PhytoKeys 61: 1–13 (2016)
doi: 10.3897/phytokeys.61.6995
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Solanum watneyi, a new bush tomato species from the Northern Territory, Australia named for Mark Watney of the book and film "The Martian"

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Academic editor: *S. Knapp* | Received 28 October 2015 | Accepted 5 February 2016 | Published 25 February 2016

Citation: Martine CT, Frawley ES, Cantley JT, Jordon-Thaden IE (2016) *Solanum watneyi*, a new bush tomato species from the Northern Territory, Australia named for Mark Watney of the book and film "The Martian". PhytoKeys 61: 1–13. doi: 10.3897/phytokeys.61.6995

Abstract

A new species of andromonoecious *Solanum* from the Australian "bush tomato clade" of *Solanum* subgenus *Leptostemonum* is described. *Solanum watneyi* Martine & Frawley, **sp. nov.** is closely allied with *S. eburneum*, and is sympatric with it in parts of its range in the Northern Territory. The new species has been recognized as a variant of *S. eburneum* for decades, at times being referred to by local botanists as *Solanum* sp. "Bullita" because of its relative abundance in the vicinity of the Bullita Station area of Judbarra/Gregory National Park. Morphometric analyses show that *S. watneyi* differs statistically from *S. eburneum* in several key reproductive and vegetative characters and field observations suggest that the two sister species may represent a case of edaphic speciation. We provide morphometric evidence for the novelty of *S. watneyi*, a complete description, and cite specimens for both species.

Keywords

Judbarra, Gregory National Park, *Solanum eburneum*, *Solanum* sp. Bullita, Mark Watney, Matt Damon, The Martian, andromonoecy, Andy Weir

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Introduction

Since David Symon's monograph of Australian *Solanum* L. in 1981, numerous additional species and morphospecies have been described for the continent. This has been notably true for a set of "spiny solanums" from northern Australia defined by Symon (1981) as belonging to *Solanum* subgenus *Leptostemonum* Bitter section *Melongena* Bitter (e.g. Bean and Albrecht 2008, Barrett 2013, Brennan et al. 2006, Martine et al. 2011, 2013), a putatively natural group including the cultivated eggplant (*Solanum melongena* L.) and a number of other non-Australian species. Nine of the morphologically androdioecious – but functionally dioecious - spiny solanums known in Australia at that time were included by Symon in this group, as were a set of species that exhibit andromonoecy, with each inflorescence consisting of a basal hermaphroditic flower accompanied by numerous staminate flowers that rise above it in a distal cyme.

Later work employing molecular phylogenetics (Martine et al. 2006, 2009, Vorontsova et al. 2013) showed that section *Melongena* sensu Symon (1981) was polyphyletic. A set of Australian andromonoecious species, however (including *S. chippendalei* Symon, *S. diversiflorum* F. Muell. and *S. beaugleholei* Symon), represent a moderately supported grouping identified by Martine et al. (2006) as the "bush tomato clade" – a finding that supports inferences by Symon (1981), Whalen (1984) and Bean (2004) regarding their similarities and relatedness. One species inferred to be in this clade, *S. eburneum* Symon, was among the many new species described by Symon (1971) during his long career.

Apparently endemic to a small region of the Northern Territory around the East Baines River, *S. eburneum* appeared to Symon to be restricted to gray clay soils. Meanwhile, botanists collecting in surrounding areas, including Pete Latz (NT Herbarium, Alice Springs), had observed populations across a broader range that were recognizably distinct from the similar *S. eburneum*. A specimen sent by Latz to Symon in 1976 led the latter botanist to conclude that it matched "no very satisfactory name" used at the time and that he could "do no better than affin. *eburneum*" (excerpt from letter on specimen NTD9293, *P.K. Latz 5325*). Field identification was also sometimes challenging, especially along the Bullita Stock Route where the range of the apparently more widespread morphotype comes into contact with *S. eburneum* in Judbarra/Gregory National Park. Still, the morphotype was recognizable enough to be identified for years on collection labels as *S.* sp. "Bullita" (*Latz 12401*) in reference to Latz's assignment of that identifier to the putative new taxon beginning in the early 1970s. Until now, however, no morphometric comparison between the two morphotypes has been undertaken.

In 2014, CTM and family surveyed the vicinity of the East Baines/Victoria Highway/Bullita Stock Route region for occurrences of *S. eburneum* and *S.* sp. "Bullita." Seeds of typical *S. eburneum* (from the type locality as per Symon 1981) and *S.* sp. "Bullita" populations were collected and then grown at Bucknell University, where morphometric analyses were conducted on the two taxa in order to define the differences between them and to determine the novelty of *S.* sp. "Bullita." We here describe this species as new, and contrast both its morphology and distribution with its close relative *S. eburneum*.

Morphological comparisons

In early May 2014, populations of *S. eburneum* were visited along the Victoria Highway corridor between Timber Creek and the Northern Territory border with Western Australia, including the type locality (Symon 1981) at the intersection of the highway and the East Baines River. Herbarium specimens and mature fruits were collected, with seeds extracted, dried, and stored for future use. Similar populations identified as *S.* sp. "Bullita" were then collected in the same manner along the Bullita Stock Route in the Bullita section of Judbarra/Gregory National Park. Leaf material for each taxon was collected and dried in silica for subsequent DNA work (not included here).

To establish populations for morphometric analyses seeds were soaked for 24 hours in 1000-ppm gibberellic acid and sown in a controlled growth chamber environment at Bucknell University. They germinated at a rate of 70-90% in 2-3 weeks, with seedlings transferred to individual pots in our research greenhouse after establishment. All plants were grown in a common soil mix under identical horticultural conditions. Thirty-eight vegetative and reproductive characters were measured across developmental stages in 41 cultivated plants. These data were analyzed using ANOVA in the statistical software JMP-Pro 12 (SAS Institute Inc., Cary, North Carolina, USA) to define characters differing between the taxa. Character differences were corroborated and "field-truthed" by examination of herbarium specimens, including accessions held at the Northern Territory Herbarium, Palmerston (DNA) (See "specimens examined" and Appendix 1) from across the geographic range of each taxon (Figure 1). Characterization of trichomes is based on descriptions by Bean (2012) for *S.* sp. "Bullita" derived from the author's examination of herbarium specimens.

Results

The ANOVA analyses found that of 38 discrete vegetative and reproductive characters that were measured, 17 differed with statistical significance between *Solanum eburneum* and *S. watneyi* (Table 1). An additional set of qualitative characters also proved useful for drawing distinctions between the taxa (Table 2).

Taxonomic treatment

***Solanum watneyi* Martine & Frawley, sp. nov.**
urn:lsid:ipni.org:names:77153383-1
Figs 2–3

Diagnosis. *Solanum watneyi* is distinguished from *S. eburneum* by its weakly erect and sprawling habit, long internodes and fruiting pedicels, often scabrous dark green

Table 1. Statistical comparison of characters, *S. watneyi* and *S. eburneum*. Single asterisk (*) indicates statistical significance with a 95-99% confidence interval; double asterisk (**) indicates statistical significance with >99% confidence interval. SD = standard deviation. All measurements in cm, except trichome density (per 0.5 cm leaf disk) and number of seeds per fruit.

	S. eburneum			***S. watneyi***			
Character	**Average**	**SD**	**n**	**Average**	**SD**	**n**	**p-value**
internode length	2.16	0.67	16	4.01	0.98	25	<.0001**
petiole length	2.68	0.80	16	3.36	3.36	25	<.0095**
stem prickle length	0.40	0.00	16	0.26	0.26	25	<.0001**
apical (upper 2-3 stems) leaf length	11.32	0.10	16	12.39	2.5	25	<.1372
apical leaf width	1.41	0.41	16	2.47	0.65	25	<.0001**
basal (lower 2-3 stems) leaf length	13.66	1.83	16	16.80	3.85	25	<.0061**
basal leaf width	2.03	0.88	16	3.97	1.15	25	<.0001**
male corolla diameter	3.46	0.31	16	4.01	0.62	25	<.0061**
hermaphrodite corolla diameter	4.03	0.35	16	4.75	0.58	25	<.0017**
fruit pedicel length	3.45	0.64	14	4.22	0.65	19	<.0341*
plant height	43.62	10.86	16	45.85	6.90	25	<.4165
leaf adaxial trichome density	174	59.00	24	105.00	21.46	25	<.0001**
leaf abaxial trichome density	194	26.00	24	133.00	27.81	28	<.0004**
fruit length	1.80	0.29	12	2.13	0.36	20	<.0058**
fruit width	2.20	0.38	12	1.89	0.31	20	<.0364*
fruit wall width	0.31	0.09	5	0.55	0.09	5	<.0038**
seeds per fruit	78	38.00	12	44.00	23.62	20	<.0031**

Table 2. Selected qualitative characters found to differ conspicuously between *Solanum eburneum* and *Solanum watneyi* sp. nov.

Character	***S. eburneum***	***S. watneyi***
habit	erect, compact	sprawling/lax, open
lobing of leaves	deep, numerous	± shallow (if present), few
corolla color	darker purple, 'mauve'	lighter purple, 'dusty purple'
corolla margins	more or less flat	wavy, undulating
fruit shape	± globose	± ellipsoidal
fruit color at maturity	white, 'creamy' without striping	yellow, 'light lemon' with light brown striping
fruit interior at maturity	liquid-filled	more or less dry
fruit firmness at maturity	soft, squishy	firm
fruit location	pendant from stems, but not on ground	pendant, on or near ground
seed color at maturity	black	light to dark brown

leaves, dusty purple corollas, and lemon-yellow thickly-walled ellipsoidal fruits often held on or near the ground.

Type. AUSTRALIA. Northern Territory: Judbarra/Gregory National Park, Bullita Stock Route, 6 km north of Bullita Campground turnoff, 16°03.100"S, 130°27.201"E,

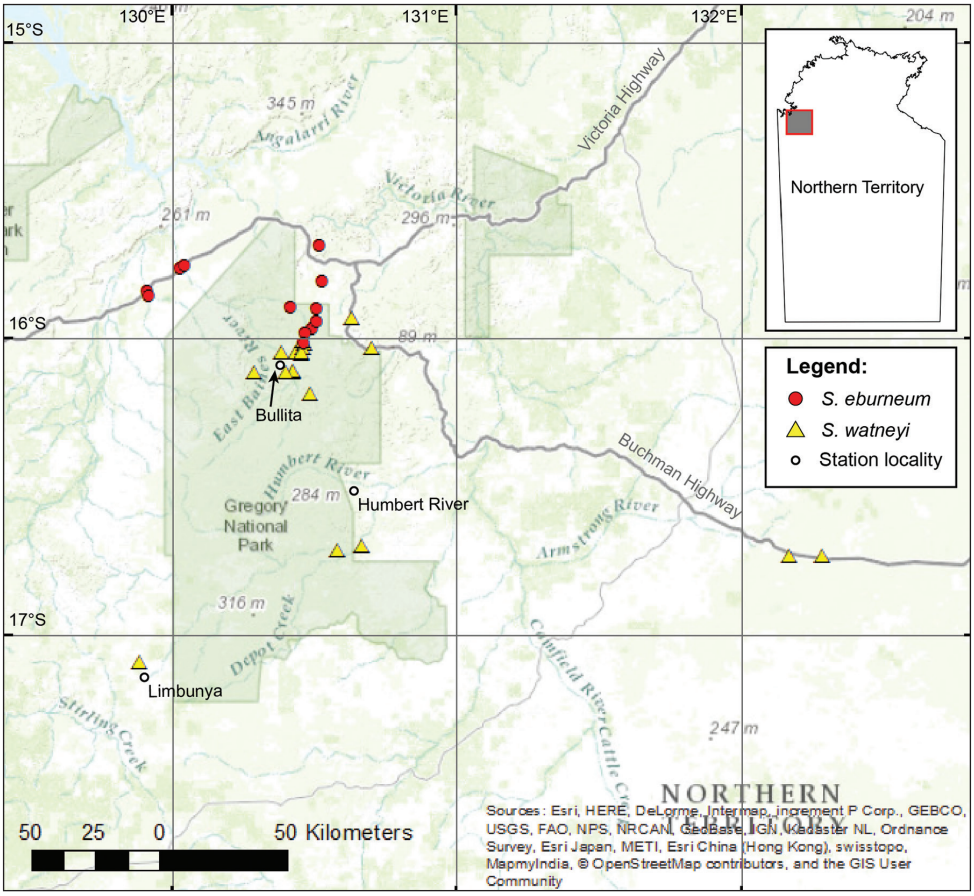

Figure 1. Distribution map of *S. watneyi* and *S. eburneum* based on accessions held by DNA, BUPL and CONN. Specimens of *S. eburneum* mapped are cited in Appendix 1.

6 May 2014 (staminate and hermaphrodite flowers; fruit), *Christopher T. Martine and Rachel F. Martine 4065* (holotype: DNA; isotypes: BUPL, CONN)

Description. Weakly erect to sprawling sub-shrub to 50–60 cm. Rhizomatous and apparently clonal. Stems slender, woody, often bending to ground, especially when weighted by fruits; initially single stemmed, with strong lateral branching beginning at ca. 5–10 cm; internode lengths on mature stems averaging about 4 cm. Overall plant aspect dark green to gray-green, with older stems eventually pea-green to yellow-brown; pubescent throughout with porrect stellate trichomes (stems, leaves, pedicels, calyces) with stalks 0–0.1 mm long, lateral rays 6–10, central ray (midpoint) 1–1.5 times as long as the lateral rays; pubescence of stems short and loose. Prickles sparse, straw-colored, straight, slightly widened at base, fine, 2–5 mm long, scattered on stems. Sympodial units difoliate, the leaves solitary or geminate. Mature leaves 12–16 cm × 2–6 cm, alternate, lanceolate-elliptic, with 6–8 pairs of primary veins; young leaves lighter green and gray-hairy but becoming dark green above, slightly paler

beneath, both sides closely and densely stellate tomentose, older leaves becoming scabrous and uniformly dark on both sides, retaining dense tomentum along veins; base attenuate; margins entire, sinuate or occasionally shallowly 6–8 lobed; apex rounded, mucronate; scarcely armed along midvein beneath; petiole 3–3.5 cm long with few to no prickles. *Inflorescence* a supra-axillary andromonoecious cyme 9–11 cm long, consisting of a basal hermaphrodite flower and a distal group of 3–7 (usually) staminate flowers (the most basal staminate flowers occasionally expressing as hermaphrodite), typically 1–2 staminate flowers open at a time, common peduncle typically 2–5 mm (-20) long, rachis slightly less tomentose than stems. Flowers 5-merous, heterostylous. *Hermaphrodite flower* ca. 2.5 cm below the staminate flowers, opening first; pedicel 2–3 cm long at anthesis, elongating further after fertilization, armed with prickles 2–5 mm long; calyx lobes 5–8 mm long, armed with long, straight prickles and stellate trichomes; corolla 4–5 cm in diameter, dusty purple, rotate; acumens ca. 2 mm; ovary glabrous, ca. 2 mm diameter at anthesis; style 11–12 mm (including capitate stigma), curved; stamens equal; filaments ca. 1 mm; anthers 6 mm long, oblong-lanceolate to somewhat tapered, poricidal at the tips, in a loose anther cone. *Staminate flowers* with pedicels 15–16 mm long, unarmed or with few prickles; calyx lobes 7–8 mm long with a few 3–4 mm weak prickles or prickles absent, the lobes ending with a slender filiform acumen ca. 3 mm long, slightly reflexed; corolla 2.5–4.5 cm in diameter, dusty purple, broadly stellate to rotate; acumens ca. 0.5 mm; stamens of same proportions as in hermaphrodite flower; ovary, style, and stigma vestigial and not exserted beyond the stamens. *Fruit* an ellipsoidal berry 2–2.5 cm long, 1.5–2.2 cm wide, light green with dark green stripes when young, maturing to lemon-yellow with faint brown stripes; flesh firm, the locules 2, not liquid-filled and the internal cavity dry, the fruit wall ca. 0.5 cm thick, the fruits retained on plant after maturation. Fruiting pedicels 3.5–4.5 cm long, deflexed so fruits resting on ground at maturity. Fruiting calyx enclosing and exceeding fruit in early development, eventually covering up to 2/3 of developed fruit, the lobes long-acuminate, blunt-tipped, and weakly reflexing as fruit matures, short stellate-pubescent and armed with sharp spines 2–5 mm long, these single or paired along the calyx sutures, the lobes often fused in a 3+2 or 4+1 arrangement. Mature seeds up to ~100 per fruit, 2.5–3.5 mm, tan to dark brown, finely reticulate.

Distribution and ecology. *Solanum watneyi* is presently known from a small range of localities in the sub-arid, monsoon-influenced, zone of northwestern Northern Territory (Fig. 1) at elevations around 100–150 m. The species is locally abundant along the Bullita Stock Route and nearby areas, but abundance elsewhere is not well known. *Solanum watneyi* appears to be associated, at least in Judbarra, with the "Ridges, Hogbacks, Cuestas, and Structural Plateaux" land unit defined by Brocklehurst et al. (1996), where it occurs in open *Eucalyptus* woodlands. Field collections have been made in well-drained limestone-based soils variously described as being sandy, sandy-loamy, clayey-loamy, and loamy. Collections from 70–80 km east of the Bullita section suggest that the species range extends eastward into the Wanimyn Trust and the landscapes around the Buchanan Highway; and collections from Limbunyah Station hint toward a westward range extending toward the Western Australia border (Fig. 1).

Figure 2. Illustration of *Solanum watneyi*. Mature branch with flowers and a developing fruit. Based on plant grown at Bucknell University from seeds of *Martine and Martine 4065*. Drawing by Rachel F. Martine.

The areas where *S. watneyi* has been collected most frequently are along graded roads (Fig. 2D), suggesting that this taxon is disturbance-adapted. Although collections have been made in areas that experience bushfires, specific fire ecology adaptations are unknown. The pollination biology has not been studied, but the flowers are likely buzz pollinated (see Anderson and Symon 1988) – as evidenced by anthers with terminal pores and the need for physical manipulation of anthers during hand pollinations in cultivation. Seed dispersal appears to be biotic given the fleshy nature of the fruits, which ripen to yellow at maturity. Symon (1979) included *S. eburneum* in a group of solanums with firm yellow berries likely to be dispersed by mammals or larger birds; *S. watneyi* fits this same profile.

Phenology. Most flowering specimens have been collected from March-May, at the transition from the wet to dry seasons, with fruiting specimens collected in April-June. Earlier flowering collections (e.g. *K. Brennan 9002*, 27 Jan 2000) suggest that blooming may begin during the rainy season and extend into the dry season. Plants in cultivation began flowering about 90 days after seed germination; and fruits took about 60 days to mature following hand pollination.

Etymology. The specific epithet of "watneyi" is inspired by the book and film, *The Martian*, in which the protagonist finds himself stranded on Mars surrounded by the planet's harsh terrain and reddish soils. In a shelter, he manages to grow a crop of potatoes (*Solanum tuberosum*) before finally being rescued by his astronaut colleagues. We've chosen to name *Solanum watneyi* after this character, Mark Watney, in part because of the similarly reddish soils of its habitat and the congeneric nature of the potato – but, most notably, as a way to honor the creation of a sci-fi hero botanist by author Andy Weir (Weir 2013) and to acknowledge perhaps the finest paean to botanical science (and botanical field work) that Hollywood has yet presented (see Martine 2015).

Preliminary conservation status. Based on IUCN Red List Categories (IUCN 2012), *S. watneyi* should be considered Data Deficient (DD). While the species appears to be relatively widespread over a range of approximately 6000 km^2, it has been collected in fewer than 20 localities. The small number of collections, coupled with the fact that populations often consist of multiple individuals, suggests that the species is common in some localities but uncommon on the regional and global scales (apparently of restricted distribution). Further data are required before a certain conservation status can be determined. Key populations are protected in Judbarra/Gregory National Park and appear secure.

Specimens examined. AUSTRALIA. Northern Territory: Bullita Homestead (ca. 8 km north), 16°03'--"S, 130°26'--"E, 14 Apr 1996 (fr), *P.K. Latz 14752* (NT); Gregory National Park, Bullock Paddock Creek area, 16°11'21"S, 130°28'59"E, 13 Apr 1996 (fr, fl), *G.J. O'Neill 3* (DNA); Humbert River Station, 16°42'S, 130°40'E, 14 Jun 1974 (fr), P.K. Latz 5325; Bullock Paddock Creek, 16°6'55"S, 130°17'27"E, 13 Apr 1996 (fl), *M. Woodward 94 and R. Booth*; Gregory National Park, N. of Bullita Homestead, 16°06'57"S, 130°25'26"E, 11 Apr 1996 (fl), *N.G. Walsh 4185* (DNA); Gregory National Park, 16.07°S, 130.24°E, 6 Feb 1986 (fl), *B.G. Thomson 1185* (DNA/NT); Jasper Gorge area, 16°1'59"S, 130°42'3"E, 27 Jan 2011(fl), *K. Brennan 9002* (DNA); Judbarra/Gregory National Park,

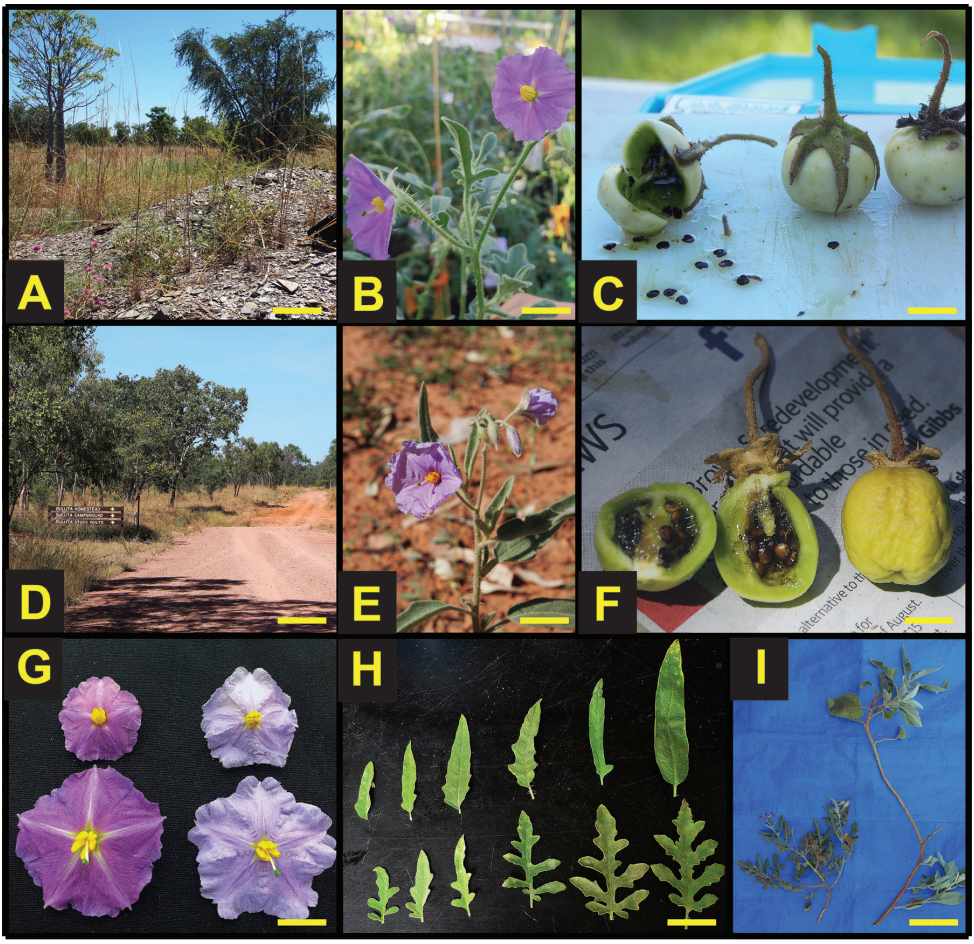

Figure 3. Comparisons of *Solanum eburneum* and *Solanum watneyi*. **A–C** *S. eburneum* in habitat (gray cracked clay), in flower, and mature fruits **D–F** same for *S. watneyi* (habit showing reddish sandy loam) **G** corolla comparisons of staminate (upper) and hermaphrodite (lower) flowers for *S. eburneum* (left) and *S. watneyi* (right) **H** leaf shape across varying leaf ages for *S. watneyi* (top) and *S. eburneum* (bottom) in cultivation; *I*) field growth habit of *S. eburneum* (left) and *S. watneyi* (right) showing the more sprawling and prostrate nature of *S. watneyi*. Photos **A, C, D, E, F, I** by CTM; **B, G** by JC; **H** by EF.

Bullita Stock Route, 32 km south of Victoria Highway, 16°00.491'S, 130°27.952'E, 5 May 2014 (fl, fr), *C.T. Martine and R.F. Martine 4061* (BUPL); Judbarra/Gregory National Park, Bullita campground, 16°06.802'S, 130°25.394'E, 5 May 2014 (juv), *C.T. Martine and R.F. Martine 4063* (BUPL); Judbarra/Gregory National Park, Bullita Stock Route, 6 km north of Bullita Campground turnoff, 16°03.100'S, 130°27.201'E, 6 May 2014 (fl, fr), *C.T. Martine and R.F. Martine* 4065; Judbarra/Gregory National Park, 8 km north of Bullita campground, 16°01.103'S, 130°27.790'E, 5 May 2014 (fl, fr), *C.T. Martine and R.F. Martine 4067* (BUPL).

