells were typical of the species, the habit turned out (10–20 cm), the leaves strongly bent. Thus, the co-occurred form of *D. aduncus* (Hedw.) Warnst. growing in the pools is macroscopically distinguishable in much less curved leaves.

In the first (northernmost) pool, both *Calliergon megalophyllum* and *Drepanocladus sordidus* were found in a scattered stand on an area of >200 m^2. The shallow water in the pool is strongly coloured with humic acids, which is partly caused by the adjacent fen meadow. Yet the water chemistry in the pool is also influenced by the nutrient-rich, hard water from the fishpond body, the penetration of which depends on water level (Adamec and Lev 1999). Vegetation within the microsite is represented by the weakly compact association *Typhetum angustifoliae* Pignatti 1953, where the dominant stands are formed by *Typha angustifolia* L., *Phragmites australis* (Cav.) Trin ex Steud., *Carex rostrata* Stokes, *C. paniculata* L., *Juncus effusus* L. and *J. bulbosus* var. *fluitans* (Lam.)

Beck. Also the macrophytes associated with nutrient-poor, low-mineralised waters were observed there, e.g. *Utricularia australis* R. Br., *Riccia fluitans* L., *Nitella gracilis* (Sm.) Ag., *N. flexilis* (L.) Ag., *Chara delicatula* Ag. and *Chara globularis* Thuill.

Only isolated shoots of *Calliergon megalophyllum* were found interspersed on the eastern fen margin of the first pool adjacent to an afforested fen meadow within *Carici elatae – Calamagrostietum canescentis* Jílek, 1958 (variant with *Comarum palustre* L.). They grew in the vegetation dominated by *Calamagrostis canescens* (Weber) Roth, *Agrostis canina* L., *Juncus effusus*, *Peucedanum palustre* (L.) Moench, *Lycopus europaeus* L., *Viola palustris* L., *Hydrocotyle vulgaris* L. and *Sphagnum* spp.

Another site of *Calliergon megalophyllum* was also found in the Třeboň Basin - in a small humic pool in the sand-pit complex near Branná. The very dense and dominant stand occupies an area of >30 m^2, which amounts to ca. half of the surface area of the pool. Although the total water column in the moss stand is 20–40 cm deep, the water is completely filled by plant dominants (*Comarum palustre* L., *Calliergon megalophyllum*, *Hydrocharis morsus-ranae* L.) and the moss grows only near the water surface and an apical part of the shoots often emerges. At this site, the moss also grew scarcely along the adjacent shoreline of a large shallow sand-pit pool in a ca. 20 m long reach. It was evident that these plants were dispersed from the small pool during the events of high-water level or transferred by large animals.

In summary, both moss species grew in relatively soft waters (conductivity 8.8–19.8 mS/m) and within a narrow pH range of 5.94–7.04 in the Třeboň Basin and NE Poland (Table 1), which is in agreement with data from other European sites (Suppl. material 1).

Molecular recognition of *Calliergon megalophyllum* and *Drepanocladus sordidus*

Sequence alignments of selected target DNA regions support the recognition of two individuals of aquatic moss species in the study area: *Calliergon megalophyllum* and *Drepanocladus sordidus*. Our original sequences obtained from the examined specimens are homogeneous in all DNA regions tested. The only minor detected genetic differences, if present, concern original versus GenBank DNA sequences.

Genetic analysis of *Calliergon megalophyllum* specimens resulted in the uniform plastid and nuclear data within the testing group (Czech Republic, KRAM B-249804; Poland, KRAM B-249803 and KRAM B-177615; Sweden, MAC B88612) with two single nucleotide polymorphisms (SNP's) detected only from *trn*L-*trn*F plastid region. Recognised SNPs are related to the sequence ends, which could come up as an effect of the technical sequencing errors.

Similar results can be found by comparing plastid DNA sequences within the group of *Drepanocladus sordidus* specimens (Czech Republic, KRAM B-249802; Poland, KRAM B-75950; Finland, KRAM B-55364; USA, S B39576). All sequences are identical, with only three SNPs detected from *trn*L-*trn*F intergenic spacer, likewise at the ends of the sequences. Quite opposite, in the group of nuclear ITS sequences of *D. sordidus* specimens we found, four SNPs, and two insertion/deletion polymorphisms (indels), which differ in the original sequences generated with this study from data in GenBank.