Discussion. *Solanum watneyi* has been known for some time as a recognized morphotype, having been described by Latz as *Solanum* sp. "Bullita" in the early 1970s. This name has been used as an identifier by other botanists since that time (e.g. Bean 2012), appearing on the labels of herbarium specimens that are similar to *S. eburneum* yet conspicuous enough in the characters identified above to merit attention.

Previous studies inferred that *Solanum eburneum* is part of the "Bush tomato clade" (Martine et al. 2006, 2009), a clade of andromonoecious species that appears to have arisen between 4 and 1.5 million years ago (Särkinen et al. 2013). Preliminary results from a large-scale next generation molecular study (Martine et al. in prep) infer that *S. watneyi* is most closely related to *S. eburneum* and *S. chippendalei*. *Solanum watneyi* stands out among this group based on morphological differences that include its conspicuously long fruiting pedicels and internodes, lighter purple corollas, and a sprawling habit that often finds mature fruits resting on ground.

In the western (Bullita) tract of Judbarra/Gregory National Park, *S. watneyi* is locally common along the roadsides of the Bullita Stock Route between the Victoria Highway and the old Bullita Homestead, where it has been collected numerous times. Its abundance along this dirt thoroughfare suggests that the species appears, like many solanums, to respond favorably to disturbance. In fact, it appears most vigorously on the edges of graded dirt roads, resprouting from rootstocks after passes from mechanized grading equipment (Martine, pers. obs.)

While our ex situ morphometric analyses and most field observations are consistent with the distinctive morphological gestalt of *S. watneyi*, collections from around the Bullita Station can be somewhat confusing – with vegetative characters approaching intermediacy between it and *S. eburneum*. A small set of ex situ crosses between them (Martine, unpublished) suggests that interspecific hybridization is possible. Symon (1981) described *S. eburneum* as a narrowly-occurring species of "broad, shallow, seasonally dry *Melaleuca* swamps or flats with heavy grey soils" around the East Baines River. This localized endemism aligns with the characteristic physiography described by Brocklehurst et al. (1996) for the East Baines corridor, with *S. eburneum* occurring on clays and lithosols found on alluvial plains and rises along the river course as it runs northwest out of the Bullita section of the park (and on Dick Creek to the west and Timber Creek to the east). The presence of *S. watneyi* on well-drained sandy-loamy soils on the (largely) southern edge of this range suggest that the two closely related taxa might have diverged on disparate soil types in the last few million years (dating based on Särkinen et al. 2013).

Recent land use history may have brought the species into secondary contact on the north-south edge of their ranges in the central area of the Bullita Section, where an underlying geology including sandstone, siltstone, and dolomite creates an especially complex physiography (Brocklehurst 1996). The remote Bullita cattle station, the homestead of which is now a park attraction and outstation site, operated in this area for several decades beginning in the early 1900s. The Bullita Stock Route, a graded access road running south from the Victoria Highway, closely parallels the East Baines River near the homestead – providing a corridor of frequently disturbed habitat by which *S. eburneum* and *S. watneyi* might move and come into contact with the aid of

road grading equipment or, perhaps historically, livestock. We suggest that the combined effect of ancient-origin physiography and recent disturbance in this area has created a zone of hybridization that deserves further study.

Acknowledgements

Rachel Martine contributed the species illustration and, along with Isee Martine, Jackson Martine, and Erin Sullivan, provided critical field support and specimen collection assistance in the field. Thanks to Ian Cowie and Deborah Bisa for assistance in the Northern Territory Herbarium. Tara Caton, Dan Hayes, and Wanda Boop provided greenhouse support at Bucknell. Helpful comments were provided by Peter Jobson, Peter Latz, Ben Marsh, and four peer reviewers during manuscript preparation; and communications assistance came from Heather Johns, Jeff Canning, Andy Hirsch, Richard Hund, and Heather Cacanindin. Funding was provided through Bucknell via the David Burpee Endowment and the Wayne E. Manning Internship Fund (to ESF), plus a Botanical Society of America Undergraduate Research Award (to ESF).

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Appendix 1

Specimens examined and mapped (Fig. 1), *S. eburneum* Symon. AUSTRALIA. Northern Territory: Timber Creek, behind caravan park, 15°41'S, 130°31'E, 6 Sep 1993 (fl), *J.R. Lally 114* (DNA); Judbarra/Gregory National Park, Bullita Stn., 15°53'44'S, 130°24'39"E, 13 Feb 1992 (fl), *I. Cowie 2344 and P. Brocklehurst* (DNA); 9 miles west of East Baines River (Dick Creek), Oct 1971 (fl), *D.E. Symon 5232* (DNA); Judbarra/Gregory National Park, Bullita Stock Route, 29 km south of highway, 15°57'57. 4"S, 130°29'06.2"E, 26 May 2004, *C.T. Martine 769 and W.R. Barker* (CONN); Victoria Highway, 22 km west of East Baines crossing, 15°52'10.4"S, 129°52'35.7"E, 26 May 2004 (old fr), *C.T. Martine 770 and W.R. Barker* (CONN); Victoria Highway, East Baines River crossing, 15°45.677'S, 130°01.748'E, 16 April 2014 (fr), *C.T. Martine 4007 and E. Sullivan* (BUPL); Victoria Highway, 5 km east of East Baines River crossing, 15°45.086'S, 130°02.702'E, 16 April 2014 (fr), *C.T. Martine 4007 and E. Sullivan* (BUPL); Bullita Stock Route, 7.5 km south of highway, 15°48.532'S, 130°31.636'E, 5 May 2014 (fl), *C.T. Martine and R.F. Martine 4058* (BUPL); Judbarra/Gregory National Park Bullita Stock Route, 19 km south of highway, 15°54.252'S, 130°30.387'E, 5 May 2014, *C.T. Martine and R.F. Martine 4059* (BUPL); Judbarra/Gregory National Park Bullita Stock Route, 27 km south of highway, 15°58.075'S, 130°29.375'E, 5 May 2014 (fl), *C.T. Martine and R.F. Martine 4060* (BUPL); Judbarra/Gregory National Park Bullita Stock Route, 33 km south of highway, 5 May 2014 (fl), *C.T. Martine 4062 and R.F. Martine 4062* (BUPL).

PhytoKeys 61: 15–25 (2016)
doi: 10.3897/phytokeys.61.7258
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Solanum lagoense (Solanaceae, Geminata clade), a new species from Lagoa Santa, Minas Gerais State, Brazil

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Academic editor: *C. Morden* | Received 21 November 2015 | Accepted 2 February 2016 | Published 25 February 2016

Citation: Stehmann JR, Moreira NC (2016) *Solanum lagoense* (Solanaceae, Geminata clade), a new species from Lagoa Santa, Minas Gerais State, Brazil. PhytoKeys 61: 15–25. doi: 10.3897/phytokeys.61.7258

Abstract

A new species of *Solanum* (Solanaceae) from the Geminata clade is described for the Brazilian flora. *S. lagoense* Stehmann is only known from Lapinha, a rocky massif located in the Lagoa Santa karst region of Minas Gerais State. The flora of this area, including Solanaceae, was studied in detail in the second half of the 19th century by the Danish botanist Eugene Warming. The species differs from other members of the Geminata clade in Brazil in its geminate leaves of different sizes, simple multicellular trichomes present on the new growth and young stems, short extra-axillary inflorescences with few (1-3) flowers, and its stellate corollas with cucullate and strongly reflexed lobes. Here we present a description, taxonomic comments and a preliminary assessment of conservation status of this critically endangered species.

Resumo

Uma nova espécie de *Solanum* (Solanaceae) pertencente ao clado Geminata é descrita para a Flora do Brasil. *S. lagoense* Stehmann habita o sub-bosque da Floresta Estacional associada a afloramentos calcários junto à gruta da Lapinha, em Lagoa Santa, Minas Gerais, uma área inventariada em detalhe por Eugene Warming, no século XIX. A espécie é distinta das demais Geminata, por apresentar folhas geminadas de tamanhos desiguais, ramos apicais com tricomas simples, multicelulares, inflorescência extra-axilar, curta, com poucas flores (1-3), corola estrelada, reflexa e cuculada. São apresentadas a descrição da espécie, comentários taxonômicos, bem como a avaliação que sugere o status de Criticamente Ameaçada à espécie.

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Keywords
Eugene Warming, endemism, assessment of extinction risk

Palavras-chave
Avaliação do risco de extinção, endemismo, Eugene Warming

Introduction

Solanum L. (Solanaceae) is one of the ten largest genera of flowering plants, with 1,250-1,700 species distributed on all continents except Antarctica, but with its highest species diversity in the Neotropics (Frodin 2004; Nee 1999). Among the Solanaceae, *Solanum* is morphologically easy to recognize by its combination of anthers opening by apical pores and a usually evenly 5-lobed calyx. This combination of traits is not shared with any other genera in the family (Hunziker 2001). Important crops are found in the genus, such as potato (*S. tuberosum* L.), tomato (*S. lycopersicum* L.) and eggplant (*S. melongena* L.) that are widely cultivated around the world and contribute to the economies of many countries (Hawkes 1999).

Approximately 272 species of *Solanum* occur in the Brazilian flora, of which 131 are endemic to the country (Stehmann et al. 2015). The highest species richness and endemism are found in the Atlantic rain forest, a biome recognized as a biodiversity hotspot at a global level (Mittermeier et al. 2004). The Atlantic forest originally consisted of an almost continuous strip of land of variable width along the Brazilian coast. Today, this huge forest is represented by remnants and biologically impoverished fragments representing less than 12% of its original cover (Ribeiro et al. 2009). Despite this, several new species in *Solanum* have been described from the Atlantic forest in recent years (Giacomin et al. 2013; Giacomin and Stehmann 2014; Knapp et al. 2015), indicating that the inventory of the Brazilian flora is far from completion (Sobral and Stehmann 2009).

With more than 11,000 species of angiosperms, Minas Gerais State has been recognized as the richest in Brazil (Forzza et al. 2010; Forzza et al. 2012). This floristic richness is associated with the diversity of environments found in Minas Gerais: Atlantic rain forest, Cerrado (savanna-like vegetation), and Caatinga (dry and open thorn scrub). Transition areas between these main vegetation types, mainly those associated with the Espinhaço range, have received special attention since the 19th century, when European naturalists such as Auguste Saint-Hilaire, Carl F. Martius, George Langsdorff, and others travelled in the inner part of the country, describing its flora. Some of these botanists were based in Minas Gerais for long periods of time and explored particular areas in depth; these include the Swede Anders F. Regnell working in Caldas (Concha-Quezada 2011; Dahlgren 1962) and the Dane Eugene Warming in Lagoa Santa (Warming 1908).

Lagoa Santa is a karstic (limestone) region of the Serra de Espinhaço long known for its important paleontological and archeological sites (Berbert-Born 2002). The first

scientist to explore its countless caves was the Danish paleontologist Peter Wilhelm Lund (1801-1880), who found many exemplars of the Brazilian megafauna and human fossils. The botanist Johannes Eugenius Bülow Warming (1841-1924) was Lund's secretary between 1863 and 1866. He collected and took to Europe over 3,000 dried plant specimens. These, in addition to the more than 700 herbarium sheets donated by Lund, are today held in the herbarium of the Natural History Museum in Copenhagen (Gomes 2006). Many of these specimens are nomenclatural types and were cited in the Flora Brasilensis (Martius 1846). Warming distributed herbarium material to many specialists in Europe (Warming 1908). The Solanaceae were worked on by W. P. Hiern who described seven new species and two varieties of *Solanum* (Hiern 1876).

As part of a larger project following Warming's footsteps, we searched for species with few records and nomenclatural type populations in the same places where Warming collected in Lagoa Santa. During the development of this project, samples of an unusual species of *Solanum* from the Geminata clade were collected. This group is well studied and the Brazilian species of the group have recently been revised (Knapp et al. 2015). We compared our specimens with the others described for the clade and with Warming's collections kept in the Copenhagen herbarium (C) and other herbaria of the world. We could not match it with any known species and therefore recognize it as new, and describe it here.

Materials and methods

Specimens of *Solanum* from the following herbaria (acronyms follow http://sciweb.nybg.org/science2/IndexHerbariorum.asp) were examined: BHCB, BM, BR, C, CEPEC, G, HUEFS, K, MBM, PAMG, OUPR, RB, SP, UEC, VIC. We use IUCN (2014) criteria to assess the conservation status of the species.

We collected in Lagoa Santa from December 2014 to March 2015, and focused our efforts on the areas surrounding the rocky massifs such as Lapinha, Sumidouro, and Morro do Baú. These localities present unique environmental conditions due to higher degrees of shade that lead to higher humidity and temperature stability, thus contributing to different species compositions than the surrounding savanna matrix (cerrado).

Results and discussion

***Solanum lagoense* Stehmann, sp. nov.**
urn:lsid:ipni.org:names:77153384-1
Figures 1, 2

Diagnosis. *Solanum lagoense* is similar to *Solanum restingae* S. Knapp, *S. amorimii* S. Knapp & Giacomin, and *S. psilophyllum* Stehmann & Giacomin but differs from them by its pilose stems and longer fruiting pedicels (> 1.5 cm long).

Type. BRAZIL. Minas Gerais: Município Lagoa Santa, Gruta da Lapinha, Salão dos Bigodes, 19°33'57"S, 43°57'52"W, 716 m, 16 Jan 2015, *N.C. Moreira & R. Gurgel 158* (holotype: BHCB [BHCB021206]; isotype: BM).

Description. Shrub to 1.5 m, rhizomatous, with clonal reproduction; young stems terete, but slightly angled, glabrous or pilose with simple, uniseriate, and recurved trichomes, each with 8–15 cells; new growth always pilose, with stem obviously angled; bark of older stems brown, slightly winged from the leaf bases. Sympodial units difoliate, geminate, the leaves of a pair differing in size, but not usually in shape. Leaves simple; major leaves 5.6–12.4 cm long, 2.2–4.7 cm wide, elliptic, membranous, glabrous on both surfaces, the abaxial surface olivaceous to moss green, the adaxial surface dark green; major veins 7–9 pairs, drying somewhat darker than the lamina and slightly sunken on the adaxial surface, somewhat prominent and lighter on abaxial surface; base attenuate, sometimes slightly asymmetric; margins entire, slightly revolute; apex acute, the tip somewhat blunt; petiole 0.6–1.0 cm long, glabrous; minor leaves 1.6–2.9 cm long, 0.9–1.7 cm wide, differing from major leaves only in size and in having a shorter petiole. Inflorescences 0.2–2 cm long, extra-axillary, arising below the nodes, unbranched, with 1–3 flowers, glabrous; peduncle ca. 3 mm; pedicels 1.4–1.5 cm long, ca. 0.3 mm in diameter, slender, abruptly swollen at the apex, spreading or pendant at anthesis, glabrous, articulated at the base; pedicel scars spaced 0.5–2 mm apart. Buds globose, the corolla strongly exserted from the calyx tube before anthesis. Flowers 5-merous, all perfect. Calyx with the tube ca. 1.0 mm long, broadly conical, the lobes 1.0–1.2 mm long, ca. 1.3 wide, triangular or obtuse, strongly reflexed at anthesis, glabrous adaxially, minutely papillate abaxially, the papillae denser at the tips. Corolla ca. 1.0 cm in diameter, white, stellate, lobed 2/3 of the way to the base, the lobes 1-nerved, ca. 4–5.2 mm long, ca. 2.4–3.6 mm wide, ovate, spreading at anthesis, glabrous, minutely papillate on the margins and the apex, the tips cucullate. Stamens ca. 3.5 mm long; filament tube ca. 0.7 mm long, the free portion of the filaments ca. 0.3 mm long, glabrous; anthers 2.4–2.5 mm long, ellipsoid to slightly obovate, ca. 0.7 mm wide at the base, ca. 0.9 mm wide at the apex, yellow, poricidal at the tips, the pores large and introrse, lengthening to slits with age. Ovary glabrous; style 5–6 mm long, glabrous; stigma not expanded, blunt, the surface minutely papillate. Fruit a subglobose berry, slightly depressed, 1.2–1.3 cm long, 1.3–1.5 cm in diameter, green, darker toward the pedicel, the pericarp not markedly shiny, thick, the mesocarp not juicy; fruiting pedicels 1.7–2.2 cm long, less than 1 mm in diameter at the base, ca. 2 mm in diameter at the apex, gradually expanded to the apex, pendant and hidden under the foliage; fruiting calyx lobes somewhat hyaline, not markedly expanding in fruit, but clearly recurved. Seeds 15–30 per berry, flattened, ellipsoid to irregularly ellipsoid or sometimes ovate-reniform, 3.2–4.0 mm long, 2.8–3.1 mm wide, dark brown, vernicose, with pale incrassate margins, the seed coat obscurely foveolate.

Distribution. Known only from the type locality at the Gruta da Lapinha, Lagoa Santa, Minas Gerais, in southeastern Brazil.

Specimens examined (paratypes). **BRAZIL. Minas Gerais:** Mun. Lagoa Santa, Gruta da Lapinha, Salão dos Bigodes, 19°33'57"S, 43°57'52"W, 716 m, 23 Jan 2015, *J. R. Stehmann & N. C. Moreira 6360* (BHCB). Mun. Lagoa Santa, Gruta da Lapinha,

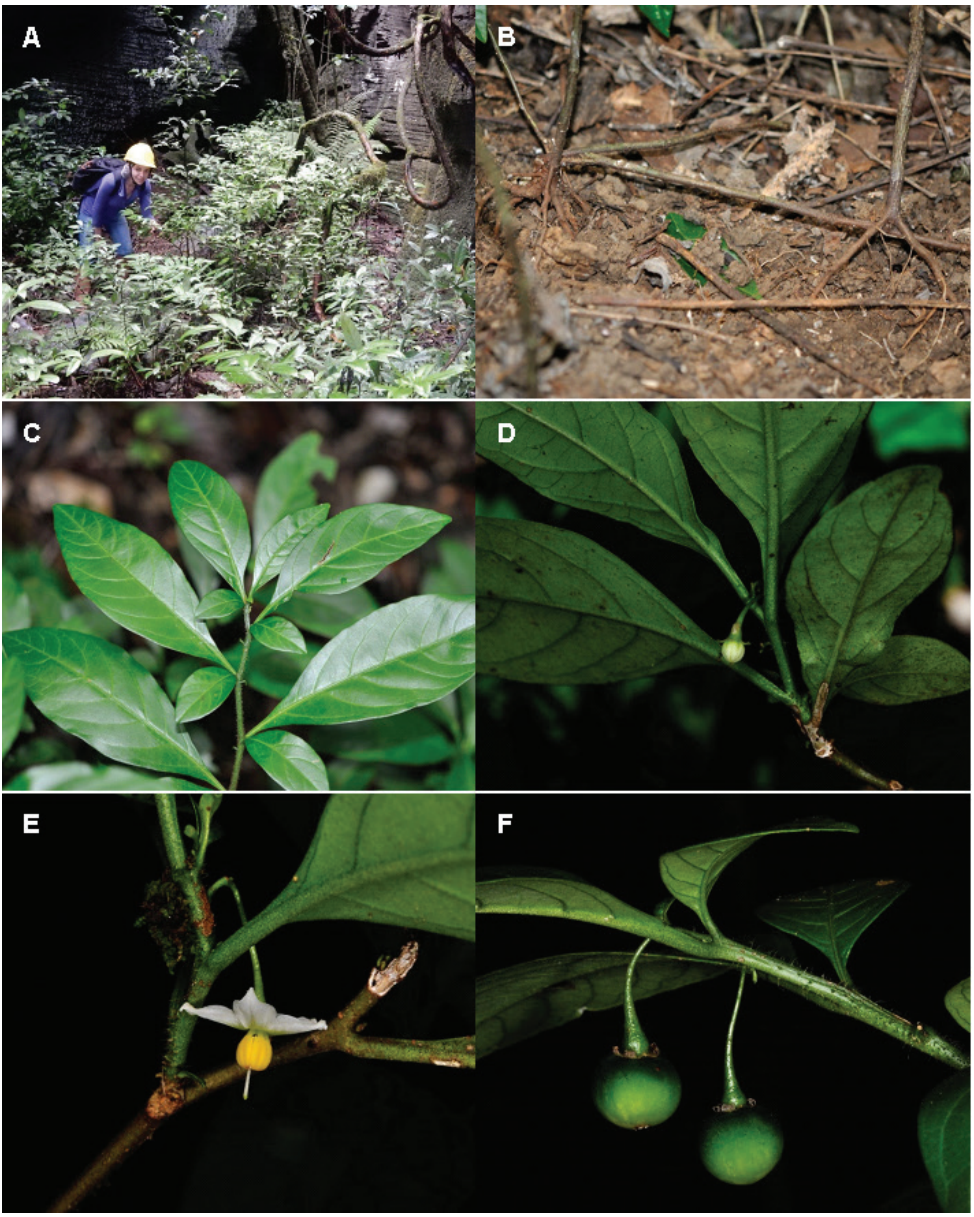

Figure 1. *Solanum lagoense*. **A** Habit and Nayara Moreira standing close to plants **B** Clonal reproduction via rhizomes **C** Geminate leaves of different sizes **D** Bud **E** Flower showing the cucullate and spreading corolla lobes **F** Fruits showing the markedly recurved calyx lobes. **A, C, D** *Stehmann et al. 6360*; **B, E** *Stehmann et al. 6361*; **F** *Stehmann et al. 6374*.

Vale Romano, 10°33'57"S, 43°57'57"W, 912 m, 24 Mar 2015, *J. R. Stehmann et al. 6361* (BHCB). Mun. Lagoa Santa, Gruta da Lapinha, near Vale Romano, 19°33'57"S, 43°57'48"W, 912 m, 24 Mar 2015, *J. R. Stehmann et al. 6374* (BHCB).

Figure 2. Holotype specimen of *S. lagoense* (*N.C. Moreira & R. Gurgel 158* [BHCB021206]).

Ecology. *Solanum lagoense* grows on well-drained soils in the understory of the seasonal forest (Floresta Estacional Semidecidual) that covers the entrance of caves as well as the canyons and blind valleys associated with the carbonatic rocky massifs of Lagoa Santa. This specific habitat is very stable with respect to temperature and humidity throughout the year, in comparison with Cerrado, the typical vegetation matrix in the region. An extensive subterranean system of rhizomes connects individuals in the populations we have sampled (Figure 1B), indicating that this species is capable of vegetative reproduction. We observed no bees visiting the flowers. The green fruits, hanging and hidden under the foliage, suggest dispersal by bats that inhabit the caves, but the natural history of this species is in need of detailed study.

Phenology. Flowering specimens were collected in January, occasionally in March, while fruiting material was seen in January, February, and March.

Etymology. The name refers to Lagoa Santa, a Brazilian locality where two important Danish researchers, Peter Lund and Eugene Warming, worked in the mid 19th century. Warming started his botanical career here studying the Cerrado flora and its ecological relationships. Nowadays he is recognized as one of the Fathers of Ecology.

Preliminary conservation status (IUCN 2014). Critically Endangered (CR) B1, 2 a, b(ii, iii, iv). This species is known from a single locality, the Gruta da Lapinha, included in the Parque Estadual do Sumidouro, a protected area that encompasses 52 caves. There is an increasing human pressure in its microhabitat near the base of the limestone walls, where many climbing routes are in constant use. The limestone outcrops have being mined for decades, drastically reducing the habitat of this species. The surrounding landscape is changing very quickly with the growth of the municipality of Lagoa Santa, influenced by the Vector North project that fostered the expansion of the metropolitan region of Belo Horizonte, the capital of the state (Auler and Piló 2015). All of these threats support an assessment of Critically Endangered. Efforts to locate new populations in the conservation unit, as well as in similar habitats associated with caves outside it are needed.

Notes. *Solanum lagoense* is a small shrub with entirely glabrous leaves, short inflorescences, few small flowers, and green fruits that are hidden below the foliage. These characters are common in species belonging to Geminata clade, a group that is highly diverse in the Atlantic forest (Knapp 2002; Knapp et al. 2015). *Solanum lagoense* is similar to *S. restingae, S. amorimii* and *S. psilophyllum* Stehmann & Giacomin due to its glabrous and geminate, but not dimorphic leaves. The latter three species are distinguished by their glabrous stems, even on the new growth, and short fruiting pedicels (up to 1.5 cm long), whereas *S. lagoense* has clearly pilose young stems and longer fruiting pedicels. *Solanum restingae* is endemic to Bahia and Espírito Santo states and has a strongly winged stem and basally attenuate leaves. *Solanum amorimii* grows in southern Bahia, but also in far northeastern Minas Gerais; its stem is not winged, the leaves are somewhat auriculate at the base. Despite its occurrence in the region of the Serra do Cipó and the Iron Quadrangle relatively close to Lagoa Santa, *S. psilophyllum* has longer petioles (>1.5 cm) and leaves (>10 cm) and more flowers per inflorescence (5–8).

Other species belonging to the Geminata clade recorded in the southern part of Espinhaço mountains in Minas Gerais are *S. verticillatum* Knapp & Stehmann, *S. gnaphalocarpon* Vell., *S. intermedium* Sendtn., and *S. warmingii* Hiern, the last three collected by Warming in Lagoa Santa and cited or described by Hiern (1877). It is noteworthy that after Warming's intensive collecting efforts in Lagoa Santa (1863-1866), including the Lapinha and Sumidouro limestone outcrops, few new species have been described in the last decades. This can be due to Warming's extensive collecting or to the fact that few researchers have been collected recently in the area. Most collecting efforts in the southern Espinhaço chain have been concentrated in rocky quartzite fields (campos rupestres) found in high altitude areas (above 900 m) that houses one of the richest floras of the Neotropical region, almost half of the species endemic (Echternacht et al. 2011; Giulietti and Pirani 1997).

At first glance, *S. lagoense* also resembles species belonging to *Solanum inornatum* clade, but the trichomes, leaf arrangement, and number of seeds are quite distinct. While *S. inornatum* group shows trichomes with few cells (up to 4), geminate leaves differing in form, and translucent fruits with few seeds (up to 10) (Giacomin 2015), *S. lagoense* has multicellular soft trichomes, with more than eight cells, geminate leaves equal in form and hard, green berries with more than 15 seeds per fruit.

The clonal reproduction in *S. lagoense* is noteworthy. All individuals of the population studied have horizontal rhizomes below the leaf litter, linking all the plants together, similar to other members of the Geminata clade such as *S. arboreum* of northern South America (Knapp 2002) and *S. psilophyllum* of the southern Espinhaço range in Minas Gerais. In Solanaceae, vegetative reproduction is common in the tuber-bearing potatoes (Hawkes 1990; Spooner et al. 2014), and has also been reported in weedy species of the Leptostemonum clade growing in open places or forest margins such as *Solanum viarum* Dunal, *S. palinacanthum* Dunal, *Solanum guaraniticum* A. St.-Hil., and *S. paniculatum* L., all common species of southeastern Brazil (Mentz and Oliveira 2004). It appears clonal reproduction is widespread across *Solanum*, and it has been reported in the Cyphomandra, Morelloid, Dulcamaroid, and Brevantherum clades (Giacomin and Stehmann 2014; Vallejo-Marín and O'Brien 2007). The extent of this habit and reproductive mode is not well-documented in Neotropical solanums largely because the underground parts are rarely collected or even observed in these woody plants (see Knapp 2002).

Lagoa Santa is considered an example of a well-catalogued site. Warming compiled a thorough collection listing 2,593 plant species (Warming 1908). Our discovery of this new species in Lagoa Santa strengthens the claim for more floristic and taxonomic inventories in Brazil, not only in poorly collected areas such as Amazonia (Sousa-Baena et al. 2014), but also in "well-studied" areas. In-depth floristic inventories in places with difficult access or with distinct and poorly documented microclimatic conditions, have often resulted in discoveries of new rare and endemic species, even in what appear to be well-catalogued sites.

Acknowledgements

We thank the curators of the herbaria we visited, especially Ib Friis and Per Olof Ryding at the Natural History Museum, Denmark, where most of Warming's collections are kept, and Sandra Knapp for comments and English review. We are also indebted to the Instituto Estadual de Florestas - IEF for the permission to collect in the Parque Estadual do Sumidouro. This work was supported by FAPEMIG (APQ-01706-13) and CNPq (309304/2013-0) to JRS.

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PhytoKeys 61: 27–35 (2016)
doi: 10.3897/phytokeys.61.7420
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Liparis aphylla (Malaxideae, Orchidaceae), a new leafless record from Peru

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Academic editor: *L. Peruzzi* | Received 19 November 2015 | Accepted 17 January 2016 | Published 25 February 2016

Citation: Damian A, Ormerod P (2016) *Liparis aphylla* (Malaxideae, Orchidaceae), a new leafless record from Peru. PhytoKeys 61: 27–35. doi: 10.3897/phytokeys.61.7420

Abstract
Liparis aphylla G.A.Romero & Garay was previously known only from two herbarium specimens collected in 1945 and 1977 in Ecuador and Colombia, respectively. This little-known species is hereby reported for the first time for Peru. An updated description, line illustration, color photographs and distribution map of *L. aphylla*, as well as an identification key to the Peruvian species of *Liparis* are provided.

Resumen
Liparis aphylla G.A.Romero & Garay solo se conocía de dos especímenes de herbario colectados en 1945 y 1977 en Ecuador y Colombia, respectivamente. Esta especie poco conocida se registra por primera vez para Perú. Se presenta una descripción actualizada, ilustración de línea, fotografías a color y un mapa de distribución de *L. aphylla*, así como una clave de identificación para las especies peruanas de *Liparis*.

Keywords
Orchidaceae, *Liparis aphylla*, Cajamarca, Peru, *Liparis* section *Aphylla*

Palabras clave
Orchidaceae, *Liparis aphylla*, Cajamarca, Peru, *Liparis* section *Aphylla*

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Introduction

Liparis Rich. *s.l.* is a large cosmopolitan genus of about 480 species, reported in tropical Asia, Malesia, eastern Australia, the Pacific Islands (including Hawaii and Tahiti), Madagascar, Africa, subtropical and tropical Americas, temperate Europe, Asia and North America. The genus is composed of both terrestrial and epiphytic species; with small to prominent pseudobulbs; one to several (rarely none) conduplicate to plicate leaves, a terminal inflorescence of one to many; flowers usually resupinate, small or medium-sized, yellow, green, orange, or purple; the sepals are similar, although the lateral ones are often wider and shorter than the dorsal one; the labellum is firmly attached to a footless, often arched column; the incumbent anther bears four pollinia grouped in two pairs, and lacking caudicles or stipe but with minute viscidium. According to a recent molecular phylogenetic study (Cameron 2005), *Liparis* contains four major clades, two of which include primarily Asiatic-Malesian epiphytic taxa with narrow conduplicate leaves, and the other two consist mostly of terrestrial plants with worldwide distribution and broader, conduplicate to plicate leaves. However, further studies are needed to better understand its evolutionary history and to clarify its delimitation and position within the tribe Malaxideae.

Schlechter (1921), compiled the first account of Liparis in Peru and reported three species, namely *L. crispifolia* Rchb.f, *L. elegantula* Kraenzl, and *L. ramosa* Poepp. & Endl. Later, Schweinfurth (1959) listed eight species, adding *L. elata* Lindl. [= *L. nervosa* (Thunb. ex A. Murray) Lindl.], *L. laticuneata* C. Schweinf., *L. retusa* Fawc. & Rendle, and *L. vexillifera* (Lex.) Cogn. Bracko & Zarucchi (1993) added two unvouchered records, namely *L. luerii* Dodson [= *L. serpens* Garay] and *L. neuroglossa* Rchb.f. to the list of Peruvian taxa (see Ormerod 2012). As far as we know, *L. neuroglossa* is only known from the Bolivian type collection. Taking into account the previous records and four additional Peruvian species described by Ormerod (2012), currently we recognize the following 11 species for this country: *L. ecallosa* Ormerod, *L. elegantula*, *L. laticuneata*, *L. nervosa*, *L. ramosa*, *L. retusa*, *L. rusbyi* Rolfe, *L. schunkei* Ormerod, *L. serratiloba* Ormerod, *L. vargasii* Ormerod, and *L. vexillifera*.

During field exploration conducted by the senior author in the montane rainforest of Cajamarca, Peru, in 2014, a small terrestrial individual plant of *Liparis* was collected and subsequently identified as *Liparis aphylla*. Because of the scarcity of information about this rare orchid, we provide an updated description and line illustration, we illustrate it with color photos for the first time and we provide additional information regarding its ecology and morphological variation.

Materials and methods

A live plant of *Liparis aphylla* was collected in May 2014 in Cajamarca, Peru (see detailed locality data under "Additional specimen examined" below). Specimen identification was made by comparing the plant with the original publication of the species

in Garay and Romero (1999). A herbarium specimen was prepared, and two flowers were preserved in a solution consisting of 70% ethanol, 20% water, and 10% glycerol. An updated description was prepared based on all collections of *L. aphylla* available (either physical specimens or digital images).

Taxonomy

***Liparis aphylla* G.A.Romero & Garay**
Figs 1, 2

Liparis aphylla G.A.Romero & Garay. Harvard Pap. Bot. 4(2): 483. 1999.

Type. COLOMBIA. Boyacá: Sierra del Cocuy, 2800 m, "terrestre, entre musgos asociada con *Masdevallia* sp., aparentemente saprófita; tépalos blanco-verdosos, labelo púrpura lila" 20 July 1997, *M. Ospina Hernández 1487* (Holotype: AMES!).

Description. Herb, 4–10 cm tall, terrestrial. Rhizome and roots not seen. Pseudobulb subglobose, 2.5–5 × 2 mm, enveloped by a basal foliaceous green sheath 1.5 cm long. Leaves not seen. Inflorescence racemose, erect, successively (up to 6) flowered (usually two are open at a time), 7.8 cm. long; peduncle slender, 4 cm long; rachis weakly flexuous, distichous, 3.8 cm long; floral bracts lanceolate. acute, green, 5–7 × 3 mm. Flowers widely opening, resupinate, fragrance not detected, sepals and petals greenish, labellum rosy brown with a darker median stripe, column greenish suffused with rosy brown, pollinia yellow. Green, 4-6 long ovary with clavate, narrowly winged pedicel. Dorsal sepal oblong-lanceolate, obtuse, erect, 1–veined, 3–5.5 × 0.9–1.5 mm. Lateral sepals obliquely oblong-ovate, obtuse, midvein low carinate, parallell to each other under the labellum, 1-veined, 3–5 × 0.6–2 mm. Petals linear, obtuse, reflexed, 1–veined, 2.6–5 × 0.5–0.6 mm. Labellum subquadrate, distal margin serrate-denticulate, medially with a thickened glossy stripe, 3–5 × 3.5–5 mm; callus bilobed, each side with an erect, subquadrate lobe between which there is a distally thick-walled elliptical cavity. Column semiterete, thick basally but slender above, arcuate on its distal half, apex with small triangular wings on each side, 3 mm long; pollinia four in two pairs, waxy, triangular; anther cap ovoid. Capsule and seeds not seen.

Ecology and distribution. *Liparis aphylla* is found in the Andes of Colombia, Ecuador and Peru, within an elevation range of 2600–3300 m. The distribution of this species, based on herbarium records, appears to be highly disjunct (Figure 3). However, this extreme patchiness may be an artifact of limited collecting, and we suspect that *L. aphylla* likely occurs throughout the Andean range, at climatically suitable locations ranging from the Cordillera Oriental/East Andes in Colombia to the northern Andes of Peru. Plants of *L. aphylla* grow terrestrially among loose moss in wet, cold montane cloud forest with abundant bryophytes. Flowering period: May–July.

Additional specimens examined. ECUADOR. Prov. Azuay: East Cordillera, 4–6 km N. of Sevilla de Oro, 2745–3050 m, 16 August 1945, W.H. Camp E-4774

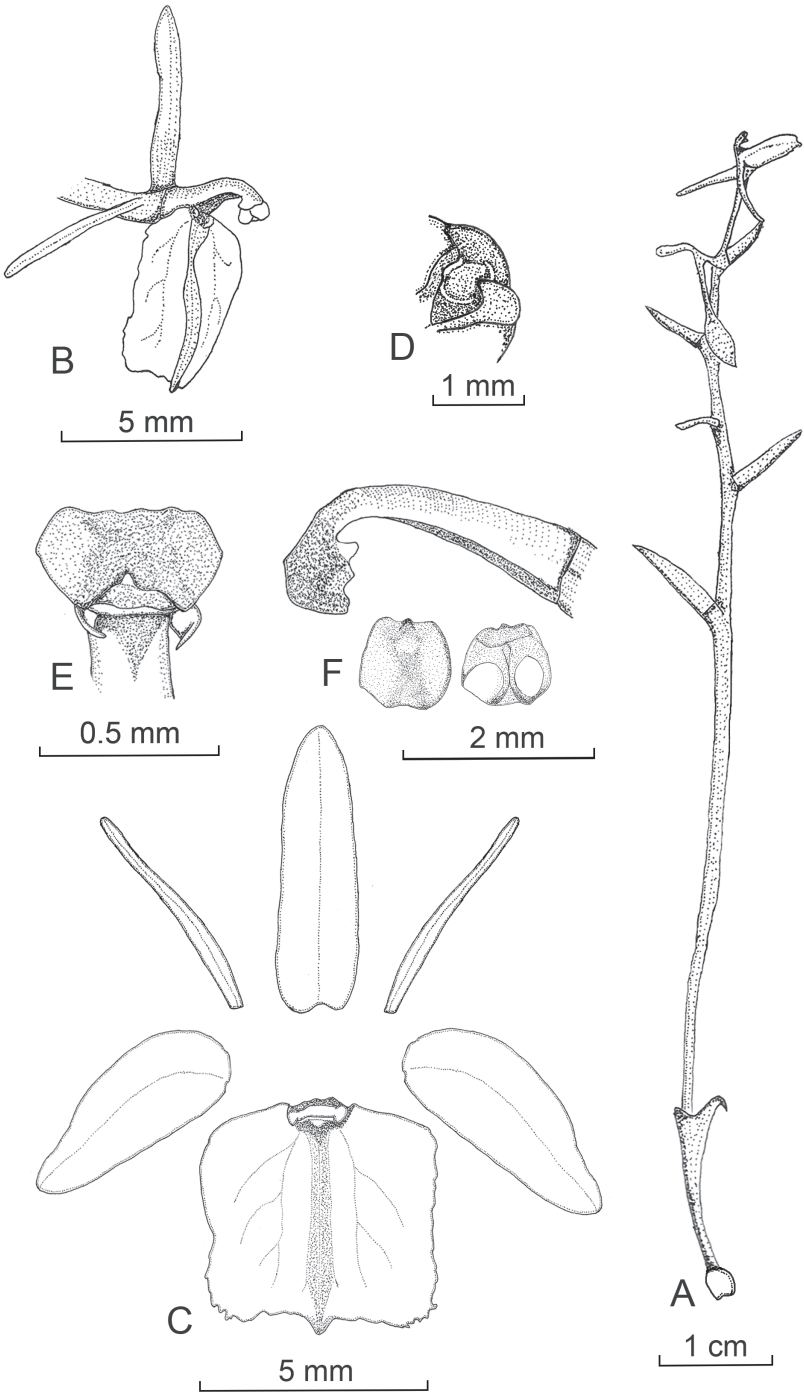

Figure 1. *Liparis aphylla.* **A** Habit **B** Flower **C** Dissected perianth **D** Detail of the labellum disk base **E** Column withouh the anter cap, ventral view **F** Column lateral view, and anther cap. Drawn from *A. Damian 0100* (MOL!).

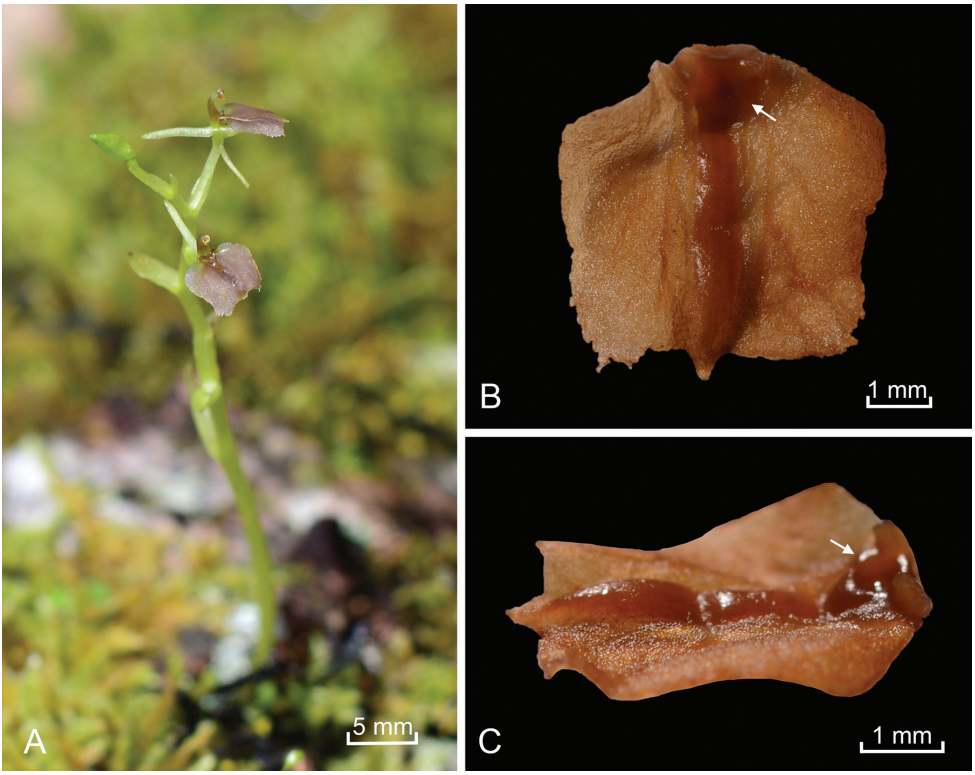

Figure 2. *Liparis aphylla*, **A** Habit **B–C** Two views of the of labellum. Arrows show the distinct elliptical concavity of the callus. Photographer: A. L. Damian.

(AMES!, NY); **PERU.** Departamento Cajamarca, provincia Chota, Querocoto, entrance road to "La Granja", 6°20'6.70"S, 79°9'24.49"W; terrestrial, montane rainforest, 2600 m, 01 May 2014, *A. Damian 0100* (MOL!, ADP-spirit 3033).

Conservation status. This species is presently know only from three location worldwide; according to the IUCN Red List (IUCN 2014) and Roque and Leon (2006) criteria, it should be listed as critically endangered (CR) B1ab(iii).

Discussion. *Liparis aphylla* was described from an individual plant collected in Sierra del Cocuy, Colombia, by Romero and Garay (1997) and from another record from Azuay, Ecuador, (1977). These two specimens, along with the Peruvian specimen reported in this paper, represent the only available material of this tiny rare orchid. The overall morphology observed in these three specimens, is quite uniform except for considerable variation in labellum shape, which ranges from quadrate in the specimen *Camp E-4774* to subquadrate in *Ospina Hernández 1487.* Moreover, the elliptic concavity of the callus of our specimen did not appear to be present in other two specimens, although it is not clear if the absence of this concavity in the latter two specimens is an artifact of preservation.

Unlike any others members of *Liparis*, *L. aphylla* appears as a leafless orchid with poor-developed root system. However, these two conditions need to be studied care-

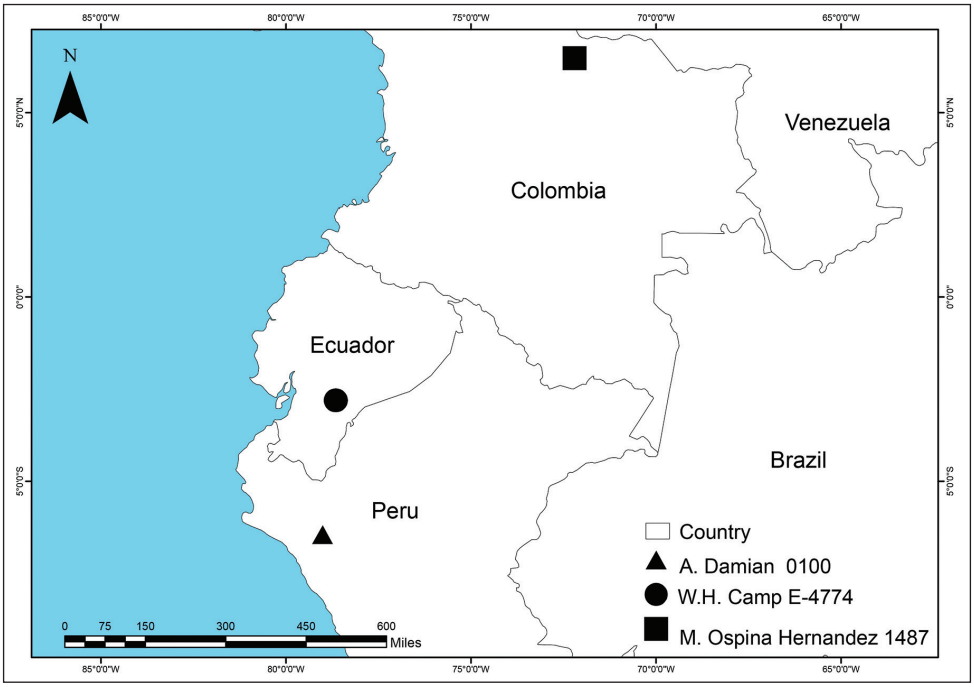

Figure 3. Known distribution of *Liparis aphylla*.

fully. Although we were unable to see any remnant roots or rhizome on the specimens examined, Ospina Hernandez sheet (1487) includes an interesting note cited as "Plant tubers covered by fungal hyphae (...)". It is highly possible that "tubers" on this context actually refers to the pseudobulb and not to the presence of subterranean stems or shoots that resemble any kind of root-like system or rhizome as it occurs in many basal Epidendroids orchids (Pridgeon et al. 2005, Campbell 2014). A closest analysis of the original drawing of *L. aphylla* by Romero and Garay (1997) shows sort of filamentous structures emerging beneath the pseudobulb. Since the dimensions of these formations are indistinct (0.3 × 0.1 cm), is fairly accurate to attribute those filamentouse root-like structures to the "fungal hyphae" which Ospina was referring in the first place.

Another strikingly feature on *L. aphylla* is its leaflessness. As it happens with rhizome and roots, no remnants of withered or decomposed leaves were observed neither in the field nor in available herbarium specimens. As a result of this uncommon state within *Liparis*, Romero & Garay decided to establish *Sect. Aphylla* (Romero and Garay 1997) to include this single species, which outstands essentially for its leafless habit, well-developed pseudobulb, plants of small size and muscicolous habitat. However, additional observations whether this set of characters, especially those referring to leaves and roots, are continuous or not along specimens were missing.

Leaflessness is a feature that is present in many angiosperms (Vicent et al. 2013, Calswards et al. 2006) and Orchidaceae is not the exception. At least 235 orchid species and 43 genera are leafless, most of them found in Epidendroideae (Freudenstein

and Barrett 2010). For instance, within tribe Malaxideae, two orchids have reported being leafless: *Malaxis aphylla* (King & Pantl.) T.Tang & F.T.Wang and *Malaxis saprophyta* (King & Pantl.) T.Tang & F.T.Wang (Vincent et al. 2013). Most of these leafless orchid display any of the following arrangements or life-forms: (1) well-developed shoot system which forms the main body (e.g. leafless *Vanilla*), (2) shoot system reduced, i.e. shootless orchids, roots forming the main body of the plant (e.g. Vandeae) (Carlsward et al. 2006), (3) roots fleshy, fasciculate, leaves basal but lacking at flowering time (e.g. Spiranthinae: Cranichideae) (Salazar 2003), and (4) myco-heterotrophic orchids, achlorophyllous, roots reduced or absent, rhizome fleshy, coralloid, tuberlike or cylindric (e.g. Aphyllorchis, Gastrodia) (Rasmussen 2000). A major question rise then among others, which life-form represents better to *L. aphylla*?. Although Romero and Garay (1997) suggested it could be referred to as a "saprophyte", this term proved to be inaccurate (Leake 1994). We believed *L. aphylla* could represent a partially myco-heterotrophic (holo-mycotrophic) plant, i.e. clorophyllous plant that combines autotrophy and myco-heterotrophy to obtain carbon during at least one stage of its life cycle (Rasmussen 1995). The nonexistence of a well-developed root system, leaflessness (= myco-heterotrophic species) and retainment of chlorophyll on its basal sheath, stem and bracts seem to confirm this hypothesis. Nonetheless, it is important to keep in mind that the myco-heterotrophic status is "putative" on this species, and remains speculative until a careful physiological analysis has been carried out.