Table 1. Summary of vegetation and abiotic factors found at microsites of *Calliergon megalophyllum* (CM) and *Drepanocladus sordidus* (DS) at CZ: Ptačí blato and Branná sites, Třeboň Basin Biosphere Reserve, South Bohemia, Czech Republic, in 2017 and PL: Błaskowizna, Suwałki Landscape Park, NE Poland. The pools at Ptačí blato are counted from the north.

No. of the pool	Water depth (cm)	Plant dominants	Rare mosses	Electr. conduct. (mS/m)	pH	Comments on rare moss abundance
a) CZ: Fen pools at Ptačí blato fishpond						
1st	0–5	*Phragmites australis*, *Carex* spp., *Typha angustifolia*, *Juncus effusus*, *Utricularia australis*, *Lythrum salicaria*	CM, DS	13.5–19.5	6.13–6.42	both species common
4th	0–4	*Carex* spp., *Sparganium erectum*, *Utricularia ochroleuca*, *Agrostis canina*	CM	13.8–15.8	6.24–6.36	CM scarcely
9th	0	*Calamagrostis canescens*, *Juncus effusus*, *Galium uliginosum*, *Carex rostrata*, *Lysimachia vulgaris*	DS	–	–	DS very scarcely
b) CZ: Fen meadow E of 1st bay of Ptačí blato fishpond						
	0–5	*Calamagrostis canescens*, *Juncus effusus*, *Hydrocotyle vulgaris*, *Viola palustris*, *Sphagnum* spp.	CM	15.8	6.36	CM very rare
c) CZ: Humic pool in Branná sand-pit						
Open stand	20–40	*Comarum palustre*, *Hydrocharis morsus-ranae*	CM	11.2	6.04–6.08	dominant
Shaded stand	20–30	*Comarum palustre*, *Carex acuta*, *Lysimachia vulgaris*	CM	8.8	5.94–6.10	dominant
d) PL: Peat hollow in mire E of Boczniel Lake						
	70–150 (floating)	*Comarum palustre*, *Myriophyllum verticillatum*, *Hydrocharis morsus-ranae*, *Sparganium natans*, *Stratiotes aloides*, *Calliergon giganteum*, *Utricularia* spp.	CM	16.9–19.8	6.95–7.04	CM rare

Bayesian and maximum likelihood species delimitation

Species recognition of the specimens of *Calliergon megalophyllum* and *Drepanocladus sordidus* collected from the Třeboň Basin was well supported by all BI and ML analyses (see Figs 3, 4, 5, 6). Both of the guide BI and ML trees for either the nuclear (ITS) or selected plastid data (*atp*B-*rbc*L, *rpl*16, *trn*G, *trn*L-*trn*F) represent identical topologies, with posterior probabilities (PP), and bootstrap support (BS) values of greater than or equal to 0.90 (PP), and 90% (BS), calculated for the split between the studied species and their closest relatives. The only exception is the plastid based ML tree obtained for *D. sordidus* moss species, for which bootstrap support is lower than 90%, and is equal to 74%. Both support values (PP; BS) are presented at single, representative nuclear ITS or plastid trees for a given moss species.

The plastid and nuclear ITS analyses of *Calliergon*, *Loeskypnum*, *Straminergon*, and *Warnstorfia* produced very similar tree topologies, and both have resulted in a monophyletic, well-supported clade consisting strictly of *C. megalophyllum* specimens represented by the following individuals: Czech Republic, KRAM B-249804; Poland, KRAM B-249803 and KRAM B-177615; Sweden, MAC B88612, suggesting that they are genetically homogeneous. In contrast with the above, phylogenetic analyses of