Identification key to Peruvian species of *Liparis*

1 Leaves absent ..... ***L. aphylla***
– Leaves present at flowering **2**
2 Plants not decumbent; pseudobulbs or pseudobulb-like basal thickening present **3**
– Plants decumbent, pseudobulbs absent **4**
3 Leaf solitary, basal or near the base ..... ***L. vexillifera***
– Leaves several, spreading, basal or near the base ..... ***L. nervosa***
4 Leaves appearing singly on rhizome **5**
– Leaves appearing in pairs on rhizome or subapproximate on erect stem **6**
5 Labellum subquadrate, ca. 7.5 mm wide ..... ***L. retusa***
– Labellum papilioforme, ca. 10.2 mm wide ..... ***L. vargasii***
6 Labellum reniform ..... ***L. serratiloba***
– Labellum cuneate to pandurate or obovate **7**
7 Labellum cuneate **8**
– Labellum elliptic, pandurate to obovate **9**
8 Labellum disc with central thickened band ..... ***L. laticuneata***
– Labellum disc with minute bilobed forcipate callus ..... ***L. elegantula***
9 Labellum lacking basal callus ..... ***L. ecallosa***
– Labellum with basal callus **10**

10 Labellum elliptic-pandurate or narrowly obovate, to 6mm wide; basal callus V-shaped (edges apically convergent) .....***L. schunkei***

– Labellum suborbicular to broadly obovate, 9-12 mm wide; basal callus not V-shaped (edges parallel).....***L. rusbyi***

Acknowledgments

We thank the herbarium and library staff at the Harvard University Herbaria (A, AMES, GH) for their help and hospitality; John Li Flores for his assistance with the distribution map; Brad Boyle, Camila Crifó and Nicole Mitidieri for his valuable observations; Gustavo Romero for assisting with literature, and to the reviewers for their valuable recommendations on the manuscript.

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PhytoKeys 61: 37–46 (2016)
doi: 10.3897/phytokeys.61.7295
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RESEARCH ARTICLE

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Rafflesia consueloae (Rafflesiaceae), the smallest among giants; a new species from Luzon Island, Philippines

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Academic editor: *A. Sennikov* | Received 24 November 2015 | Accepted 24 January 2016 | Published 25 February 2016

Citation: Galindon JMM, Ong PS, Fernando ES (2016) *Rafflesia consueloae* (Rafflesiaceae), the smallest among giants; a new species from Luzon Island, Philippines. PhytoKeys 61: 37–46. doi: 10.3897/phytokeys.61.7295

Abstract

A new species of *Rafflesia* (Rafflesiaceae) from Luzon Island, Philippines, *Rafflesia consueloae* Galindon, Ong & Fernando, is described and illustrated. It is distinct from all other species of *Rafflesia* in its small-sized flowers, the upright perigone lobes, and prominently cream-white disk surface that is often devoid of processes. Its small-sized flowers, with an average diameter of 9.73 cm when fully expanded, make it the smallest of the largest flowers in the world.

Keywords

Conservation, ecology, holoparasitic plants, taxonomy

Introduction

Rafflesia R.Br. (Rafflesiaceae) is a genus of endophytic, holoparasitic plants, well-known for producing the largest flowers on record (Kuijt 1969, Meijer 1985, 1997, Nais 2001). The Philippines is one of the centers of diversity of the genus (Barcelona et al. 2009b, Pelser et al. 2013), with at least 12 species thus far recorded from the archipelago (Teschemacher 1842, Blanco 1845, Hieronymus 1885, Barcelona and Fernando 2002, Fernando and Ong 2005, Barcelona et al. 2006, 2008a, 2008b, 2009a, 2009b, 2011, 2014, Galang and Madulid 2006, Balete et al. 2010, Pelser et al. 2013), eight of which were described only since 2002. Of all known Philippine species, five

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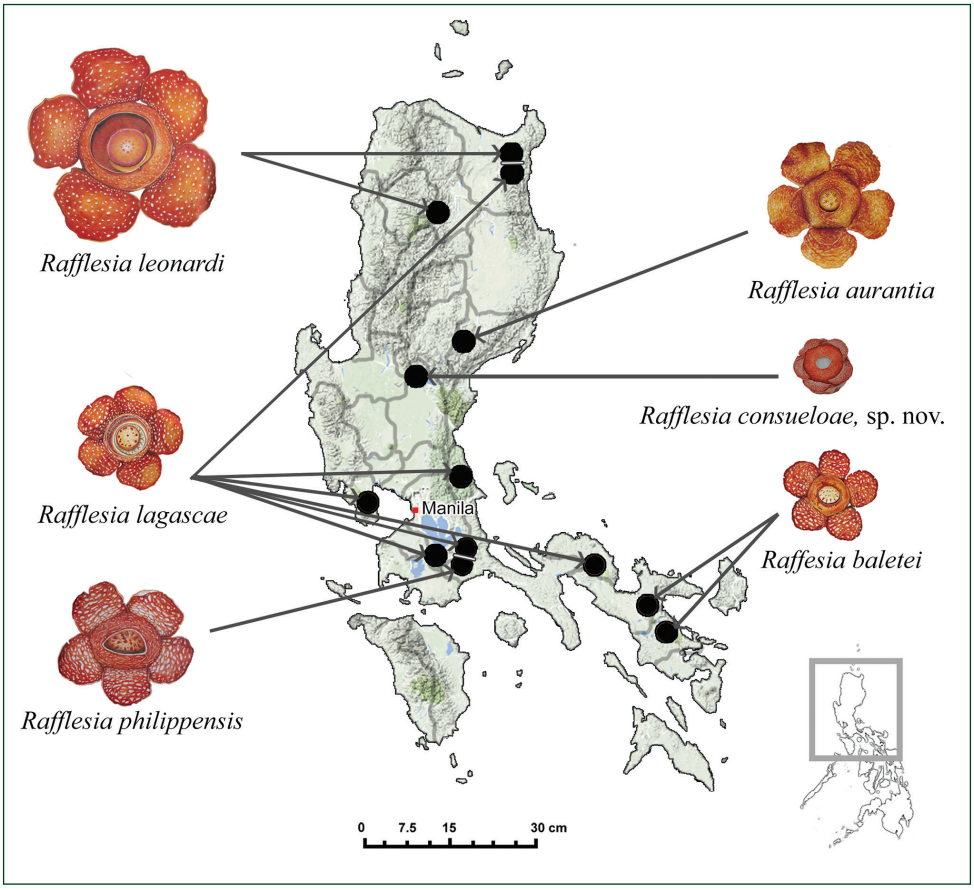

Figure 1. Distribution of the six species of *Rafflesia* on Luzon Island, Philippines, including the new species, *Rafflesia consueloae*. All *Rafflesia* images were drawn by Ms Yasmin S. Ong, five of which were originally published in David et al. (2011). Their use here is with permission of the book publisher, the Energy Development Corporation. All images are scaled relative to the actual sizes of each species. Map source: http://wikimapia.org/#lang=en&lat=12.533115&lon=121.069336&z=6&m=t

are recorded from Luzon Island, viz., *Rafflesia aurantia* Barcelona, Co & Balete (Barcelona et al. 2009a) from Quirino Province; *R. baletei* Barcelona & Cajano (Barcelona et al. 2006) from Camarines Sur Province; *R. lagascae* Blanco (Blanco 1845, Barcelona et al. 2009, 2011 [as *R. manillana* Teschem.], Pelser et al. 2013) from Cagayan, Bataan, Rizal, Laguna, Quezon, and Camarines Norte Provinces; *R. leonardi* Barcelona & Pelser (Barcelona et al. 2008a, 2011) from Cagayan and Kalinga Provinces, and *R. philippensis* Blanco (Blanco 1845, Barcelona et al. 2009) [as *R. banahawensis* Madulid, Villariba & Agoo (2007), and as *R. banahaw* Barcelona, Pelser & Cajano (2007)] from Laguna and Quezon Provinces (Figure 1).

In this paper, we describe *Rafflesia consueloae*, the 6th species from Luzon Island, and the 13th for the entire Philippine archipelago.

Taxonomy

***Rafflesia consueloae* Galindon, Ong & Fernando, sp. nov.**
urn:lsid:ipni.org:names:77153385-1
Figures 2–4

Diagnosis. This species is distinct from all other *Rafflesia* species in its small-sized flowers (average of 9.73 cm diameter), the upright perigone lobes, and the prominently cream-white disk surface which is often devoid of processes. On Luzon Island, it overlaps in the size of mature buds and number of anthers with *Rafflesia baletei* and *Rafflesia aurantia* (Table 1).

Type. PHILIPPINES. Luzon Island: Nueva Ecija Province, Municipality of Pantabangan, Brgy. Fatima, Mt Balukbok, 15°50'17.30"N, 121°05'21.60"E, 325 m elevation, ♂ flowers, 19 March 2014, *Fernando & Galindon 3373* (spirit collection; holotype PNH, isotype PUH).

Description. Endophytic holoparasite. *Mature buds* 6.4–9.9 cm in diameter (average 8.27 ± 0.82 cm, n=147), covered with three overlapping layers of bracts, each layer with five bracts, those in innermost layer up to 6.5 cm long and 5 cm wide, light brown. *Flowers* 6.6–12.7 cm in diameter (average: 9.73 ± 1.33 cm, n=63) when fully expanded, up to *c.* 6.0–13 cm (average 9.49 ± 1.63 cm, n=74) tall. *Perigone lobes* 5, generally upright throughout their length, the apex only slightly recurved, the basal parts imbricate, reddish brown in fresh bloom, becoming darker with age, 3.1–3.8 cm long, 3.2–5 cm wide, orbicular, covered with sharply-edged fine warts and areola-forming ornamentations, the warts dense and powdery white when fresh, concolorous with background tissue with age; the undersurface of topmost lobe generally smooth, others with wart impressions on the distal half; the lobes usually shrinking towards the diaphragm at senescence. *Diaphragm* 3.2–9.0 cm in diameter (average 6.87 ± 1.11 cm, n=85), often slightly darker or rarely concolorous with the perigone lobes, warts thin with blunt whitish tips when fresh, forming variably-shaped impressions of perigone warts; the rim of aperture entire, whitish in fresh bloom, becoming dark with age; diaphragm aperture 1.47–3.85 cm (average 2.57 ± 0.58 cm, n=92); windows absent. *Ramenta* throughout the inner side of the flower tube, glabrous, darker on the tips, denser on the perigone tube floor, each 0.5–3 mm long, slender, apices unbranched, clavate; middle portion 1–2 mm long, cleaved apically up to 3 branches, swollen; sparse towards the aperture, irregular, up to 1.5 mm long. *Disk c.* 4–4.5 cm across, prominently cream-white in newly opened flowers, slightly dome-shaped centrally in male flowers, slightly crateriform in female flowers; the rim prominently raised to slightly arching, to 2.5–3.0 mm high, irregularly serrate and shallowly to deeply incised; brown acicular hairs sparsely scattered all over the disk; disk processes usually absent, or rarely, if present centrally disposed, in male flowers up to 10, in female flowers 11–18, monomorphic, to *c.* 3 mm tall, apex with 2–3 brown bristles. *Column* to 4 cm from the base of the cupule to the upper surface of the disk; neck of column to *c.* 1.5 cm wide; the lower surface of the disk near the rim (corona) concolorous with upper disk surface, in female flowers generally

Table 1. Diagnostic characters separating *Rafflesia consueloae* from *Rafflesia aurantia* and *Rafflesia baletei.* Data on *Rafflesia aurantia* from Barcelona et al. (2009a, 2009b, 2011), *Rafflesia baletei* from Barcelona et al. (2006, 2009b, 2011).

	Rafflesia consueloae	***Rafflesia aurantia***	***Rafflesia baletei***
Mature bud diameter (cm)	6.4–9.9 (ave. 8.27 ± 0.82, n=147)	8.5–9	7.5–9
Flower diameter (cm)	6.6–12.7 (ave. 9.73 ± 1.33, n=63)	*c.* 20	9–22
Perigone lobe orientation	generally erect or upright throughout their length; the apex only slightly recurved; the basal parts imbricate	arching, distantly disposed	erect basally, but recurved halfway distally
Perigone color	reddish brown	orange	orange or reddish orange
Diaphragm rim color vs. diaphragm color	whitish when fresh, becoming darker with age	concolorous	darker
Diaphragm surface	warts thin, with blunt whitish tips when fresh, forming variably-shaped impressions of perigone warts	sharp-edged, areoles forming	reticulate
Diaphragm diameter (cm)	3.2–9.0 (ave. 6.87 ± 1.11, n=85)	10	7–8.5 (–12)
Aperture diameter (cm)	1.47–3.85 (ave. 2.57 ± 0.58, n=92)	3–3.6	3–3.5
Number of disk processes	usually absent, or rarely if present centrally disposed	indefinite	19–26
Disk rim	irregularly shallowly to deeply incised	entire	irregularly and shallowly crenulate
Disk surface color	distinctly dull cream white in newly opened flowers	light orangish, with prominent processes	glistening cream-white, becoming reddish brown at the periphery
Disk processes types	when present monomorphic, the tips with brown acicular hairs or bristles	polymorphic, flattened, peripheral ones narrowly lanceolate, spinose	monomorphic, conical, or slightly laterally compressed, often branched
Disk processes maximum length (mm)	3	5–10	10
Ramenta length (mm)	0.5–3, longer towards the base of the tube	7–10	2, longer towards the base of the tube
Number of anthers	12–14	12–14	11–14

smooth, while in male flowers covered with fine brown bristles, each to *c.* 1 mm long. *Male flowers* with 12–14 anthers, entrenched in sulci 4–7 mm across, the sulci whitish; male flowers occasionally with vestigial ovaries. *Female flowers* with lunate ovary, *c.* 2.9–4 cm wide by 0.6–1 cm tall; female flowers occasionally with vestigial anthers. *Young fruit* 7.2 cm wide × 5 cm tall, top surface coarse, resembling turtle carapace, ovary 5.5 cm wide × 1.5 cm tall, positioned 2.2 cm from the cupule base.

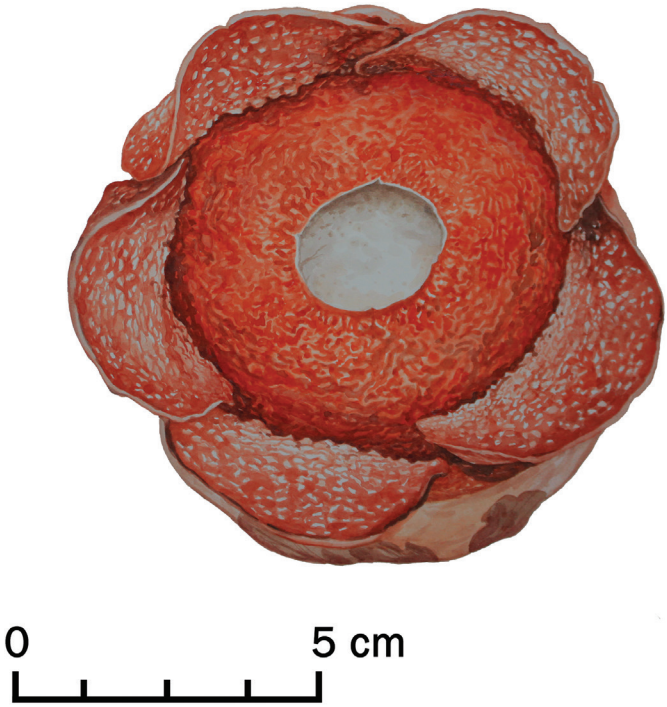

Figure 2. Colour illustration of *Rafflesia consueloae* Galindon, Ong & Fernando based on the holotype, *Fernando & Galindon 3373* (PUH). Colour illustration by Ms Yasmin S. Ong.

Distribution. Endemic to the Philippines. Luzon Island, Nueva Ecija Province, Municipality of Pantabangan. The species is currently known only from two mountain sites with remnants of tropical lowland evergreen rain forests, Mt Balukbok and Mt Pantaburon, about 2 km apart, all within the Pantabangan-Carranglan Watershed.

Habitat and ecology. This species occurs between 300 and 500 m elevation. It is restricted to roots of *Tetrastigma* sp. (Vitaceae) (*Fernando & Galindon 3374*: PUH) growing among climbing bamboo (*Dinochloa luconiae* (Munro) Merr.) thickets. In the type locality on Mt Balukbok, the forest canopy is about 15–20 m tall and includes trees of *Radermachera pinnata* (Blanco) Seem. (Bignoniaceae), *Pterocymbium tinctorium* Merr. (Malvaceae), *Diplodiscus paniculatus* Turcz. (Malvaceae), *Bombax ceiba* L. (Malvaceae), *Maranthes corymbosa* Blume (Chrysobalanaceae), and *Dysoxylum gaudichaudianum* (A.Juss.) Miq. (Meliaceae). The middle canopy consists of *Ficus botryocarpa* Miq., *Ficus ampelas* Burm.f. (Moraceae), *Artocarpus ovatus* Blanco (Moraceae), *Syzygium* sp. (Myrtaceae), *Macaranga tanarius* (L.) Müll.Arg. (Euphorbiaceae), and dense clumps of the erect bamboo *Schizostachyum lumampao* (Blanco) Merr. (Poaceae). On Mt Pantaburon, the populations of *Rafflesia consueloae* are proximate to an old reforestation area planted with *Gmelina arborea* Roxb. (Verbenaceae) and mango (*Mangifera indica* L.; Anacardiaceae).

Additional specimens examined. Philippines. Luzon Island: Nueva Ecija Province, Municipality of Pantabangan, Brgy. Fatima, Mt Balukbok, 15°50'17.30"N, 121°05'21.60"E, 330 m elevation, bisexual flower bud, 19 March 2014, *Fernando & Galindon 3376* (PUH); 15°50'17.30"N, 121°05'21.60"E, 330 m, immature fruit, 19 March 2014, *Fernando & Galindon 3377* (PUH); 15°50'15.19"N, 121°05'21.40"E, 336 m elevation, ♀ flower bud, 19 March 2014, *Fernando & Galindon 3378* (PUH); 15°50'15.19"N, 121°05'21.40"E, 336 m elevation, partially opened ♀ flower, 19 March 2014, *Fernando & Galindon 3379* (PUH); 15°50'12.20"N, 121°05'15.00"E, 380 m elevation, old ♂ flower, 19 March 2014, *Fernando & Galindon 3380* (PUH). Brgy. West Poblacion, Mt Pantaburon, 15°50'36.62"N, 121°05'42.7"E, 435 m, ♂ flower, 14 February 2015, *Fernando & Galindon 3667* (PUH, PNH); 15°50'36.62"N, 121°05'42.7"E, 435 m, ♂ flower, 16 May 2015, *Fernando & Galindon 3773* (PUH); 15°50'37.8"N, 121°05'44.9"E, 437 m, ♂ flower, 16 May 2015, *Fernando & Galindon 3774* (PNH).

Etymology. The specific epithet honors Ms Consuelo 'Connie' Rufino Lopez, lifelong partner of industrialist Oscar M. Lopez, and a plant lover in her own right. Both delight in culturing, growing and tending their garden which includes more than 100 species of trees, orchids and other plants. With her demure but strong personality, traits which *Rafflesia consueloae* possess, she provides the inspiration for Mr Lopez's pursuit of biodiversity conservation in the Philippines.

Notes. Prior to this discovery of *R. consueloae*, *R. baletei* (Barcelona et al. 2006; David et al. 2011), with flowers (9–) 15–16 (–22) cm in diameter when fully expanded, held the record of being the smallest *Rafflesia*. Our new species, *R. consueloae*, has flowers with an average diameter of only 9.73 ± 1.33 cm (range 6.6–12.7 cm; n=63) when fully expanded, making it the smallest of the largest flowers in the world. The disk surface of *R. consueloae* is also distinctly cream-white in newly opened flowers and is almost always devoid of processes. This character is reminiscent of *R. rochussenii* Teisjm. & Binn. (Teijsmann 1850) from Java and Sumatra in Indonesia (Meijer 1997, Nais 2001). The absence of processes on the disk is also known in young flowers of *R. leonardi* (Barcelona et al. 2008a), but the disk in this species is larger (7–8 cm in diameter) and described as 'tan centrally, purplish towards the periphery'. *R. consueloae* is the third *Rafflesia* species in the Philippines reported with bisexual flowers. The other two are *R. baletei* from southeastern Luzon (Barcelona et al. 2006) and *R. verrucosa* from eastern Mindanao (Balete et al. 2010). In *R. baletei*, male and female male flowers were described separately to have vestigial organs of the other sex (Barcelona et al. 2006, 2009). But, Barcelona et al. (2009, 2011) also described the flowers of this same species as bisexual. *R. verrucosa* is also recorded to have bisexual flowers (Balete et al. 2010), although male and female flowers were not described separately. Thus, *R. consueloae* can also be considered to have bisexual flowers. Whether the flowers are functionally bisexual still has to be shown. Referring to *R. baletei* and *R. verrucosa*, Balete et al. (2010) states that 'It remains to be demonstrated however, whether either or both species are functionally bisexual.' Further studies on these three species, *R. baletei*, *R. verrucosa*, and *R. consueloae*, should help provide further insights on this issue.

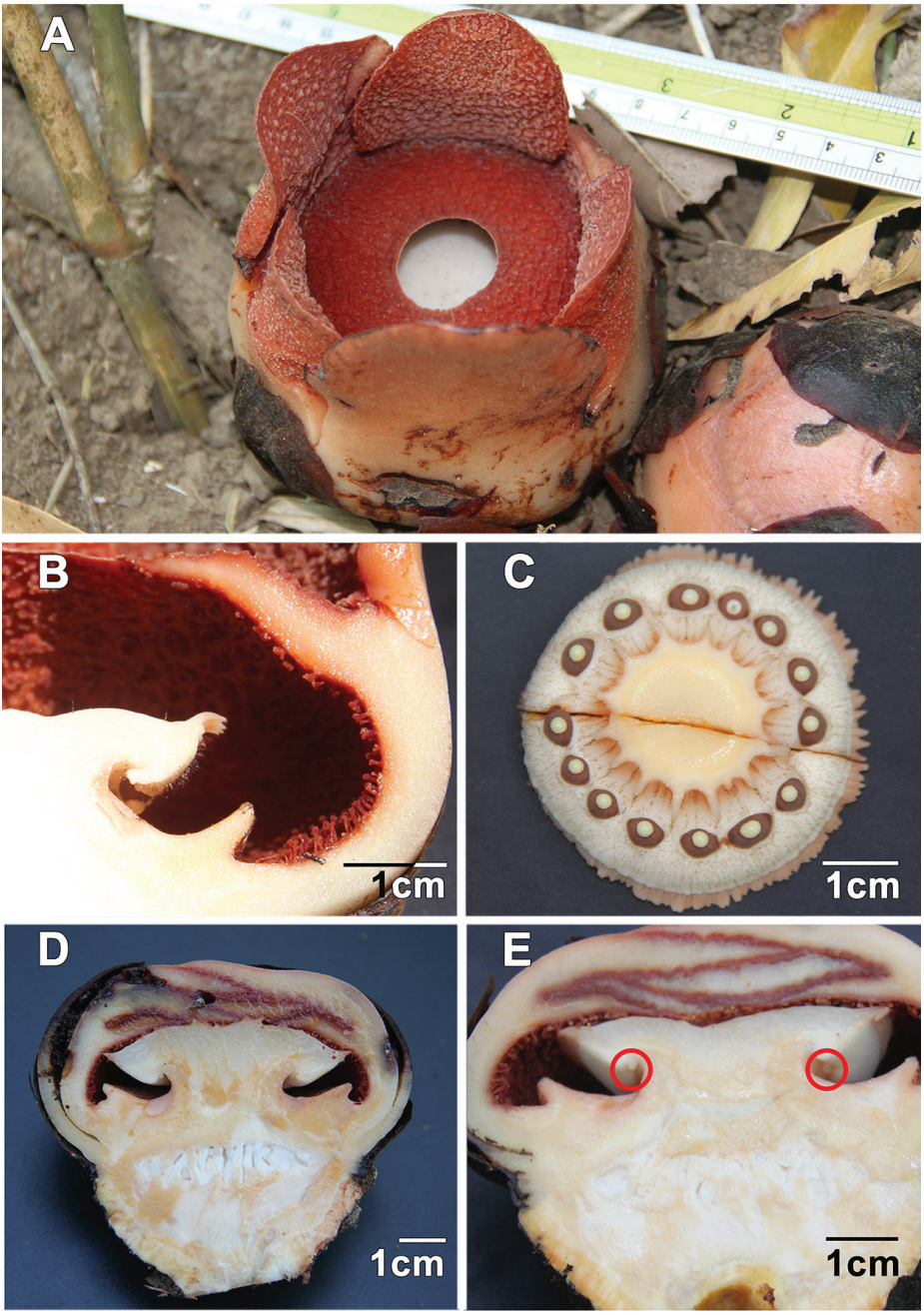

Figure 3. *Rafflesia consueloae* Galindon, Ong & Fernando. **A** Open flower **B** Longitudinal section of flower showing details of ramenta **C** Cross section through column neck showing undersurface of disk with anthers and dense fine bristles **D** Longitudinal section of female bud showing ovary **E** Longitudinal section of female bud showing lower surface of disk with vestigial anthers and generally smooth surface. **A–C** *Fernando & Galindon 3373* **D** *Fernando & Galindon 3378* **E** *Fernando & Galindon 3376*. All photographs by Edwino S. Fernando.