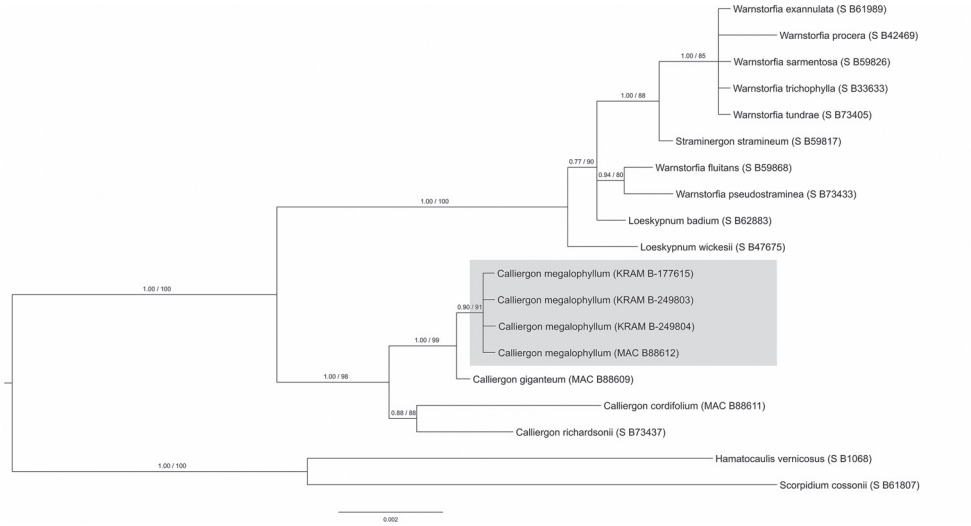

Figure 3. Cmega_concatenated plastid BI and ML analysis.

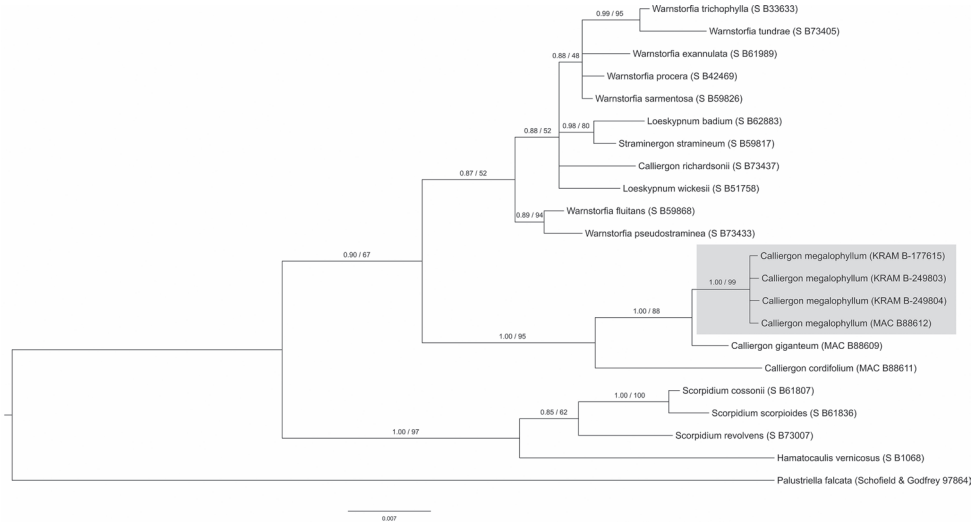

Figure 4. Cmega_ITS BI and ML analysis.

Drepanocladus, *Cratoneuropsis*, and *Pseudocalliergon* inferred from plastid and nuclear ITS data resulted in different tree topologies. Based on the concatenated plastid sequences it can be concluded that all representatives of *Drepanocladus sordidus* are genetically uniform (Czech Republic, KRAM B-249802; Poland, KRAM B-75950; Finland, KRAM B-55364; USA, S B39576). However, representatives of *Pseudocalliergon lycopodioides* (Brid.) Hedenäs, and *P. turgescens* (T. Jensen) Loeske are clustering together with the abovementioned specimens, and all form a monophyletic, well-supported clade

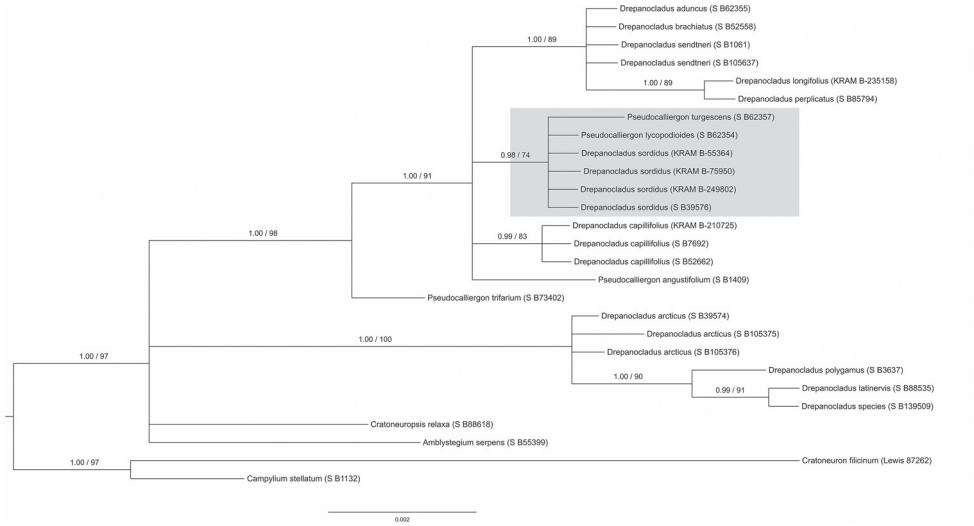

Figure 5. Dsor_concatenated plastid BI and ML analysis.

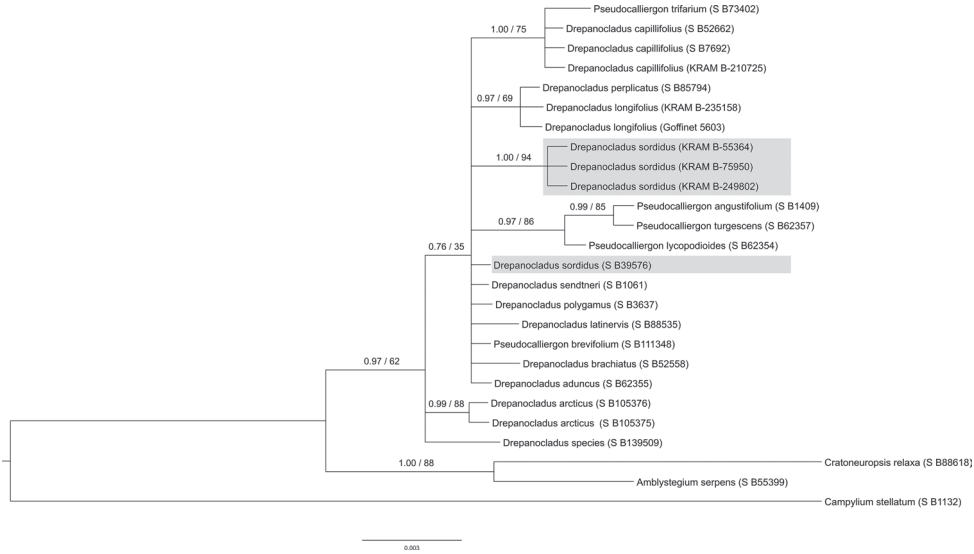

Figure 6. Dsor_ITS BI and ML analysis.

with Bayesian posterior probabilities (PP) but on the other hand they were not strongly supported with bootstrap resampling values (BS). Accordingly, we tested, in pairwise comparisons, the sequence identity within the described clade. Apart from minor genetic incompatibility detected among *D. sordidus* representatives (see section "Molecular recognition of *Calliergon megalophyllum* and *Drepanocladus sordidus*"), we found only one SNP mutation in *atp*B-*rbc*L intergenic spacer with regard to *P. turgescens* specimen.

In the nuclear ITS trees our original *Drepanocladus sordidus* specimens (Czech Republic, KRAM B-249802; Poland, KRAM B-75950; Finland, KRAM B-55364) are recognised as a monophyletic clade with high (PP) and (BS) support values. Although this clade comprised all three analysed individuals, it does not include *D. sordidus* specimen (USA, S B39576) whose sequence was downloaded from GenBank data base. Although our original ITS sequences of *D. sordidus* specimens are well differentiated (four SNP's and two indels) from the sequence of *D. sordidus* individual (USA, S B39576), their potential relationship is not well resolved. In the ITS tree, accession of *D. sordidus* (USA, S B39576) is placed in the ambiguous position among four monophyletic clades along with *D. aduncus*, *D. brachiatus* (Mitt.) Dixon, *D. latinervis* Warnst., *D. polygamus* (Schimp.) Hedenäs, *D. sendtneri* (Schimp.) Warnst., and *Pseudocalliergon brevifolium* (Lindb.) Hedenäs representatives. Here, contrary to plastid data, *P. turgescens* and *P. lycopodioides* together with the accession of *P. angustifolium* Hedenäs form a separate well-supported clade.