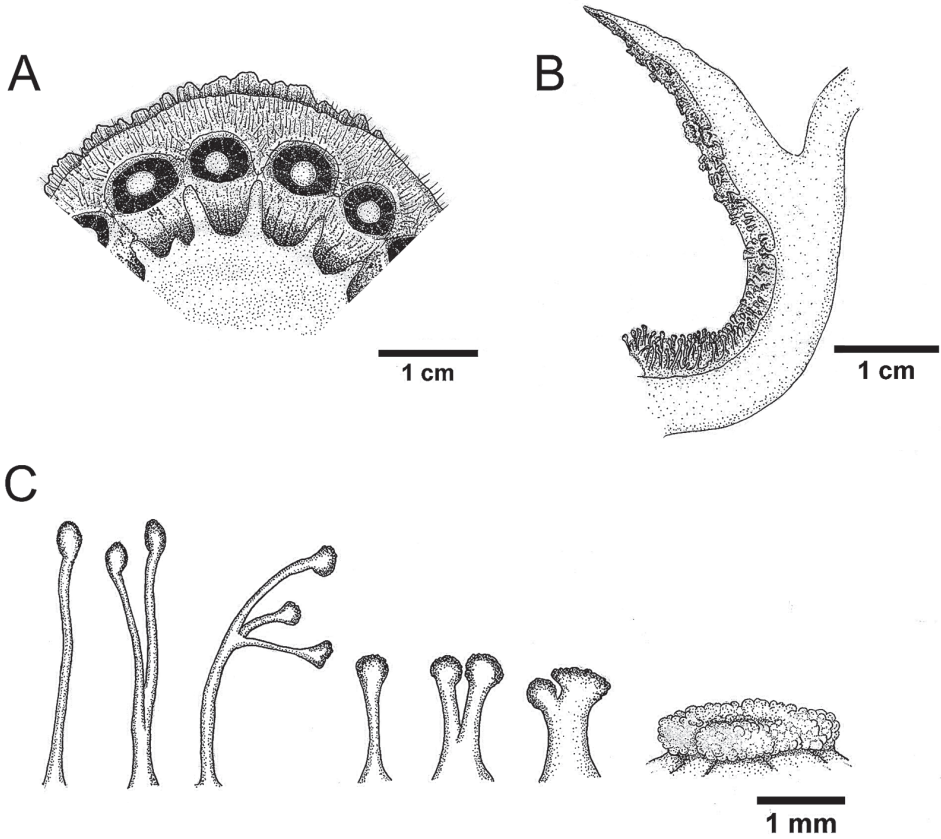

Figure 4. Line drawings of *Rafflesia consueloae* Galindon, Ong, & Fernando. **A** Anthers underneath disk **B** Thin section of perigone tube showing details of ramenta **C** Lower, middle, and upper types (left to right) of ramenta. **A–C** based on *Fernando & Galindon 3373.* Line drawings by Jason B. Fernandez.

Conservation status. Following the IUCN Categories and Criteria (IUCN 2012), we regard this species as Critically Endangered (CR B1+2bc). The extent of occurrence of the two small populations of *R. consueloae* is less than 100 km^2. Both populations are under the jurisdictional control of the National Irrigation Administration (NIA) and the Pantabangan-Carranglan Watershed Protected Area Management Board. The First Gen Hydro Power Corporation operates the Pantabangan hydroelectric facilities in the area and helps provide support in monitoring the surrounding forests and its biodiversity. However, the continued protection of the *R. consueloae* populations and other biodiversity in the area needs to be ensured as some local people still hunt wildlife there and forest fires are likely in the dry season. The vertebrate wildlife may also play a role in the biology of the *R. consueloae*.

How new *Tetrastigma* hosts get infected with *Rafflesia* seeds remains unknown. Several species of wildlife such as tree shrews, rodents, squirrels, wild pigs, elephants, and even ants have been suggested as potential seed dispersers of *Rafflesia* (Emmons et al. 1991, Hidayati et al. 2000, Nais 2001, Pelser et al. 2013); that these wildlife species might play an important role in the completion of the Rafflesia's life cycle through the

infection of new *Tetrastigma* hosts, had long been suspected but remains unproven. However, using motion-activated camera traps set up around fruits of *R. consueloae*, we were able to photograph at least two species of rodents feeding on different occasions (unpublished data, this study). What role these rodents and other wildlife species play in the life cycle of *R. consueloae* is subject of further study. The current two sites are known hunting grounds of wildlife by some members of the local community. Given the restricted range of this new species, hunting of wildlife might further exacerbate its fragile existence. Also, hunting might increase the chances of forest fires occurring, which are likely in the dry season based on personal observations and interviews with locals.

Acknowledgements

Permission to collect specimens of *Rafflesia* for scientific research was covered by Gratuitous Permit Nos. III-2013-02 and III-2014-02 issued by the Department of Environment and Natural Resources (DENR) – Region 3, San Fernando, Pampanga. We gratefully acknowledge the First Gen Hydro Power Corporation (FGHPC) for providing financial resources and access to the sites to undertake this study, specifically Federico R. Lopez, Francis Giles B. Puno, Ernesto B. Pantangco, Dennis P. Gonzales, Maria Christine T. Mapanao, Janice O. Dugan, Jose E. Jamito; and Richard B. Tantoco, Agnes C. De Jesus of Energy Development Corporation (EDC) for permission to use the images from their *Rafflesia* book; Josemaria M. Fuentes, Jay S. Fidelino, and Alyssa M. Fontanilla for compiling the images for Figure 1; Willardo A. Reyes, who found the first specimens, Carlo A. Tagudin, DSRF and FGHPC staff, and local field guides for assistance in the field work and other logistic support.

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PhytoKeys 61: 47–59 (2016)
doi: 10.3897/phytokeys.61.7590
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Four new orchid species from the Lengguru fold belt, West Papua, Indonesia

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Academic editor: *L. Peruzzi* | Received 23 December 2015 | Accepted 26 January 2016 | Published 25 February 2016

Citation: Juswara L, Schuiteman A, Droissart V (2016) Four new orchid species from the Lengguru fold belt, West Papua, Indonesia. PhytoKeys 61: 47–59. doi: 10.3897/phytokeys.61.7590

Abstract

Bulbophyllum leucoglossum, *Dendrobium centrosepalum*, *Dendrobium taeniocaule*, and *Taeniophyllum pyriforme* are here described as new species, based on herbarium specimens collected from the Lengguru fold-and-thrust belt in the West Papua Bird's neck, Indonesian New Guinea. All four novelties were found growing in submontane forest (elevation > 1000 m a.s.l.) on limestone karst. Information concerning the distribution and habitat for these taxa is provided along with diagnostic features, line drawings, high resolution photographs, and a map of collecting localities. More field studies are required to find additional populations of these new species, in order to better characterize their habitat, ecology and conservation status.

Abstract (Indonesian)

Bulbophyllum leucoglossum, *Dendrobium centrosepalum*, *Dendrobium taeniocaule*, dan *Taeniophyllum pyriforme* dideskripsikan sebagai jenis baru, dari spesimen herbarium yang dikoleksi dari beberapa lokasi di Lengguru, yang terletak di leher burung Papua Barat, Niugini-Indonesia. Empat jenis baru tersebut tumbuh di hutan submontana (ketinggian > 1000 mdpl) di wilayah tanah kapur. Informasi distribusi dan habitatnya disampaikan dalam tulisan ini lengkap dengan informasi karakter diagnosa, gambar pensil, foto, serta peta lokasi pengkoleksiannya. Penelitian lapangan selanjutannya masih diperlukan untuk mengetahui kondisi populasi jenis-jenis tersebut agar diperoleh informasi selengkapnya yang berhubungan dengan habitat, ekologi, dan status konservasinya.

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Abstract (French)

Bulbophyllum leucoglossum, *Dendrobium centrosepalum*, *Dendrobium taeniocaule* et *Taeniophyllum pyriforme* sont décrits et illustrés, sur base de spécimens d'herbier collectés dans la zone de plissement et de chevauchement de Lengguru, dans la moitié occidentale indonésienne de l'île de Nouvelle-Guinée. Ces quatre nouveautés taxonomiques ont toutes été découvertes dans des forêts karstiques submontagnardes (altitude > 1000 m). Les informations concernant la distribution et l'habitat de ces espèces sont fournies avec leurs diagnoses, des dessins, des photographies à haute résolution, ainsi qu'une carte des localités inventoriées. Des études de terrain complémentaires sont nécessaires pour trouver des nouvelles populations pour ces espèces, afin de mieux caractériser leur habitat, leur écologie et leur statut de conservation.

Keywords

Bulbophyllum, *Dendrobium*, Kaimana Regency, Kumawa Forest Reserve, limestone karst, Orchidaceae, *Taeniophyllum*, Triton Bay

Introduction

Indonesia has been classified as a megadiverse country (Mittermeier et al. 1997), and is estimated to house approximately 10% (30,000 species) of the botanical diversity of the world (World Resources Institute et al. 2005). The country is composed of over thirteen thousand islands lining the equator. The largest island, New Guinea, is also known to harbour one of the richest orchid floras in the world, only surpassed by Colombia, Ecuador, and Peru (Schuiteman and de Vogel 2007). Ormerod (2014) recorded c. 2870 species of orchids from New Guinea, 11% of the world's orchid flora, of which about 95 percent are endemic to the island (Schuiteman et al. 2001-2010). Considering that large parts of New Guinea still have low collecting densities, it is likely, as also suggested by Ormerod, that many species still await discovery here.

The island has a complex geological history, related to the tectonics of the Indo-Australian and Pacific plates. The Lengguru fold-and-thrust belt (Bailly et al. 2009) was formed by the collision of the Australian and Pacific plates, and is characterized by a series of parallel and oblique folds separated by deep valleys, which link the high mountains of the Central Range of western Papua to the moderately high mountains of the Bird's neck. According to Vollering et al. (2016), the orchid species diversity in this part of New Guinea, which at present has a very low collecting density, is predicted to be relatively low, compared to the high diversity of the Eastern Highlands and Chimbu provinces of Papua New Guinea. This prediction was based on species distribution modelling using occurrence records of 532 species and spatial environmental data. It will be interesting to see if the prediction holds up once the area is better known botanically.

In October–November 2014, the first and the last authors took part in the Lengguru 2014 scientific expedition (www.lengguru.org). One of the main objectives of this multidisciplinary research programme was to make a rapid but wide-ranging assessment of the botanical diversity in a major Papuan karst region. The ultimate goals are to generate species plant checklists for this poorly sampled area, and to incorporate these data into a regional database to further analyse plant distribution patterns at different scales.

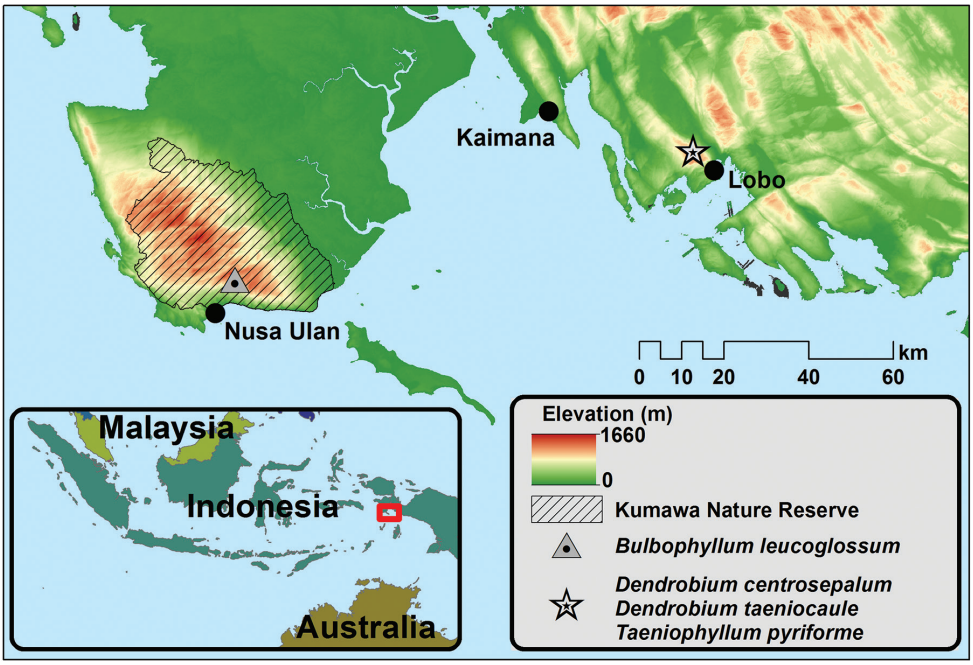

Figure 1. Main localities sampled during Lengguru 2014 expedition and distribution of the four new species in West Papua, Indonesia.

During the Lengguru expedition, we sampled 26 different sites in the limestone karst landscape (primarily swamp forest, mature lowland forest, alluvial forest, and submontane forest) from the sea shore to the top of the anticlines at around 1500 m elevation, in three main localities: Lobo village, Triton Bay; Urisa village, Arguni Bay; and Nusa Ulan, Kumawa Forest Reserve (Fig. 1). We gathered 72 fertile/flowering orchid specimens and associated material (pictures, silica-gel samples). We also collected living orchid specimens, which are now being cultivated in the Kebun Raya, Bogor (West Java) and in the Wamena Biological Gardens (Papua). Detailed examinations and comparisons with nomenclatural types of related species present in New Guinea, allowed us to identify four new species in the genera *Bulbophyllum* Thouars, *Dendrobium* Sw., and *Taeniophyllum* Blume. These novelties are described in the present paper, complemented with line drawings, photos, and information on habitats and distribution. As far as we now know, all four new species are endemic to the submontane forests of the Lengguru fold belt, at elevations above 1000 m.

Materials and methods

Most orchid collections from the Lengguru expedition were preserved in Copenhagen mix (ethanol 70% and 5% glycerol). Specimens are deposited mainly in BO, with

some duplicates in MAN, K, P and L (herbarium acronyms according to Thiers, continuously updated). Measurement and drawing of vegetative and reproductive parts were made on liquid preserved specimens, using a Wild Heerbrugg Switzerland Type 308700 stereo microscope. Additional data such as colour, habitat or ecology are mainly derived from field notes and high resolution pictures taken during the expedition.

Taxonomic novelties

***Bulbophyllum* (section *Codonosiphon* Schltr.) *leucoglossum* Schuit., Juswara & Droissart, sp. nov.**
urn:lsid:ipni.org:names:77153386-1
Figs 2A, 3A–D

Diagnosis. Similar to *Bulbophyllum pyroglossum* Schuit. & de Vogel because of the hinged lip and the hair-like appendages on the surface of the lip, but in that species the appendages are about four times longer, and they are discrete, subulate projections arranged in rows, not forming densely lacerate-fimbriate keels as in *B. leucoglossum.* Moreover, *B. leucoglossum* has two lamellae on the abaxial (concave) side of the lip; these are lacking in *B. pyroglossum*. The latter also has much broader and shorter petals, and an orange instead of a white lip.

Type. Indonesia, West Papua Province, Kaimana Regency, Nusa Ulan village, Pegunungan Kumawa Nature Reserve, 04°0.3121'S, 133°5.1227'E, 15/11/2014, *Droissart & Juswara 1789* (holotype: BO!, spirit material).

Description. Epiphytic *herb*. *Rhizome* short, creeping; *roots* wiry, branching, 0.5 mm diam. *Pseudobulbs* closely spaced, light green, narrowly ovoid, 2.0–2.4 × 0.7–0.8 cm, with c. 10 longitudinal grooves, 1-leaved. *Leaf* deeper green, linear-elliptic, gradually narrowed towards the base, 8.8–10.3 × 1.3–1.4 cm, thin-coriaceous, apex acute. Inflorescences arising from the base of the pseudobulb, becoming fascicled, erect, 1-flowered. *Peduncle* wiry, erect-patent, 1-flowered, 7–9 cm long, glabrous, with two tubular, 4 mm long peduncle-scales. *Floral bract* tubular, strongly oblique, 4.5 mm long, apex acuminate. *Pedicel-with-ovary* terete, very slender, weakly 6-ribbed, almost straight or curved, c. 2.5 cm long, glabrous. *Flowers* opening widely, the sepals patent to reflexed; sepals and petals maroon; lip white, at base wine-red, basal part of the keels sulphur-yellow; column cream-colour tinged maroon, swollen basal part and foot light green; anther pale greenish. *Dorsal sepal* linear-oblong, 14.3 × 2.8 mm, 3-veined, apex acute. *Lateral sepals* free, obliquely linear-oblong, 13.4 × 3.3 mm, 3-veined, apex acute. *Petals* linear-oblong, slightly widened towards the base, glabrous, 2.6 × 0.8 mm, apex obtuse. *Lip* clawed, slightly mobile, attached to the column-foot by a 0.3 mm long, 0.4 mm wide ligament; claw in the basal half almost quadrangular, tapering towards the blade, 2.4 × 1.5 mm, glabrous, with erect, hemi-elliptic, lobe-like margins in the basal half; blade narrowly oblong, slightly tapering towards the apex, cucullate, strongly convex above, 9.7 × 2.3 mm, margins deflexed, finely lacerate-fimbriate;

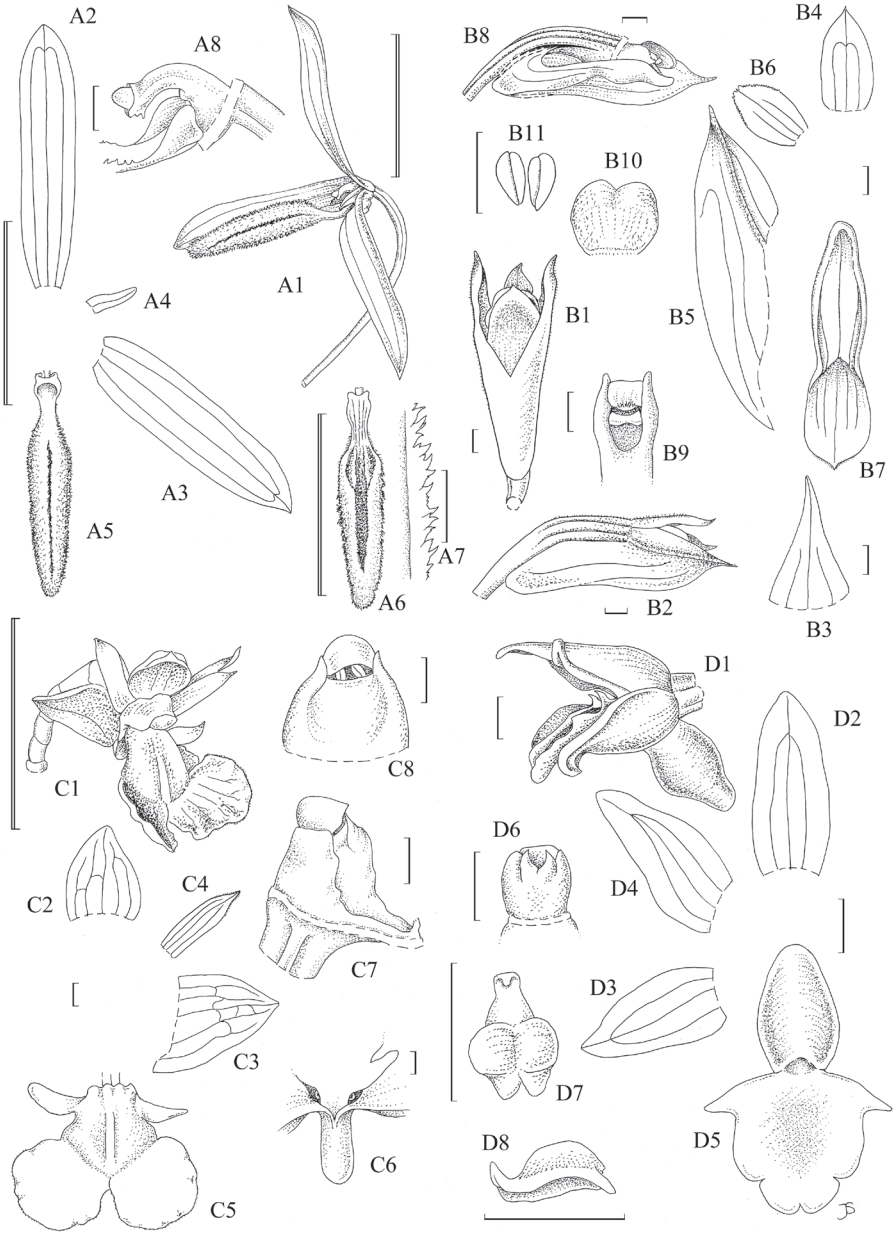

Figure 2. A *Bulbophyllum leucoglossum*: **1** flower **2** dorsal sepal **3** lateral sepal **4** petal; **5**, lip, adaxial view **6** lip, abaxial view **7** detail of crest on lip **8** column and base of lip; all after *Droissart & Juswara 1789*; **B** *Dendrobium centrosepalum*: **1** flower **2** flower, lateral view **3** floral bract **4** dorsal sepal **5** lateral sepal **6** petal **7** lip **8** flower, cut open **9** column **10** anther **11** pollinia; all after *Droissart & Juswara 1736*; **C** *Dendrobium taeniocaule*: **1** flower **2** dorsal sepal **3** lateral sepal **4** petal **5** lip **6** mentum **7** column, lateral view **8** column, ventral view; all after *Droissart & Juswara 1739*; **D** *Taeniophyllum pyriforme*: **1** flower **2** dorsal sepal **3** lateral sepal **4** petal **5** lip **6** column **7** anther, dorsal view **8** anther, lateral view; all after *Droissart &* Juswara 1735. Single scale bar = 1 mm; double scale bar = 1 cm. Drawing: Judi Stone.

blade adaxially with one median keel and two lateral keels on each side, the keels finely lacerate-fimbriate; on the concave abaxial side with two lacerate-fimbriate lamellae; apex obtuse. *Column* 2.3 mm long, curved, strongly swollen at the base, with a short but distinct, thick, 1 mm long column-foot; apical column-wings each with two short obtuse teeth, the wings 0.4 mm wide; *stigma* in lateral view with protruding lower margin; *anther* helmet-shaped, 0.6 mm long, very slightly papillose; *pollinia* not seen.

Distribution and habitat. *Bulbophyllum leucoglossum* is only known from the Lengguru fold belt in West Papua. It is currently recorded from a single location in the Kumawa Forest Reserve, near the village of Nusa Ulan (Fig. 1). The only population seen so far was found in submontane forest at 1005 m elevation, the plants growing epiphytically about 1.5 m from the ground on a slender, moss-grown, overhanging tree trunk in medium-sloping terrain. More than ten individuals were observed in the collecting locality, but only one was flowering at the time of our fieldwork (November).

Etymology. From the Greek *leuco-*, white, and *glossum*, tongue, referring to the largely pure white lip.

Notes. A distinctive species because of the five laciniate-fimbriate keels on the lip, which give it a hairy appearance. The only other known species in the large section *Codonosiphon* with a distinctly hairy-looking lip is *B. pyroglossum* Schuit. & de Vogel from Papua New Guinea, which is similar in plant habit and in the size of the flower. See the diagnosis for the main differences between the two species.

Dendrobium (section *Calyptrochilus* Schltr.) *centrosepalum* Schuit., Juswara & Droissart, sp. nov.

urn:lsid:ipni.org:names:77153387-1
Figs 2B, 3E–H

Diagnosis. The short and dense inflorescences with small, purple flowers and green-tipped, long-apiculate sepals resemble those of *Dendrobium purpureum* Roxb., a lowland species from Maluku and Sulawesi. However, the plant habit of the latter is completely different, as *D. purpureum* has robust, many-leaved, cane-like, tufted stems up to more than 50 cm long. Vegetatively, *D. centrosepalum* is more similar to *D. aurantiroseum* P.Royen ex T.M.Reeve from New Guinea, which also has unifoliate pseudobulbs on a creeping rhizome. However, the latter is a species from high elevations (2100–3350 m) with pink flowers that are about twice as large, while the sepals are not apiculate; in addition, the cross-ridge on the lip is situated below the middle in *D. aurantiroseum* and above the middle in *D. centrosepalum*.

Type. Indonesia, West Papua Province, Kaimana Regency, Lobo village, Triton Bay, 03°43.7962'S, 134°3.5962'E, 28/10/2014, *Droissart & Juswara 1736* (holotype: BO!, spirit material).

Description. Epiphytic *herb*. *Rhizome* creeping, c. 3 cm long, growing downwards; *roots* 0.5 mm diam. *Pseudobulbs* closely spaced, erect, green tinged purplish, oblongoid-fusiform, 1.3–1.5 × 0.4 cm; main internodes 3; irregularly 5-ribbed; 1-leaved at apex,

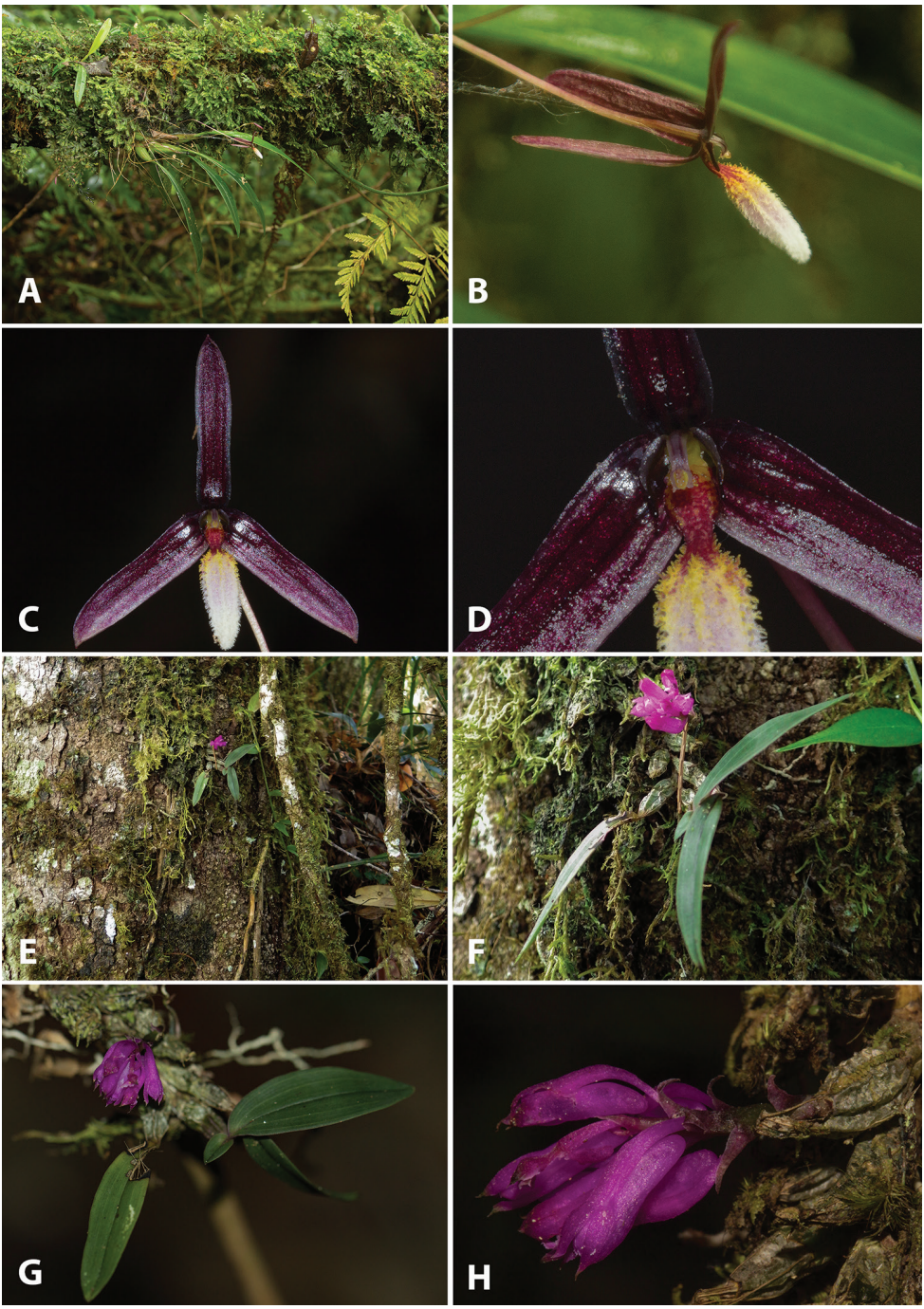

Figure 3. Photographs of living type specimens and habitats. *Bulbophyllum leucoglossum*: **A** habitat and habit **B** flower, side view **C** flower, front view **D** Flower close-up, showing details of the column and the labellum. *Dendrobium centrosepalum*: **E** habitat and habit **F, G** plant and inflorescence **H** inflorescence and flowers close-up. Photos: Vincent Droissart.

sometimes with a reduced additional leaf. *Leaves* glaucous green, deciduous, erect, narrowly elliptic, 3.3 × 1.1 cm; apex obtuse, minutely 3-dentate; margin smooth, slightly erose at apex; sheath very short. *Inflorescence* arising laterally from the upper internode of the leafless pseudobulb, erect, c. 12 mm long, c. 7-flowered; peduncle 5.2 mm long, covered by a few short scales in the basal part; rachis straight, 7 mm long. *Floral bracts* triangular, patent, 4.8 × 2.8 mm, apex acuminate, 3-nerved, glabrous. *Pedicel-with-ovary* narrowly clavate, c. 8.4 mm long, curved, with 5 rounded ribs, minutely papillose. *Flower* 10.5 mm long; sepals bright purple with greenish mucro; petals, lip and ovary bright purple. Sepals glabrous, but abaxially finely papillose on the slightly raised midvein; distinctly sharply apiculate at apex. *Dorsal sepal* ovate-oblong, 3.5 × 1.9 mm, 3-nerved; mucro 0.4 mm long. *Lateral sepals* obliquely narrowly ovate-oblong, much elongated in basal part, in total 10.8 × 2.8 mm, 4-nerved; mucro 0.9 mm long; mentum narrowly conical-cylindrical, 5.7 mm long, apex rounded, the closed apical part 4.8 mm long. *Petals* elliptic, 2.9 × 1.7 mm, emarginate, very shortly mucronate, 3-nerved, margin in upper half finely papillose. *Lip* when flattened subspathulate, 8.5 × 2.3 mm, at 5 mm above the base with a V-shaped transverse ridge, margins of the basal part adnate to the column-foot for 2.1 mm; apical part broadly elliptic, finely papillose along apical margin, apex rounded, minutely apiculate. *Column* rectangular, 1.9 mm long, wings truncate; foot 5.7 mm long; *stigma* semiorbicular, 0.8 mm wide, rostellum swollen, transversely oblongoid; *anther* cucullate-rectangular, 0.9 × 1.0 mm, minutely papillose, at base retuse, apex truncate and minutely erose; *pollinia* 0.7 mm long.

Distribution and habitat. *Dendrobium centrosepalum* is only known from the Lengguru fold belt in West Papua. It is currently known from a single locality in the Triton Bay area, near the village of Lobo (Fig. 1). The only population seen so far was found in submontane forest at 1114 m elevation, the plants growing epiphytically on a thick, vertical, moss-and-lichen-covered trunk of a tree.

Etymology. From the Greek *centron*, a sharp point, referring to the apiculate sepals.

Notes. The small, bright purple flowers in short and dense inflorescences superficially resemble those of such species as *D. dichaeoides* Schltr. and *D. limpidum* Schuit. & de Vogel, but these are quite different vegetatively, having elongate, leafy stems; in addition, in these two species the sepals are not sharply apiculate. See the diagnosis for additional comparisons.

Dendrobium (section *Brevisaccata* Kraenzl.) *taeniocaule* Schuit., Juswara & Droissart, sp. nov.

urn:lsid:ipni.org:names:77153388-1
Figs 2C, 4A–E

Diagnosis. Similar to *Dendrobium viridiflorum* F.M.Bailey in the flattened stems and the sympodially branching inflorescences with 1-flowered branches. The new species differs from *D. viridiflorum* in the relatively much shorter mentum (3.6 mm versus 7 mm long, with the free part of the lip being of about equal length in the two species),

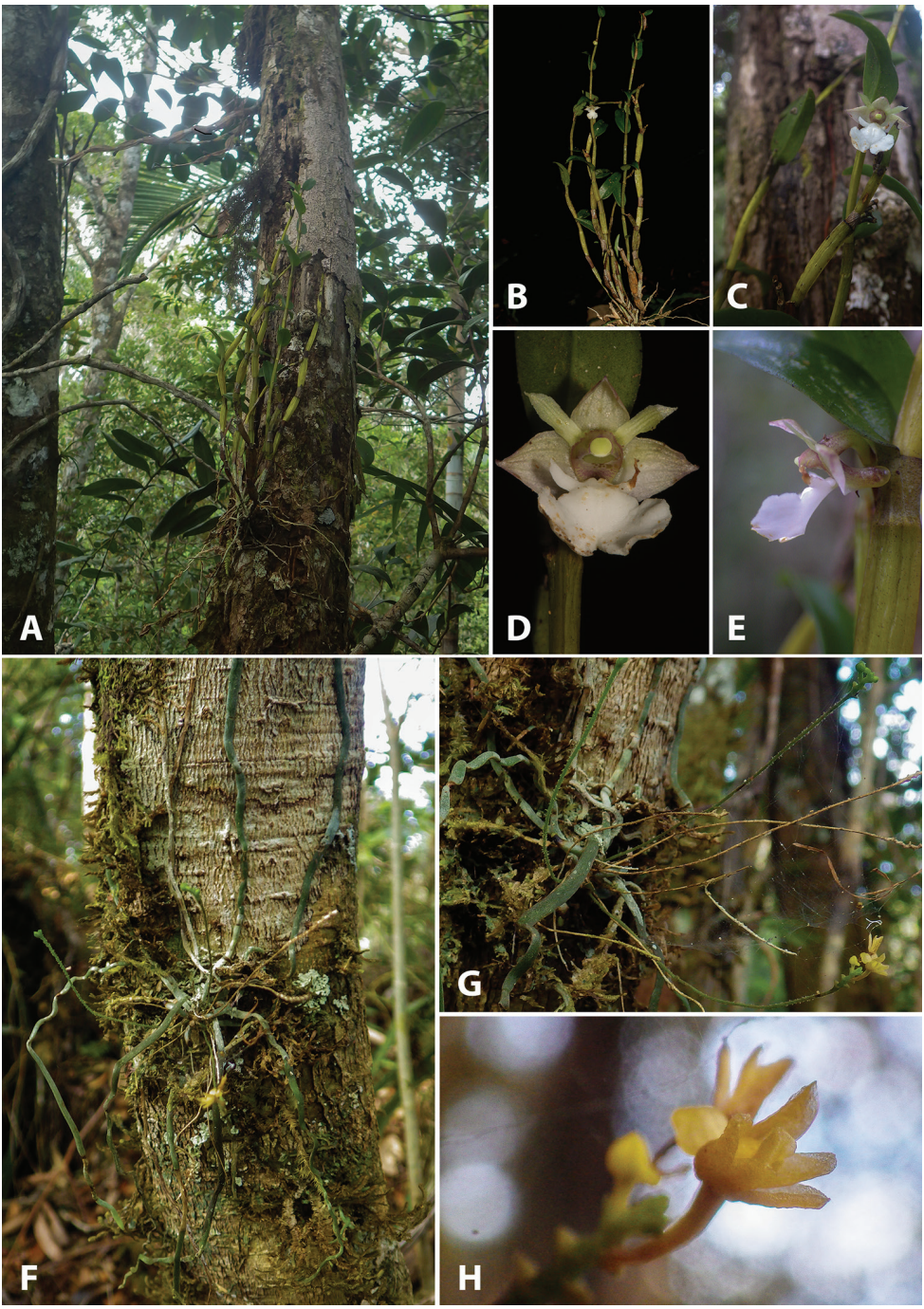

Figure 4. Photographs of living type specimens and habitats. *Dendrobium taeniocaule*: **A** habitat and habit **B** plant **C** flower and part of pseudobulb **D** flower, front view **E** flower, side view. *Taeniophyllum pyriforme*: **F** habitat and habit **G** plant and inflorescence **H** inflorescence and flowers close-up. Photos: Vincent Droissart.

the relatively much broader dorsal sepal, in the lip being wider than long (versus longer than wide), and especially in the much wider (8.5 versus 3.2 mm), bilobulate (versus entire) mid-lobe of the lip.

Type. Indonesia, West Papua Province, Kaimana Regency, Lobo village, Triton Bay, 03°43.7962'S, 134°3.5962'E, 28/10/2014, *Droissart & Juswara 1739* (holotype: BO!, spirit material).

Description. Epiphytic *herb*. *Rhizome* short, creeping; *roots* 1 mm diam., minutely verrucose. *Pseudobulbs* erect, yellowish green, elongate, bilaterally flattened, 16–21 × 0.4–0.5 cm; internodes 2.3–2.6 cm long, each internode narrowed towards the base; leafy throughout, except for two or three basal internodes; 6–8-leaved. *Leaves* deep green, long-lived, patent, oblong, 2.0–3.3 × 0.6–0.9 cm; apex unequally bilobed; sheath much shorter than the internode. *Inflorescence* arising from the apex of the internodes in the upper part of the stem, sympodially branching with age, with up to 3 branches, each branch 3–8 mm long, 1-flowered; peduncle c. 6 mm long, covered with scales in the basal part. *Floral bract* triangular, closely appressed, 2.9 mm long, apex apiculate. *Pedicel* 2.6 mm long ovary at right angles to the pedicel, 2.6 mm long, glabrous; at the base of the pedicel with an abortive rachis. *Flower* 10.3 mm high, glabrous; sepals greenish white, tinged pale purple abaxially and on the mentum; petals pale green; lip white; column pale green suffused with purple; anther pale green. *Dorsal sepal* broadly ovate, 4.1 × 3.3 mm, 5-nerved, obtuse. *Lateral sepals* obliquely broadly ovate, the free part 5.3 × 4.3 mm, 5-nerved, obtuse; mentum cylindrical, 3.6 mm long, apex rounded, the closed apical part 2.8 mm long. *Petals* linear-oblong, 4.4 × 1.2 mm, acuminate, 3-nerved, margin in upper third finely papillose. *Lip* 3-lobed, clawed, when flattened 6.7 × 8.5 mm excluding the c. 4 mm long, linear claw; lateral lobes subfalcate-oblong, patent, 2.7 × 1.0 mm; mid-lobe clawed, bilobulate (the whole lip appearing 4-lobulate), 5.7 × 8.5 mm; mid-lobe claw obtrapeziform, 1.7 × 4.4. mm; lobules of the mid-lobe rectangular-orbicular, 3.3 × 4.2 mm; the whole of the lip, except for the lateral lobes and the lobules of the mid-lobe, occupied by a sharply delimited swelling, which has two broad longitudinal crests with a narrow rib in between and which projects backwards over the claw of the lip for 0.3 mm. *Column* broadly conical in front view, 1.7 mm long, wings very short, truncate; foot 3.6 mm long; *stigma* large, 1.6 mm wide, rostellum a simple transverse ridge; *anther* cucullate-rectangular, 1.1 mm wide, glabrous; *pollinia* not seen.

Distribution and habitat. *Dendrobium taeniocaule* is only known from the Lengguru fold belt in West Papua. It is currently recorded from a single locality in the Triton Bay area, near the village of Lobo (Fig. 1). The only population seen so far was found in submontane forest at 1114 m elevation, the plants growing epiphytically on a vertical, lichen-covered trunk of a tree.

Etymology. From the Greek *taenia*, a band or strap, and *caulon*, stem; referring to the flattened, band-shaped pseudobulbs.

Notes. This species has only one obvious close relative, which is the widespread *D. viridiflorum*. Uniquely in section *Brevisaccata*, these two species share flattened stems and abbreviated inflorescences that produce up to 3, 1-flowered branches in succession

over a longer period. The other species in the section have terete stems and flowers produced simultaneously on elongate racemes. In addition to clear morphological differences, as indicated in the diagnosis, the two first-mentioned species also have different ecologies. While *D. viridiflorum* is exclusively found in mangroves and coastal forest below 200 m, *D. taeniocaule* occurs in submontane forest above 1000 m.

***Taeniophyllum* (section *Loboglossum* Schltr.) *pyriforme* Schuit., Juswara & Droissart, sp. nov.**
urn:lsid:ipni.org:names:77153389-1
Figs 2D, 4F–H

Diagnosis. Differs from all known species in sect. *Loboglossum* by the finely muricate peduncle and the hook-like basal lobules of the lateral lobes of the lip.

Type. Indonesia, West Papua Province, Kaimana Regency, Lobo village, Triton Bay, 03°43.7962'S, 134°3.5962'E, 28/10/2014, *Droissart & Juswara 1735* (holotype: BO!, spirit material).

Description. Leafless epiphytic *herb*. *Stem* very short; *roots* spreading, green, flattened, not branching, up to at least 35 cm long, 1.5–3 mm wide; some of the roots closely appressed to the bark of the phorophyte, others free hanging. *Inflorescences* c. 3 producing flowers at the same time, suberect, 5–6 cm long; peduncle filiform, 0.5 mm diam., rather sparsely muricate with c. 0.3 mm long projections; near the middle with a very small peduncle-scale; rachis distichous, glabrous, up to c. 16-flowered, with the flowers opening in succession, one or two at a time, gradually elongating, up to 11–14 mm long. *Floral bracts* cupular, in lateral view triangular, subacute, 1.2 mm long; successive bracts on the same side of the rachis 1.8 mm apart. *Flowers* apparently non-resupinate (always?), c. 5 mm high including the spur, glabrous, pale brownish yellow. *Dorsal sepal* ovate, 3.3 × 1.5 mm, obtuse, 3-veined. *Lateral sepals* somewhat obliquely ovate, 2.6 × 1.3 mm, obtuse; 3-veined; abaxially at the apex with a short lamella along the midvein. *Petals* obliquely ovate, 3.2 × 1.5 mm, obtuse, 3-veined. *Lip* spurred, 3-lobed, ecallose, margins erect to incurved, when flattened 2.7 × 3.2 mm; lateral lobes semi-oblong, rounded, 2.0 mm long from base of lip to base of mid-lobe, at the base with an erect, narrowly triangular-uncinate lobule; mid-lobe reniform, 0.7 × 1.2 mm, emarginate. *Column* short, cylindrical, 1.1 long, 1.0 mm wide, with a short, bidentate rostellum; *stigma* shallowly concave; *anther* cucullate, 0.9 cm long, 0.6 cm wide, apex rostrate, recurved; *pollinia* not seen.

Distribution and habitat. *Taeniophyllum pyriforme* is only known from Papua. It is recorded from a single locality near the village of Lobo in the Triton Bay (Fig. 1). The only population seen so far was found in submontane forest at 1114 m elevation, the plants growing epiphytically on a sparsely moss-covered tree trunk at 1.5 m above the ground.

Etymology. From the Latin *pyriforme*, pear-shaped, referring to the shape of the spur.

Notes. This inconspicuous but distinctive species would seem to fit best in section *Loboglossum*, on account of the clearly lobed lip, elongate inflorescence, distichous

rachis, and glabrous ovary. However, a muricate inflorescence has not been reported for this section before (although the otherwise very different *Taeniophyllum toranum* J.J.Sm. is described as having a furfuraceous-punctate peduncle and rachis, while the no less distinct *T. pulvinatum* is said to have a minutely glandulose peduncle). The basal, hook-like lobules on the lip are also unique.

It is likely that a large number of species of *Taeniophyllum* still await discovery in New Guinea. We believe this to be the case because most of the species are easily overlooked; the flowers often last only a day or less; and many of the known species are only recorded from the type. New Guinea is clearly the centre of diversity for this genus, with 130 species currently recorded.

Conclusions

The four new species described here demonstrate that, most likely, many new species still await discovery in poorly explored parts of New Guinea. Among our collections from the Lengguru area, 1 out of 8 species of *Bulbophyllum*, 2 of 22 *Dendrobium* species, and 1 of 2 *Taeniophyllum* species proved to be new to science, and 3 of these novelties were collected on the same day near Lobo village. This only represents species found in flower during our expedition, which is certainly a minority of the total orchid flora of the area.

The new species of *Bulbophyllum* and *Dendrobium* described here, while distinctive, do not present striking new features for these genera; they are easily classified among the known species. The new *Taeniophyllum*, on the other hand, appears to be without any obvious close relatives. This genus in particular warrants much more attention from scientific collectors and taxonomists; the diversity and phylogenetics of this genus are still poorly understood.

Acknowledgments

We thank the curators of BO and K for making their collections available and for the facilities offered to the authors. Fieldwork, laboratory activities and herbarium visits were supported by the Project Lengguru 2014 (www.lengguru.org), conducted by the French Institut de Recherche pour le Développement (IRD), the Indonesian Institute of Sciences (LIPI), the University of Papua (UNIPA), the University of Cendrawasih (UNCEN), the University of Musamus (UNMUS) and the Sorong Fisheries Academy (APSOR) with corporate sponsorship from COLAS Group, Veolia Water and the Total Foundation. Judi Stone prepared the line drawing based on sketches by André Schuiteman.

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PhytoKeys 61: 61–71 (2016)
doi: 10.3897/phytokeys.61.7017
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Taxonomy of Atlantic Central African orchids 5. A new species of *Angraecum* sect. *Conchoglossum* (Orchidaceae, Angraecinae) from Gabon and Cameroon

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Academic editor: *L. Peruzzi* | Received 30 October 2015 | Accepted 27 December 2015 | Published 25 February 2016

Citation: Ječmenica V, Droissart V, Noret N, Stévart T (2016) Taxonomy of Atlantic Central African orchids 5. A new species of *Angraecum* sect. *Conchoglossum* (Orchidaceae, Angraecinae) from Gabon and Cameroon. PhytoKeys 61: 61–71. doi: 10.3897/phytokeys.61.7017

Abstract

Recent field inventories and taxonomic research in Central Africa have resulted in the discovery of many new orchid species. Five specimens of an apparently new *Angraecum* species were collected in Gabon and Cameroon. They stand out for their hanging habit and short zig-zag stem. Morphology of leaves and habit is somewhat comparable to *A. cultriforme* and *A. stolzii,* two species from East Africa. Flowers of the novelty share the general morphology of *A. pyriforme* from which the new species is distinguished by being smaller and with a different lip-spur ratio. Here we show that these five specimens represent a new species, described here as *Angraecum lanceolatum*. The distinguishing traits include thin lanceolate leaves, convolute distally, with a rhombic lip shape. Dichotomous key to four Central African species of sect. *Conchoglossum* and a table of the diagnostic characters of the seven related Continental African *Angraecum* taxa are included here. A preliminary assessment of the conservation status of *A. lanceolatum* is provided, using the IUCN Red List Categories and Criteria.

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Résumé

Des travaux récents d'inventaires et de taxonomie ont abouti à la découverte de nombreuses espèces nouvelles d'orchidées en Afrique centrale. Cinq spécimens n'appartenant à aucune espèce d'*Angraecum* connue à ce jour ont été récoltés au Gabon et au Cameroun. Ces spécimens se distinguent par un port pendant et une tige courte disposée en zigzag. Leur morphologie foliaire et leur port sont proches de ceuxd'*A. cultriforme* et d'*A. stolzii,* deux espèces d'Afrique de l'Est. Les fleurs de cette nouveauté taxonomique présentent la morphologie générale d'*A. piriforme*, mais sont cependant plus petites et présentent un rapport différent de la longueur du labelle sur celle de l'éperon. Nous montrons ici que ces cinq échantillons représentent une nouvelle espèce, décrite sous le nom d'*Angraecum lanceolatum*. Les traits distinctifs de ce nouveau taxonsont ses feuilles minces, lancéolées et tordues à l'apex, ainsi que la forme du labelle en losange. Une clé dichotomique des quatre espèces de la section *Conchoglossum* présentes en Afrique centrale et une table des caractères diagnostiques des six taxons proches d'*A. lanceolatum* présents en Afrique continentale sont proposées. Le statut de conservation d'*A. lanceolatum* est évalué selon la méthodologie de la Liste Rouge de l'UICN.

Keywords

Angraecoid, Campo-Ma'an National Park, Ivindo National Park, Monts de Cristal National Park, IUCN Red List Categories and Criteria

Introduction

According to the latest count of WCSP (Govaerts et al. 2015), the genus *Angraecum* Bory comprises 223 species. With 173 species recorded in the Malagasy region (Govaerts et al. 2015), Madagascar and the Mascarenes are considered as the centre of diversity of *Angraecum*. Nevertheless, Central Africa also shows a high orchid diversity and endemism rate (Stévart 2003, Droissart 2009) where many new species remain to be described. A cultivation system established in São Tomé, Gabon, Equatorial Guinea and Cameroon by Stévart (2003) and his collaborators has allowed collection of thousands of flowering specimens. This has enabled taxonomic revisions of several orchid genera (Verlynde et al. 2013, Simo-Droissart et al. 2014) and the description of more than 25 new orchid taxa (e.g. Droissart et al. 2014, Stévart et al. 2014, D'Haijere et al. 2015), many of which still remain to be published.

A revision of *Angraecum* species belonging to sections *Afrangraecum* Summerh. and *Conchoglossum* Schltr. was conducted by the first author in 2015. A careful examination of specimens from main herbaria has confirmed the status of five new species, of which one is described here.

The first collection of the new species originates from Mont Seni in the Monts de Cristal National Park in Gabon (IUCN Category II National Park). This specimen was collected by Nguema Miyono (*N. Miyono 2037*) in 2001 and deposited in BRLU and LBV (abbreviations after Thiers continuously updated). Unfortunately, the material was sterile and identified as *Angraecum angustipetalum* Rendle. A few years later, during fieldwork in the Ivindo National Park in Gabon, a living plant of the same species was collected by Diosdado Nguema. The specimen was sent to the garden of

M. Biteau (Jardi-Gab, Libreville) who cultivated it in his shade-house under number *BTO23*. Since then, the plant has produced three flowering specimens (*D. Nguema s.n.*, *JBB 244* and *JBB 263*) after which it died. Following examination of the three flowering specimens and the living plant (*BTO23*), Stévart considered it as a potentially new species. Finally, fieldwork conducted in Cameroon by Droissart in February 2015 enabled another collection of that new species (*Droissart* et al. *1874*). The specimen was collected in the Campo-Ma'an National Park (South Region of Cameroon) and cultivated in Yaoundé shade-house under number *Y 5652 NY* where it flowered in June 2015. Comparison of these five specimens with the type material of related *Angraecum* species confirmed that these specimens represent a new species, described here as *Angraecum lanceolatum*.