Discussion

Ptačí blato fishpond (about 40 ha) was built at the end of the 16th century and represents one of the ca. 500 fishponds in this basin (Jeník and Květ 2002; Jeník et al. 2002). In 1872–1881, the pond was drained and the peaty soil from the bottom was extracted for fuel (Anonymus 2019). This indicates that at that time, some fen pools filled with humic water existed on the E shoreline of the fishpond, so rare mosses could survive there and a previously large mire was developing there for many centuries. During the 1970s, the fishpond managers excavated *ca*. 12 shallow pools (bays, lagoons) in the fen soil attached to the fishpond along its 400 m SE shoreline. The pools (of different sizes) have changed their connection with the body of the increasingly eutrophic fishpond since. Accordingly, they have been subject to variable botanical succession or even infilling by organic material and eutrophication (*cf*. Adamec 1999; Adamec and Lev 1999; Adamec and Kovářová 2006). The underlying rapid botanical succession has even accelerated due to the very dry 2014–2019 seasons. In contrast to the conditions in 1994–1995, when the dominant stands in several pools were formed by loose mesotrophic stands dominated by *Phragmites australis* and *Carex rostrata*, recent extensive helophyte stands in various pools are dominated by dense stands of mainly *P. australis*, *Typha angustifolia*, *Carex* spp. and *Juncus effusus* (Adamec, unpubl. obs.). In the first pool, both rare mosses co-occur with *Aldrovanda vesiculosa* which has been successfully introduced (Adamec and Lev 1999).

Presumably, *Calliergon megalophyllum* and *Drepanocladus sordidus* previously occurred in the area of the recent Ptačí blato fishpond (before the fishpond was built) in shallow, temporary inundations in *Caricion nigrae* fens, developed on peats (later mostly exploited and inundated), similar to e.g. recent *C. megalophyllum* sites in The Netherlands (Kooijman et al. 2015). This relic occurrence of *C. megalophyllum* could still be observed east of the 1st pool, where single shoots survived in the natural fen vegetation. After the creation of the fishpond, both species dispersed and have become abundant in nearby, anthropogenic habitats of fishpond pools (e.g. by zoochory of

wild boars). This was observed for *Pseudocalliergon turgescens* and other rare, northern-distributed mosses in southern Poland, which occurred there in large sand-pits, but almost disappeared in nearby fens (Krajewski 2017).

Also, the other Czech site of *Calliergon megalophyllum*, a sand-pit near Branná, is a typical man-made wetland in which sand extraction ceased perhaps in the 1950s. The small humic pool inhabited by the moss species is partly surrounded by a mixed forest so that falling leaves and branches permanently increase the trophic status to recent meso-eutrophy, and render the water strongly humic (Adamec 2008, 2009, 2010; Adamec and Kučerová 2013). Considering the recent occurrence of both rare mosses in S Bohemia, it is necessary to add that both species are, in fact, sterile and therefore, they can spread only as shoot fragments on the body of large animals (e.g., water birds, roe deer) probably for shorter distances, but there is known to be a dispersy even by small birds, migrating to long distances (Lewis et al. 2014).

The Třeboň Basin in the Czech Republic is a refuge for many glacial relics both of vascular plants and bryophytes, e.g. *Eriophorum gracile* (Kaplan et al. 2015), *Helodium blandowii* (F. Weber et D. Mohr) Warnst., *Meesia triquetra* (Jolycl.) Ångstr. (Holá et al. 2010). Many of them were also documented in the Třeboň Basin as macrofossils in Late-Glacial and Early-Holocene peat deposits (Hájková et al. 2018). Ptačí blato fishpond is located within the Třeboň Biosphere Reserve and Protected Landscape Area. However, a strong impact of the hypertrophic fishpond since the 1980s (liming, fertilisation by organic compost, overstocking by fishstock; see Pechar et al. 2002) on the adjacent fen meadow and excavated fen pools has caused a gradual deterioration of water chemistry factors towards eutrophication and reduction of water transparency (*cf.* Adamec 1999; Adamec and Lev 1999; Adamec and Kovářová 2006). This trend towards eutrophication is greatly amplified by very low water level in the fishpond and adjacent pools due to dry summer seasons since 2014, which has resulted in rapid overgrowth of the pools by dense robust helophyte stands. However, studies from Finland indicate that *Calliergon megalophyllum* is rather resistant to moderate eutrophication and could increase its abundance and even become dominant in the small bays of larger lakes or in small water bodies (Rintanen 1996).

The historic north-west Czech site of *Drepanocladus sordidus* is also a fishpond adjacent to a peat bog, where one of the largest national populations of Natura´2000 moss, *Hamatocaulis vernicosus* (Mitt.) Hedenäs, occurs (Štechová et al. 2012). *Drepanocladus sordidus* grows in N Poland mainly in soft water lakes (Banaś 2016; Chmara et al. 2018), but in Fennoscandia it also co-occurs with *Calliergon megalophyllum*, even in anthropogenic pools (Uotila 1971).

Both rediscovered moss species should be classed with a hazard category CR – critically endangered in the Czech Republic, according to the criteria for *C. megalophyllum* B2ab (III) D2 and *D. sordidus* A2c A4a B2ab (III) D2.

In our study, accurate and robust morphological species determination is confirmed by genetic homogeneity detected within all analysed KRAM specimens. Representative of *Calliergon megalophyllum* from the Czech Republic in both plastid and nuclear ITS sequence based analyses formed well-supported monophyletic clade together with specimens referred as *C. megalophyllum* from Poland and Sweden. Moreover, the

phylogeny position of *C. megalophyllum* is in accordance with Hedenäs et al. (2005) and Hedenäs (2006) investigations. Phylogenetic analysis based on plastid sequences resolved well-supported clade which includes *Dreanocladus sordidus* specimens from the Czech Republic, Poland, Finland, and the United States of America, confirming previous morphological findings. Nevertheless, the described clade, contained also individuals referred to *Pseudocalliergon lycopodioides* and *P. turgescens*. These three bryophyte species (*D. sordidus*, *P. lycopodioides*, *P. turgescens*) shared identical *trn*L-*trn*F, and almost identical (one SNP) *atp*B-*rbc*L plastid sequences. This result, however, is in agreement with the findings of Hedenäs and Rosborg (2008) and Saługa et al. (2018). Phylogenetic analysis based on nuclear ITS sequences also revealed that our original data are homogeneous, but differs from the individual of *D. sordidus* collected in the North America (USA).

In this study, the sequence variation, mainly related to *Pseudocalliergon turgescens*, *P. lycopodioides*, and *Drepanocladus sordidus* specimens, showed poor taxonomic structuring. The most likely explanation for this, regarding plastid data, could be an interspecific hybridisation, a hypothesis often reported in bryophytes (Natcheva and Cronberg 2004, 2007). Meanwhile, ITS phylogenetic analysis may reflect a different evolutionary history for the European and North American representatives. Despite this, the identity of analysed individuals should not raise doubts, since the taxonomic status of these particular specimens was confirmed in the extensive molecular analyses recently published by Hedenäs (2014), Hedenäs and Bisang (2015), and Hedenäs (2017).

In conclusion, our findings, based on morphological and molecular analyses, show that the bryophyte species *Drepanocladus sordidus* and *Calliergon megalophyllum* are present in the Třeboň Basin, Czech Republic, where the latter species form there the southernmost known populations in Europe.

Acknowledgements

This work was financially supported by EU structural funding Operational Programme Research and Development for Innovation, project No. CZ.1.05/2.1.00/19.0388 and by the Ministry of Education, Youth and Sports of the Czech Republic in the "National Feasibility Program I", project LO1208 "TEWEP", and project SGS12/PřF/2020. The work of Marta Saługa and Halina Bednarek-Ochyra has been financed through the statutory fund of the W. Szafer Institute of Botany of the Polish Academy of Sciences. Sincere thanks are due to Prof. Ryszard Ochyra, Kraków, Poland, for his invaluable help with the determination of the mosses, critically reading the manuscript and providing invaluable comments, to Dr. Lars Hedenäs, Stockholm for assistance with generating distribution maps and for information on unpublished records of *Drepanocladus sordidus* in some European countries and regions, and to Marian Wysocki, Kraków, for help with illustrative material. Special thanks are due to Dr. Brian G. McMillan, Glasgow, Scotland, U.K., for correction of the language. This study was supported (to LA) by the Czech Academy of

Sciences as a project No. RVO 67985939. Łukasz Krajewski thanks Prof. Bartosz Płachno, Kraków, Poland, for invitation and subsequently join fruitful trip to the Czech Republic in August 2016.