This paper is the fifth in a series of publications (Stévart et al. 2010, Droissart et al. 2014, Stévart et al. 2014, D'Haijere et al. 2015) based on recent intensive fieldwork and focusing on collections-based taxonomic revisions of Orchidaceae in Atlantic Central Africa.

Material and methods

This study was conducted under the framework of the first author's Master's thesis. A revision including 109 specimens from all *Angraecum* species belonging to sections *Afrangraecum* and *Conchoglossum* was undertaken. Collections of BR, BRLU, K, WAG, MA, MO, P and YA were examined and did not reveal any additional specimens of the new species. Description of the new species is based on five spirit preserved specimens originating from Gabon and Cameroon. The terminology used for description followed Systematics Association Committee for Descriptive Biological Terminology (1962a, 1962b), *Botanical Latin* (Stearn 1992) and *The Kew Plant Glossary* (Beentje 2010). Two living specimens of the new species were collected by teams of the Missouri Botanical Garden (MBG) and the Institut de Recherche pour le Développement (IRD) during fieldwork in Gabon and Cameroon. Sterile material collected in the field was grown in the shade-houses until obtaining flowered specimens preserved as spirit collections. Colour and habit characteristics given are based on the field data and high resolution photographs. Additional photographs, measurements and morphological study of spirit material were carried out using an optic microscope Zeiss STEMI SV11.

A preliminary risk of extinction assessment was made using the IUCN Red List Categories and Criteria (IUCN 2001, 2014). Georeferenced specimen data were imported into GIS to calculate area of occupancy (AOO) and extent of occurrence (EOO). The cell size for AOO was set 2 × 2 km as recommended by IUCN (2014). Each locality was regarded as a separate subpopulation. The number of 'locations' (as defined by IUCN 2014) was calculated with regard to the kind of threats, such that a single 'location' may encompass more than one adjacent population.

Taxonomic treatment

Angraecum lanceolatum **Ječmenica, Stévart & Droissart, sp. nov.**
urn:lsid:ipni.org:names:77153391-1
Figs 1, 2

Diagnosis. *Angraecum lanceolatum* is close to *A. stolzii* Schltr. (1915) but differs from it by shorter narrowly ovate leaves that convolute in the distal half, by a shorter zig-zag stem and by a rhombic lip shape. The species also resembles *A. cultriforme* Summerh. (1958) but differs from it by smaller flower size and slightly curved spur. *Angraecum lanceolatum* is also close to *A. pyriforme* Summerh. (1936) in the shape of floral parts, but differs from it by previously stated vegetative characters, hanging habit, single-flowered inflorescence and smaller flower.

Type. Cameroon. South Region of Cameroon, Campo-Ma'an National Park, nearby villages of Ebianemeyong and Nyabissan, 02°29.2488'N, 010°19.9026'E, 14 Feb 2015, *V. Droissart, T. Couvreur & N. Kamdem 1874* (holotype: BRLU!; isotype: YA!).

Description. Small epiphytic herbaceous plant. Stem hanging, slightly zig-zag in form, unbranched, up to 8.5 cm long. Leaves alternate, spaced, narrowly ovate to lanceolate, sometimes slightly falcate and always convolute in the distal part, margins entire; distinct midvein forming slight channel, accompanied with 2 or 3 nerves on each side merging into one throughout; small stomata spots visible in young leaves; leaf apex unequally bilobed, acuminate, with the larger lobe 1.5–2.8 mm long and the smaller 0.3–1.2 mm long, leaf blade 2.3–4.1 × 0.6–0.9 cm; leaf internode about 5–6 mm long. Inflorescence single flowered, eventually two-flowered; peduncle elongated 13–23 mm long, opposite to the leaf at the node. Bracts acute, 2 mm long. Flowers white, opening diameter about 12.5 mm. Ovary and pedicel not resupinate, 8 mm long. Dorsal sepal 6.2–8.5 × 3 mm, elliptic, acute, thick, with entire margins. Lateral sepals 6–7 × 2–2.2 mm, elliptic, acute, thick, with entire margins. Petals 5–6.5 × 2–2.2 mm, obliquely elliptic, acute, entire margins, similar in shape to lateral sepals. Lip 5–6 × 4.5–5 mm, concave, rhombic when flattened, widest between first third and the half, acute; spur 16–19.5 mm, cylindric, slender, straight, somewhat elliptically inflated and greenish at the apex. Column 1.5 × 2 mm. Pollinia 2, pyriforme. Fruit capsule, 18–24 × 3.5–5 mm.

Additional specimens. Gabon. Monts de Cristal National Park. Mont Seni, 13 Sept 2001, *Nguema Miyono 2037* (LBV, BRLU!); Ivindo National Park, near Langoué Bai, 17 Sept 2005, *D. Nguema s.n.* (BRLU!); ibid., *J.P. Biteau 263* (BRLU!); ibid., *J.P. Biteau 244* (BRLU!).

Distribution and habitat. Endemic to the Lower Guinea Domain (Cameroon and Gabon, Fig. 3). The specimen collected in Cameroon was found at 850 m elevation in submontane forest with *Gilbertiodendron unijugum* (Pellegr.) J. Léonard (Fabaceae). The plant was epiphyte at about 1.5 m from the ground, on the trunk of a shrub with a diameter less than 10 cm.

Phenology. Flowering occurs in June and September.

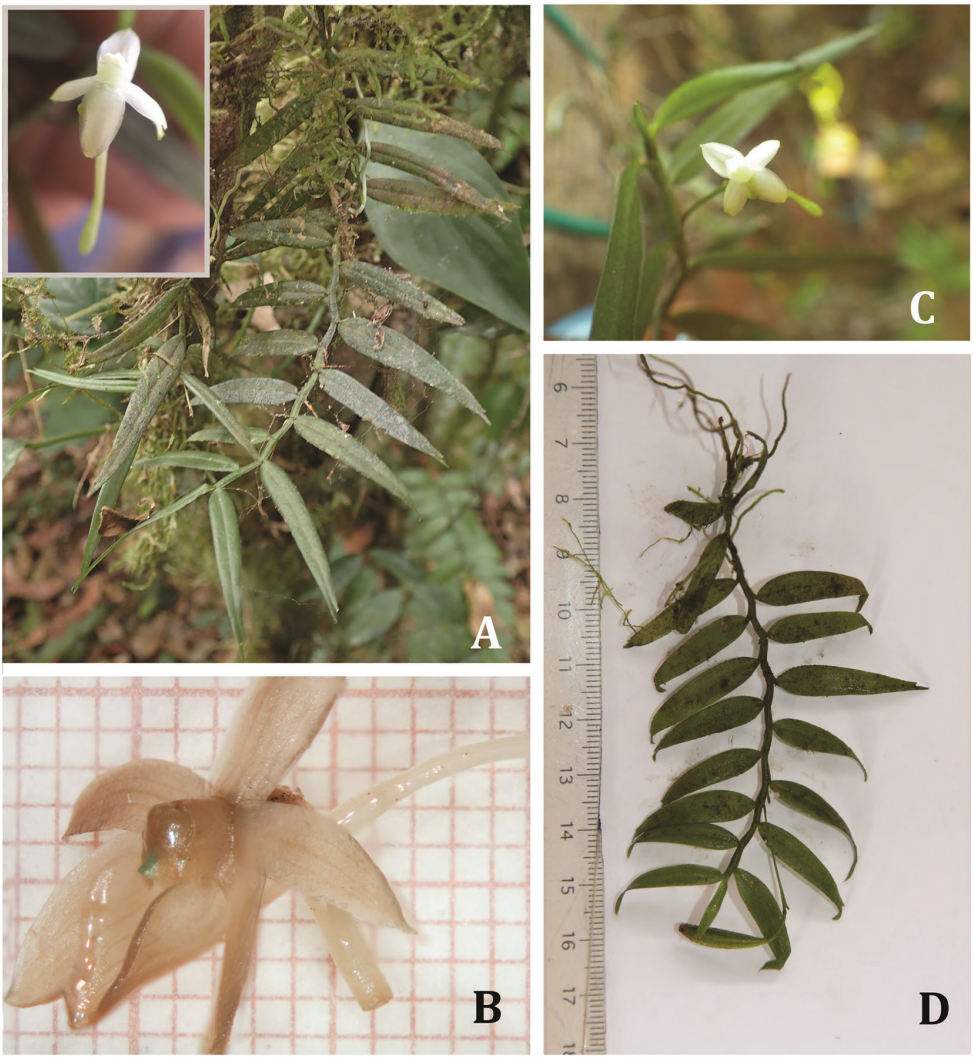

Figure 1. Photographs of living specimen of *Angraecum lanceolatum* (**A, C, D** *V. Droissart* et al. *1874* **B** *J.P. Biteau 263*): **A** habit and top view of the flower **B** half front view of the flower (from spirit material) **C** inflorescence and flower **D** habit and peduncle with fruit. Photographs taken by: **A, D** V. Droissart; **B** V. Ječmenica; **C** G. Kamdem.

Conservation. IUCN Red List category: Least Concern [LC]. The extent of occurrence (EOO) of *Angraecum lanceolatum* is estimated to be over 23,884 km^2, exceeding the 20,000 km^2 upper limit for Vulnerable status under the criterion B1, whereas its area of occupancy (AOO) is estimated to be 12 km^2 (which falls within the limits for Endangered status under the criterion B2). The species is now known from three subpopulations in Gabon and Cameroon. These three subpopulations represent three different locations (sensu IUCN 2014), less than five locations, which is the up-

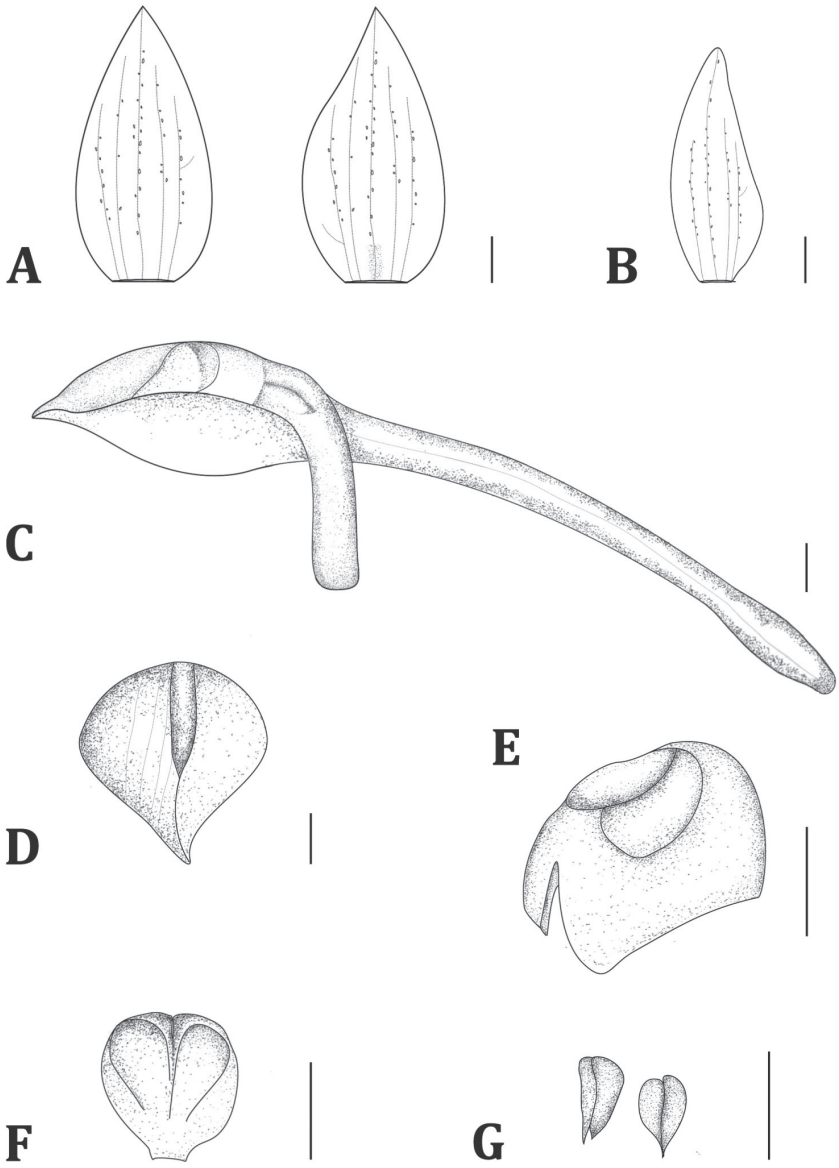

Figure 2. *Angraecum lanceolatum*: **A** Sepals **B** Petal **C** Lip, column, ovary and pedicel, spur **D** Lip, flattened, overhead view **E** Column without anther cap **F** Anther cap **G** Pollinia. Bars represent 1 mm. Illustration of specimen *D. Nguema s.n.* by Danka Ječmenica and Vladimir Ječmenica.

per limit for Endangered status under the subcriterion 'a' of criterion B2. *Angraecum lanceolatum* has only been collected in protected areas (Monts de Cristal and Ivindo National Parks in Gabon and Campo-Ma'an National Park in Cameroon). None of

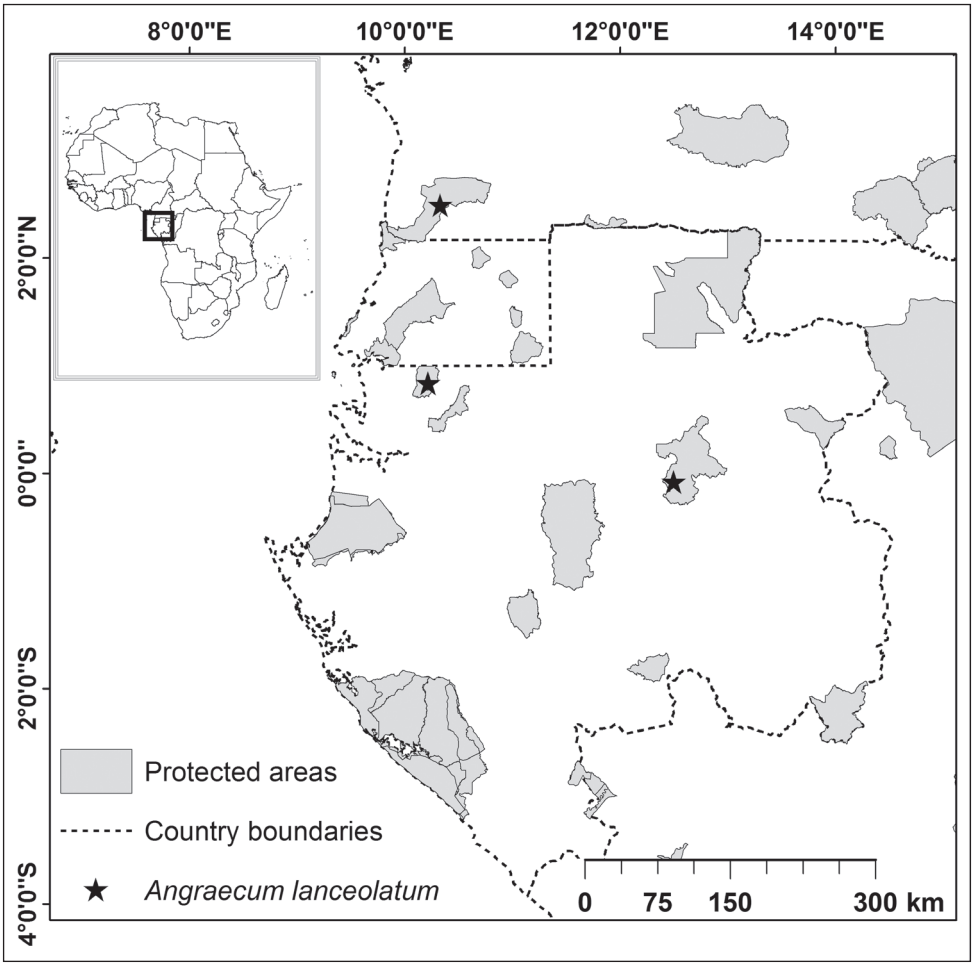

Figure 3. Distribution of *Angraecum lanceolatum* in tropical Africa.

these protected areas is under threat and they appear well managed. *Angraecum lanceolatum* is thus not threatened. The available information suggests that the number of subpopulations and mature individuals, as well as its EOO and AOO, will not decrease noticeably in 10 years or 3 generations the future. Application of the IUCN criteria therefore indicates that it cannot be regarded as Endangered despite the fact that its AOO is limited. *Angraecum lanceolatum* is therefore assigned a preliminary status of LC.

Etymology. The specific epithet of the new species owes to the particular leaf shape. Even though there are several interpretations of "lanceolate" shape according to different authors (Linnaeus, Lindley), we relied on the current depiction from Beentje (2010) that describes it as narrowly ovate and tapering to a point at the apex.

Table 1. Morphological comparison of characters for seven related continental African *Angraecum* species. All species belong to section *Conchoglossum* except for *A. pyriforme*, which is a member of section *Afrangraecum*. Diagnostic characters are indicated in bold.

Taxa	Distribution	Stem size	Leaves	Peduncle	Sepals	Petals	Lip	Spur
Angraecum stolzii Schltr.	Democratic Republic of the Congo, Tanzania, Malawi, Zambia	15.5–40 cm	5.6–8 × 0.5–0.9 cm **linearly falcate**, acuminate apex	1.3–2.2 cm	Elliptic, **acuminate, lateral falcate**, 4–7.3 mm × 1.8 mm	Elliptic, acuminate, **3–6.2 × 1.3 mm**	**Ovate**, acute, **3–5.5 × 2–2.5 mm**	Straight or slightly curved, elliptic apical inflation, **2.5–4.6 mm long**
Angraecum egertonii Schltr.	Nigeria, Cameroon, Gabon	10–22cm	2.7–4 × 1.5–1.9 cm **ovate**, acute apex	2–4 cm	Elliptic, **acute, lateral sometimes falcate**, 8–12.8 × 2–4 mm	**Elliptic to falcate**, acute, 7.5–11.5 × 1.5–2.5 mm	Elliptic to ovate, acute, 7–11 × 2.5–4.5 mm	Bent upwards with **circular apical inflation**, 6.5–8.5 mm long
Angraecum pyriforme Summerh.	Ivory Coast, Nigeria	8–11 cm	7–11 × 1–2.2 cm narrowly elliptic, **obliquely round apex**	2–4 cm	Elliptic, **acute, 7–11 × 2.5–4 mm**	**Obliquely elliptic**, acute, **6.5–8.5 × 1.5–4 mm**	**Rhombic, acuminate**, 6–7.5 × 4–4.5 mm	Straight with elliptic apical inflation, **10.5–15 mm long**
Angraecum lisowskianum Szlach. & Olsz.	Nigeria, Cameroon, Equatorial Guinea	7.5–11 cm	1.7–2.65 × 0.7–1.1 cm elliptic, **subacute apex**	0.7–1.8 cm	Elliptic, **acute, lateral subfalcate**, 6–10.5 × 1.5–3 mm	Elliptic, acute 7.5–9.5 × 1–2.2 mm	Elliptic to ovate, acuminate 6.5–8.5 × 4 mm	Straight with elliptic apical inflation, **15–21.5 mm long**
Angraecum cultriforme Summerh.	Kenya, Tanzania, Malawi, Mozambic, Zambia, Zimbabwe, KwaZulu-Natal	8–15 cm	3.7–6 × 0.4–0.8 cm **elliptic to linearly falcate**, acute apex	1.5–3 cm	Elliptic, **acuminate, 12.5–18 × 2.3–3 mm**	Elliptic, acuminate, **11–15 × 2–2.5 mm**	**Ovate**, acuminate, **10–14 × 6 mm**	Straight, **slightly ascending** with elliptic apical inflation, **20–26 mm long**
Angraecum lanceolatum	Cameroon, Gabon	Up to 8.5 cm	2.3–4.1 × 0.6–0.9 cm **narrowly ovate to lanceolate**, acuminate apex	1.3–2.3 cm	Elliptic, **acute, 6–8.5 × 2–3 mm**	**Obliquely elliptic**, acute, **5–6.5 × 2–2.2 mm**	**Rhombic, acute, 5–6 × 4.5–5 mm**	Irregularly straight with elliptic apical inflation, **16–19.5 mm**
Angraecum moandense De Wild.	Ghana, Republic of Guinea, Ivory Coast, Liberia, Nigeria, Togo, Central African Republic, Cameroon, Republic of the Congo, Gabon, Gulf of Guinea Islands, Rwanda, Democratic Republic of the Congo, Tanzania, Uganda	6–15 cm	4.2–9.2 × 0.7–1 cm **oblong**, round apex	0.6–3.5 cm	Elliptic, **acuminate**, 8–15.5 × 2–3.5 mm	Obliquely linear to elliptic, **acuminate, 8–14 × 1–2.5 mm**	Elliptic to slightly ovate, **acuminate to cuspidate**, 8–11.5 × 2.5–3.5 mm	**S-shaped** with occasionally slightly cylindrically inflated apex, 14–26 mm long

Taxonomic key to section *Conchoglossum* species from Central Africa

1a Leaves oblong; spur sigmoid, apex not or rarely slightly cylindrically inflated ... ***A. moandense***

1b Leaves not oblong; spur straight or slightly curved, apex inflated **2**

2a Leaves broadly ovate; spur apex circularly inflated..... ***A. egertonii***

2b Leaves narrowly ovate, lanceolate or elliptic; spur elliptically inflated..... **3**

3a Leaves very fleshy, broadly elliptic, up to 2.7 cm long; lip elliptic to ovate .... ***A. lisowskianum***

3b Leaves thin, narrowly ovate to lanceolate, distally convolute up to 4.1 cm long; lip rhombic ..... ***A. lanceolatum***

Notes

The diagnostic characters of species from Central African region that belong to the section *Conchoglossum,* as well as one morphologically related species of the section *Afrangraecum* are summarized (Table 1). Morphometric results of the mentioned Master's thesis and molecular data on *Angraecum* (Stévart unpublished) confirmed the status of the new species. Vegetative morphology and habit of the new species resemble *Angraecum stolzii* Schltr. in having single flowered inflorescence and sometimes slightly falcate leaves. Large and small leaf apex lobes are not prominent as in *A. stolzii*, in which the larger lobe reaches at least 10 mm, comparing to a maximum of 2.5 mm in *A. lanceolatum*. Spur is similar in shape but in the new species it is at least three times longer than the lip, while the flower in *A. stolzii* has approximately equal spur and lip lengths.

Floral morphology, particularly the lip shape of new species is similar to *A. pyriforme* Summerh. from the sect. *Afrangraecum*. Nevertheless, ratio between lip and spur lengths is close to 1:3 in the new species compared to 1:2 in *A. pyriforme*. Additionally, the new species has a distinctive habit.

The novelty is a representative of *Conchoglossum* section according to Stewart et al. (2006, see also Summerhayes 1958, *Angraecoides* sensu Garay 1973), due to its continental distribution and its white single flowered inflorescence.

Acknowledgments

We express our gratitude to the curators of several herbaria (BR, BRLU, K, L, LBV, MA, MO, P and YA) for making available their collections and for facilities kindly provided to the authors. We would like to thank Jean-Philippe Biteau, Gyslène Kamdem and Sandrine Mayogo for collecting specimens from living material in Libreville and Yaoundé shade-houses, and Diosdado Nguema for collecting the living plant in the Ivindo National Park in Gabon.We express our sincere gratitude to Dr Nestor Engone Obiang, Head of the National Herbarium of Gabon, to Prof. Henry Bourobou, Head

of IPHAMETRA (CENAREST), to Jean-Philippe Biteau (Jardi-Gab), to Prof. Bonaventure Sonké, Head of Plant Systematics and Ecology Laboratory (University of Yaoundé I), and to Benjamin Sock, conservator of Campo Ma'an National Park, for the facilities offered to the authors. We would like to thank the Agence Nationale des Parcs Nationaux du Gabon (ANPN) and Ministry of Forests and Wildlife in Cameroon (MINFOF) for allowing us to work in the Ivindo and Campo Ma'an National Parks, respectively. Fieldwork in Gabon was undertaken under the Memory of Understanding between the Centre National de la Recherche Scientifique et Technologique (CENAREST) and the Missouri Botanical Garden (MBG). Fieldwork, laboratory activities and herbarium visits were supported by the U. S. National Science Foundation (1051547, T. Stévart as PI, G. M. Plunkett as Co-PI).