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Supplementary material 1

List of 44 sites in the Třeboň Basin, S Bohemia, Czech Republic

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Data type: occurrence

Explanation note: List of 44 sites in the Třeboň Basin, S Bohemia, Czech Republic, where an extensive search for *Calliergon megalophyllum* and *Drepanocladus sordidus* was conducted in 2017–2018: The following sites were checked: old sand-pit near Spolí-Domanín, Domanínský fishpond near Domanín, pool in a peatbog V Rájích near Spolí, inlet area of Ruda fishpond near Branná, old sand-pit near Ruda fishpond near Branná, Chodec fishpond near Třeboň, Nový u Smitky fishpond near Stará Hlína, humic forest fishpond near Mláka, peatbog at Starý Vdovec fishpond near Stříbřec, peatbogs at Nový Vdovec fishpond near Stříbřec, peatbog near Příbrazský fishpond near Příbraz, peatbog near Výtopa fishpond (W part) near Lutová, humic pool and peatbog near Staré jezero fishpond near Lutová, sand-pit complex Cep I near Suchdol nad Lužnicí, Smržovský fishpond in Smržov, Dvořiště fishpond near Smržov, Potěšil fishpond near Lužnice, Stehlík fishpond near Lomnice nad Lužnicí, fen pools in the extracted fen Karštejn near Val, inlet area of Černiční fishpond near Lužnice, Loužek fishpond near Lužnice, old shallow sand-pit near Ptačí blato fishpond, inlet area of Záblatský fishpond near Záblatí, extracted fen lake near Ponědrážka, pools in the peatbog at Hliníř fishpond near Ponědrážka, peatbog at Švarcenberk fishpond near Ponědrážka, small fishpond in Dunajovická hora near Dunajovice, old sand-pit in Dunajovická hora near Dunajovice, sand-pit near Kramolín, sand-pit near Hluboká u Borovan, small forest fishpond near Jílovice, Žemlička and Horní Rohožný fishponds near Hluboká u Borovan, small humic forest fishpond near Hluboká u Borovan, old extracted sand-pit near the Dračice river near Františkov, old shallow forest sand-pit Bosna near Rapšach, humic Horní Kočvarů fishpond at Velký Londýn near Františkov, old shallow sand-pit at Velký Londýn near Františkov, fen pool in the Dračice river floodplain near Františkov, Skalice, Medenice and Svobodný fishponds near Františkov and humic fishpond Vydýmač in the complex of the Pele peatbog near Chlum u Třeboně..

Link: https://doi.org/10.3897/phytokeys.154.51454.suppl1

Supplementary material 2

A comparison of phytosociological releves from world sites of *Calliergon megalophyllum* (and *Drepanocladus sordidus*) from the present and literature data

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Data type: occurrence

Explanation note: Explanations: S Bohemia, Czech Republic: 1 – Ptačí blato pond, 1st lagoon, 2 – Ptačí blato, fen margin of the 1st pool, 3 - Ptačí blato, 4th lagoon, LA on 27.8.2017, 4 – Branna sand pit; 5 – NE Poland, Suwałki Landscape Park, hollow peat in mire E of Boczniel lake, (+) – present in this mire close to *C. megalophyllum*, but not in the identical habitat, ŁK on 16, 17 and 29 July 2017; 6 – Poland (10 localities; Lisowski 1960, Karczmarz 1971, Ochyra and Tomaszewicz 1982, Ochyra and Szmajda 1983), 7 – NE Netherlands, fen pool (Kooijman et al. 2015), 8 – Sweden (13 sites; Kooijman et al. 2015), 9 – N Germany (Meinunger and Schröder 2007), 10 – S Finland (35 lakes; Karttunen and Toivonen 1995), * – dominant species, + – present species, water depth, pH and EC with median values, (n) – number of records.

Link: https://doi.org/10.3897/phytokeys.154.51454.suppl2

Supplementary material 3

Sample information and GenBank accession numbers

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Data type: molecular data

Link: https://doi.org/10.3897/phytokeys.154.51454.suppl3