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PhytoKeys 61: 73–80 (2016)
doi: 10.3897/phytokeys.61.7904
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RESEARCH ARTICLE

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Circumscription and synopsis of *Eugenia* section *Speciosae* Bünger & Mazine (Myrtaceae)

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Academic editor: *P. de Lange* | Received 25 January 2016 | Accepted 4 February 2016 | Published 25 February 2016

Citation: Bünger MO, Mazine FF, Lucas EJ, Stehmann JR (2016) Circumscription and synopsis of *Eugenia* section *Speciosae* Bünger & Mazine (Myrtaceae). PhytoKeys 61: 73–80. doi: 10.3897/phytokeys.61.7904

Abstract

A new section of *Eugenia* (Myrtaceae) is described, segregate from *Eugenia* sect. *Phyllocalyx*. Phylogenetic studies suggest that *Eugenia* sect. *Phyllocalyx* as traditionally delimited is paraphyletic. To maintain the monophyly of each of the sections in *Eugenia s.l.,* we herein opt to circumscribe a new section and recognize six taxa in sect. *Speciosae*, which has a distribution mostly in southeastern Brazil and northern South America. Nomenclatural notes are made and a taxonomic key is provided for the species of the section.

Keywords

Amazon Forest, Atlantic Forest, Neotropics, Myrteae

Introduction

Eugenia Linnaeus is a widespread tropical genus with about 385 species in Brazil (Govaerts et al. 2014, Sobral et al. 2015), most of which grow along the Brazilian Atlantic rainforest biome (Oliveira-Filho and Fontes 2000). *Eugenia* is unique among Myrtaceae in having a native distribution that spans nearly the entire geographic range of the family (Snow 2011).

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The genus *Phyllocalyx* was segregated from *Eugenia* by Otto Berg (1856) being characterized especially by peduncles with leaf-like bracts and showy sepals, proportionally larger than the flowers. The name *Phyllocalyx* O. Berg (1856) is also illegitimate, being a later homonym of *Phyllocalyx* A. Rich. (1847). When Niedenzu, in 1893, transfered *Phyllocalyx* O. Berg to *Eugenia*, he named it *Eugenia* sect. *Phyllocalyx.* This name is treated as *nomen novum* and has the same type as the illegitimate name. It has priority from 1893 and must be cited as *Eugenia* sect. *Phyllocalyx* Nied., not as *Eugenia* sect. *Phyllocalyx* (O. Berg) Nied. (McNeill et al. 2012 – Article 58.1).

Recently, based on a molecular (nuclear and plastid markers) phylogenetic analysis, Mazine et al. (2014) recognized nine clades in *Eugenia* s. l. They also confirmed the inclusion of *Calycorectes*, *Hexachlamys*, and *Phyllocalyx* in *Eugenia.* The "Phyllocalyx clade" or "clade 6" sensu Mazine et al. (2014) refers to *Eugenia* sect. *Phyllocalyx* Nied. comprising c. 15 species widely distributed in the Atlantic Forest, from eastern Brazil to Paraguay. The section is characterized by peduncles with leaf-like bracts and showy sepals, proportionally larger than the flowers (Berg 1856, under *Phyllocalyx*), and is currently being monographed (Bünger et al. unpubl. res.). A remarkable result of Mazine et al. (2014) is the placement of *Eugenia wentii* – traditionally included in *Eugenia* sect. *Phyllocalyx* (Mc Vaugh 1969) – in "clade 9" althoug this clade does not have any support.

After broad sampling of *Eugenia* sect. *Phyllocalyx* within a molecular framework (using five markers, one nuclear and four plastid) (Bünger et al. unpubl. res.), results show that *Eugenia* sect. *Phyllocalyx* sensu Berg emerges as a paraphyletic group. The clade containing most species previously placed in section *Phyllocalyx* and also containing the type-species of the section (*Eugenia involucrata* DC.) emerges as a well-supported monophyletic group (PP Bayes: 0.99; PP Beast: 0.97; ML: 75). A second, also well-supported clade (PP Bayes: 1; PP Beast: 1; ML: 100) includes species previously included in *Eugenia* sect. *Phyllocalyx* (*Eugenia bunchosiifolia* Nied., *E. hermesiana* Mattos, *E. longipetiolata* Mattos, *E. macedoi* Mattos, *E. speciosa* Cambess and *E. wentii* Amshoff) but emerges with high support (PP Bayes: 0.99; PP Beast: 0.99; ML: 72) as sister to clade 9 *sensu* Mazine et al. (2014). Now, the clade 9 also emerges with high support (PP Bayes: 0.99; PP Beast: 0.99; ML: 86).

Bünger et al. (unpubl. res.) also have optimised morphological characters across the molecular tree, presenting useful results with which to distinguish the sections. Results indicated that these characters are uncommon in *Eugenia s.l.* and can therefore be used to support placement of species inside a genus/subgenus/section (e.g. Berg 1857, Niedenzu 1893, McVaugh 1969, Mattos 1989). Although these two clades do not emerge in a monophyletic group, they share the floral characters of showy sepals and bracteoles that could be homoplastic characters in *Eugenia s.l.*

To avoid continued recognition of a paraphyletic taxon we herein recognize a new section called *Eugenia* sect. *Speciosae* and provide the new circumscription of *Eugenia* sect. *Speciosae*, an identification key and a synopsis of the known species of this new section.

Taxonomic synopsis

The section name "*Speciosae*" was chosen based on the fact that *Eugenia speciosa* is the most geographically widespread species in this group. The specific epithet "*speciosa*" is also the oldest within the section (Cambessédes 1832)

***Eugenia* sect. *Speciosae* Bünger & Mazine, sect. nov.**
urn:lsid:ipni.org:names:77153396-1

Notes. Trees or shrubs; hairs simple. Indeterminate inflorescence which produces a floral region that, for instance, produces monads, dyads or triads and vegetative innovative shoots, as an auxotelic inflorescence (Briggs and Johnson 1989); bracteoles linear or narrowly elliptic persistent at anthesis but caducous in mature fruits; flowers showy always 4–merous; sepals showy, free, foliaceous, sepals and petals concealing the apex of the bud; ovary 2–locular; ovules 2–many, placenta axile. Fruit crowned by the calyx lobes. Seeds 1–2; seed coat membranous or cartilaginous; embryo with fused cotyledons.

Type. *Eugenia speciosa* Cambess. Fl. Bras. Merid. 2 (19): 351. 1832.

Eugenia sect. *Speciosae* contains six species with three occurring in the Atlantic Forest of Brazil, and one distributed in northern South America, in the Amazon. The Atlantic Forest-Amazon disjunction distribution represents a classic biogeographic pattern of the Southern Hemisphere (McVaugh 1968).

1. *Eugenia bunchosiifolia* Nied., Nat. Pflanzenfam. 3, Abt. 7: 82. 1893.

Basionym: *Phyllocalyx grandifolius* O. Berg, Fl. Bras. 14(1): 333. 1857.
Type: Brazil. *Habitat ad urbem Santos in prov. S.Pauli, fructificat Majo:* Sellow s.n. (holotype: B, destroyed; lectotype here designated: K[000170006]!)
Phyllocalyx grandifolius var. *pyriformis* O. Berg, Fl. Bras. 14(1): 591. 1859.
Type: Brazil. *Habitat in silvis prope urbem Rio de Janeiro, e.g. ad Tejuca, florebat Novembri, fructificabat Septembri:* Riedel s.n. (holotype: LE! [photo])
Eugenia santensis Kiaerskou, Enum. Myrt. Bras. 163. 1893, nom. superfl.
Type: Based on *Phyllocalyx grandifolius* O. Berg
Eugenia littoralis Mattos, Loefgrenia 42:1. 1970, nom. illeg.
Type: Brazil. São Paulo: Peruibe, Prainha, 25 Jul 1969, Mattos 15599 (holotype: HB!)
Eugenia brunoi Mattos, Loefgrenia 99:2. 1990, syn. nov.
Type: Based on *Eugenia littoralis* Mattos

Notes. *Eugenia bunchosiifolia* is a tree 3–15m alt. from the coastal Atlantic Forest of Brazil, growing in rainforests from Paraná, Rio de Janeiro and São Paulo states. This

species has glabrous leaves with obscure glandular dots visible on both faces, leaf apices are acuminate, without cartilaginous margins, the hypanthium is velutinous. The lectotype of *Eugenia bunchosiifolia* was chosen because the holotype was destroyed in the Second World War. The specimem found at K was a isotype and now considered the lectotype of this name.

The protologue and the examinated holotype of *Eugenia brunoi* matches with those of *E. bunchosiifolia*, hence this species is here synonymized with *E. bunchosiifolia*

2. *Eugenia hermesiana* Mattos, Loefgrenia 94: 1. 1989

Type. Brazil. São Paulo: Salesópolis, na Estação Biológica de Boracéia, 15 Jan. 1968, *Rabello, E. s/n.* (holotype: HAS, not found).

Notes. This species has glabrous leaves without cartilaginous margins, dots visible mostly abaxially, leaf apices are acute or obtuse, the hypanthium is velutinous. *Eugenia hermesiana* is a shrub up to 3 m high from São Paulo State (Brazil), growing in the coastal Atlantic Forest. There are few specimens located in BHCB, IAC, NY, SP and SPSF. It is a threatened species classified as Endangered in the Brazilian Official List of Flora Threatened Species (MMA 2014).

3. *Eugenia longipetiolata* Mattos, Dusenia 8: 162. 1968.
Fig. 1D

Basionym: *Stenocalyx mutabilis* O. Berg, Fl. Bras. 14(1): 347. 1857.
Type: Brazil. *Tingua*, Schott 5854 (lectotype here designated M [M-0170971]!; isolectotype W! [photo])
Eugenia mutabilis Nied., Nat. Pflanzenfam. 3, Abt. 7: 81. 1893, nom. illeg.
Type: Based on *Stenocalyx mutabilis* O. Berg
Eugenia tinguana Mattos, Loefgrenia 123: 1. 2006, nom. superfl.
Type: Based on *Stenocalyx mutabilis* O. Berg

Notes. *Eugenia longipetiolata* is a tree up to 15 m high from coastal Atlantic Forest of Brazil, growing in ombrophilous forests from Rio de Janeiro and São Paulo states. This species has leaves with visible, flat gland dots on both faces, black-floccose simple trichomes on abaxial faces, caudate apices, non-cartilaginous margins and a ferruginous-pubescent hypanthium.

The lectotype was chosen for *Stenocalyx mutabilis* because Berg did not indicate a single specimen and Mattos did not designate a ectotype when he published the nom. nov.. The specimen from M was seen and here considered the lectotype for the name.

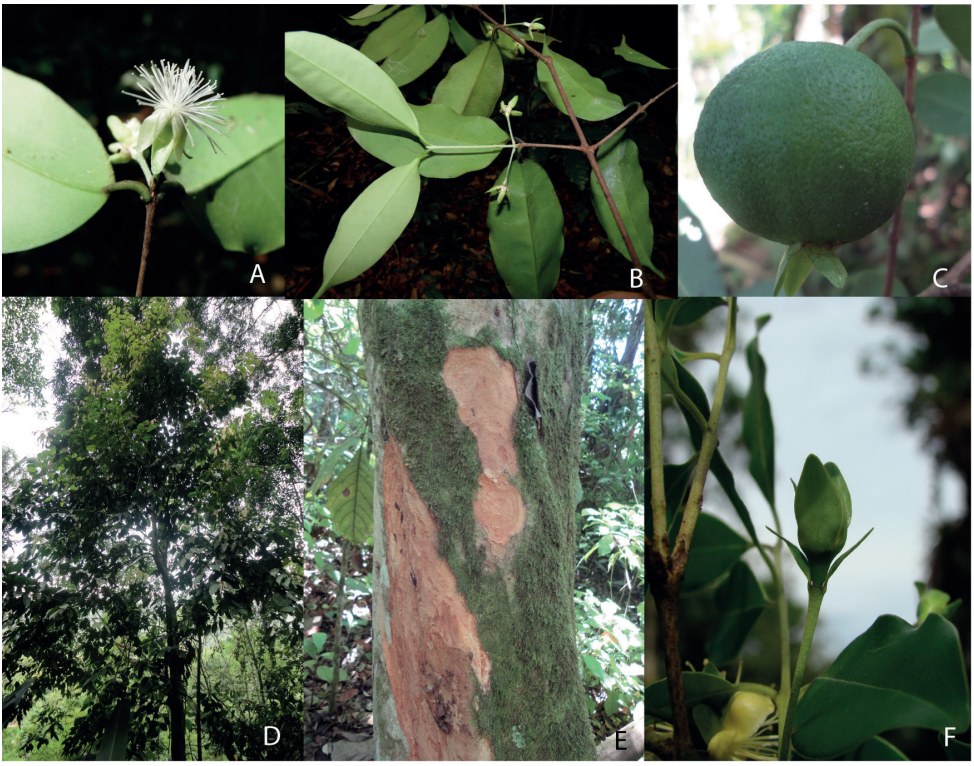

Figure 1. A, B Auxotelic inflorescence and foliaceous calyx, *Eugenia wentii* (photo by B. Holst) **C, E, F** *Eugenia speciosa*, mature fruit with decidous bracteoles, stem bark and position and format of the bracteoles (photos by M.O.Bünger); D *Eugenia longipetiolata* (photo by M.O.Bünger).

4. *Eugenia macedoi* Mattos & D. Legrand, Loefgrenia 67: 24. 1975.

Type. Brasil, Minas Gerais: Ituiutaba, San Vicente, 12 Sep. 1950, *Macedo, A. 2574* (holotype: MVM, not seen; isotype US! [00603977])

Notes. *Eugenia macedoi* is known only by two specimens colected in Minas Gerais and Goiás States (Brazil). This species is a shrub growing in the Cerrado biome (like *savannas*). Apparently it is the only species of the section that occurs in dry areas. This species has glabrescent leaves without cartilaginous margins, dots visible on both faces, leaf apices are acute, and the hypanthium is velutinous.

5. *Eugenia speciosa* Cambess., Fl. Bras. Merid. (quarto ed.) 2(19): 351. 1832.
Fig. 1C, E, F

Phyllocalyx speciosus (Cambess.) O. Berg, Fl. Bras. 27(2–3): 307. 1856.

Type: Based on *Eugenia speciosa* Cambess.

Phyllocalyx retusus O. Berg, Fl. Bras. 14(1): 331. 1857.
Type: Brazil. *Habitat ad ripas flaminis Rio Pardo in Montevideo:* Sellow s.n. (holotype B, probably destroyed; isotypes: K! [000276590], BR! [0000005261277]).
Phyllocalyx limbatus O. Berg, Fl. Bras. 14(1): 332. 1857.
Type: Brazil. *Habitat ad Angra dos Reys in prov. Rio de Janeiro: Pohl 264, 5760., loco incerto ajusdem prov., Sellow* s.n. (lectotype here designated BR! [526061-Sellow]!; isolectotype: B (fl.), probably destroyed; W (fr.) [photo]!).
Phyllocalyx macrosepalus O. Berg, Fl. Bras. 14(1): 332. 1857.
Type: Brazil. *Habitat ad Alegres et Manoel Jesu praedia in prov. Minarum:* Mikan s.n., Pohl s.n. (lectotype here designated: BR! [526984]; isolectotypes: M! [M-0171010], W [photo]!).
Phyllocalyx marginatus O. Berg, Fl. Bras. 14(1): 332. 1857.
Type: Brazil. *Habitat in prov. Rio de Janeiro:* Martius s.n. (holotype: BR! [526094].
Eugenia retusa (O.Berg) Nied., Nat. Pflanzenfam. 7: 82. 1893.
Type: Based on *Phyllocalyx retusus* O. Berg
Eugenia caldensis Kiaerskou, Enum. Myrt. Bras. 162. 1893.
Type: Based on *Phyllocalyx marginatus* O. Berg
Eugenia macrocalyx Mart. ex B.D.Jacks, Index Kew. 1: 908. 1893.
Type: Based on *Phyllocalyx macrosepalus* Berg

Type. Brazil. *In sabulosis prope praedium vulgo Fazenda d'Araucaria in prov. S.Pauli, floret Octobri:* Saint-Hilaire s.n. (lectotype: P [P01902768]!; isolectotype: MPU! [photo])

Notes. *Eugenia speciosa* is a tree 5–12 m high from Atlantic Forest in southern and southeastern Brazil. It is common in rainforests and "restingas". This species also occurs in montane Atlantic Forest in Minas Gerais State (Brazil) and also occurs in Paraguay, Argentina, Uruguay and Bolivia. This species has leaves with visible, salient dots on both faces, glabrous, obtuse apices with cartilaginous margins and a glabrous hypanthium.

The lectotypes chosen for *Phyllocalyx limbatus* and *Phyllocalyx macrosepalus* are from BR; they were seen and we consider that the specimens that well represent the names. The lectotype that was chosen for *Phyllocalyx limbatus* is a specimen that is a duplicate (isotype) of the specimen that was in B which was destroyed in the Second World War. For thus, we consider it as the lectotype for this species.

6. *Eugenia wentii* Amshoff, Recueil Trav. Bot. Néerl. 39: 160, f. 4. 1942.
Fig. 1A, B

Phyllocalyx wentii Amshoff, Recueil Trav. Bot. Néerl. 39: 158, f. 4. 1942
Type: Based on *Eugenia wentii* Amshoff nomen alternativ.
Calycorectes macrocalyx Rusby, Mem. New York Bot. Gard. 7: 313. 1927.
Type: Bolivia. Bopi River Valley. Rusby 666 (holotype: NY! [00386736]; isotypes: BKL! [photo], MICH! [photo], US! [photo])
Eugenia macrocalyx (Rusby) McVaugh, Fieldiana, Bot. 29(3): 212. 1956, nom. illeg.
Type: Based on *Calycorectes macrocalyx* Rusby

Type. Suriname. Fluv. Coppename inf., Went FAFC 142 (holotype: U! [0005034])

Notes. *Eugenia wentii* is a treelet or tree 3–6 m high from the Amazon forest; it is found in Amazônia and Pará States (Brazil), French Guyana, Suriname, Venezuela, Bolivia, Colombia, Ecuador and Peru. This species has glabrous leaves with flat, visible gland dots on both faces, caudate apices without cartilaginous margins and a velutinous hypanthium.

Key to species of *Eugenia* sect. *Speciosae*

1 Hypanthium glabrous.....***E. speciosa***
– Hypanthium with trichomes
2 Leaves with caudate apices and black-floccose indument on mature leaves.... .....***E. longipetiolata***
– Leaves with acuminate apices, acute, obtuse or rostrate; glabrous or without black-floccose hairs
3 Leaves usually with cartilaginous margins .....***E. bunchosiifolia***
– Leaves always without cartilaginous margins
4 Leaves with acuminate or rostrate apices..... ***E. wentii***
– Leaves with acute or obtuse apices
5 Calyx lobes acuminate 50 to 70 mm long. .....***E. hermesiana***
– Calyx lobes acute 3.9 to 7 mm long. .....***E. macedoi***

Acknowledgements

We thank all curators of the visited herbaria for allow us to study the specimens and to Coordenacão de Aperfeicoamento de Pessoal de Nível Superior (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the financial support received by the first and the last authors.

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PhytoKeys 61: 81–91 (2016)
doi: 10.3897/phytokeys.61.7408
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Trachelomonas bituricensis var. *lotharingia* M.L. Poucques 1952, a morphologically interesting, rare euglenoid new to the algal flora of the Czech Republic

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Academic editor: *E. Cooper* | Received 4 December 2015 | Accepted 25 January 2016 | Published 25 February 2016

Citation: Juráň J (2016) *Trachelomonas bituricensis* var. *lotharingia* M.L. Poucques 1952, a morphologically interesting, rare euglenoid new to the algal flora of the Czech Republic. PhytoKeys 61: 81–91. doi: 10.3897/phytokeys.61.7408

Abstract

This report describes the discovery of the rare euglenoid taxon *Trachelomonas bituricensis* var. *lotharingia* in a small mesotrophic pond in the Czech Republic. Only limited data are available on the distribution of this taxon as same as for typical variety of *Trachelomonas bituricensis*, even though this taxon is morphologically very well defined. I provide a brief discussion of the taxonomic validity of this taxon based only on morphological features, which are characteristic for the taxonomy of the genus *Trachelomonas*. This finding is completely new for the algal flora of the Czech Republic. This report provides new information about the worldwide distribution of this taxon and its ecology.

Keywords

Czech Republic, floristics, microalgae, *Trachelomonas*

Introduction

Floristics studies have had a long tradition in the Czech Republic beginning in the second half of the 19th century, when several works about alga flora in this country were published. Since the publication of pioneering works by Kirchner (1878) and

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Hansgirg (1892, 1899), Lhotský and Rosa (1955) published a list of algal and cyanobacterial species from the Moravia region. The current knowledge about algal diversity in this region was summarised by Poulíčková et al. (2004). All of these reports describe floristic studies examining the prevalence of all groups of algae in our state. These studies, combined with recent reports about the distribution of various groups of algae (e.g., Caisová and Gąbka 2009, Kaštovský et al. 2010, Kučera et al. 2008 and Šťastný 2010), provide comprehensive information about algal flora. Unfortunately, little is known about several of these groups and their distribution, e.g., diatoms, dinophytes and euglenoids.

I performed a nearly 5 year survey during my bachelors and masters studies investigating the diversity of photosynthetic euglenophytes (Juráň 2010, 2012) based on extensive literature reviews and my own floristic studies across the country. As a result, I constructed a preliminary checklist of euglenoid taxa of the Czech Republic including several species that were newly reported in our state. This checklist will be published soon. One of these new species is *Trachelomonas biturícensis* var. *lotharingia* from Ďáblík pond in South Bohemia.

The genus *Trachelomonas* includes euglenoids with their cells enclosed in envelopes (loricas) comprising polysaccharides with a content of iron and several inorganic compounds (Pereira et al. 2003). These loricas are highly variable in shape and surface morphology. Listed features are traditional markers used in *Trachelomonas* taxonomy, as proposed by Deflandre (1926). Since the original description of *Trachelomonas* by Ehrenberg (1834), more than 1700 taxa have been identified due to this high morphological variability in the genus (Guiry and Guiry 2015).

Trachelomonas biturícensis was originally described by Wurtz (1947), who identified this species in plankton from the pond of the Hardouine in La Brenne, France. In the typical species, the lorica is covered with long, sharp, curved spines. One variety of this species, *Trachelomonas biturícensis* var. *lotharingia*, was first described by Poucques (1952). The description of new taxon was based on material from a wetland in the Woëvre region in France. This variety has shorter collars (see Fig. 3) than the typical forma described by Wurtz (1947). In addition, the edge of the collar is more undulated.

Methods

The aim of this study was to survey the algal flora of the small mesotrophic pond Ďáblík (South Bohemia region, Czech Republic, 48°49'41.0"N, 14°35'49.6"E, see Figs 1 and 2). This habitat is a small pond that functions as a primary retention pond, without fishery management. This pond contains huge communities of *Carex* spp. and *Sphagnum* spp. and a stable population of the charophycean alga *Nitella flexilis*. The pond is progressively becoming overgrown with vegetation. The locality is favourable for the growth of threatened vascular plants, e.g., *Nymphaea candida*, *Calla palustris* and *Menyanthes trifoliata*. Wetland plants *Utricularia australis* and *Potamogeton obtusifolius* are common in this locality (Albrecht 2003).

Figure 1. Location of the studied locality.

Figure 2. Photograph of a free water surface with knotweed (*Potamogeton* sp., at the front) and *Carex* spp., together with *Sphagnum* spp. communities (left).

In 2012 and 2013, a pilot survey was taken, and in 2014, a more detailed survey with monthly sampling at five chosen locations was performed. The aim of this survey was to record algal diversity, especially for loricate euglenoid genera *Trachelomonas* and *Strombomonas*. Samples were taken using a 20 µm plankton net, and the material was fixed in formaldehyde solution and Lugol's iodine solution. Samples were examined microscopically under an Olympus BX51 microscope and photographed with an Olympus DP-71 camera with DP Controller 3.1.267 software. Samples fixed in iodine solution were used for scanning electron microscopy. Materials for scanning electron microscopy were prepared as described by Conforti (2009). The material was filtered through polycarbonate membrane filters (1 µm pore size) and air-dried. Filter pieces were attached to stubs and subsequently coated with gold. The specimens were then saved for future scanning electron microscopy analysis or examined under a JEOL JSM-7401F scanning electron microscope (Institute of Parasitology, Biology centre of AS CR, České Budějovice).

Results

The algal flora of the Ďáblík pond is dominated by dinophytes (*Peridinium* spp.), together with desmids and metaphytic communities of *Spirogyra* spp. steril., as well as diatoms (especially *Gomphonema* species). Taxon-rich flora of the loricate euglenoids will be studied in detail using optical and scanning electron microscopy in conjunction with comparisons of the chemical and physical parameters of pond water. Based on the preliminary results, some of the taxa appear to represent new algal flora of the Czech Republic, but these taxa require further study. The most interesting finding is the discovery of *Trachelomonas bituricensis* var. *lotharingia*, a newly recorded variety of algal flora in the Czech Republic. This variety is quite common in Ďáblík pond, which contains a stable population of this alga. This finding represents the first record of this taxon among algal flora of the Czech Republic based on a detailed literature review and the floristic survey across the Czech Republic that I performed during my bachelors and masters studies (Juráň 2010, 2012).

The loricas in this species are (41 –)45–46 µm in length and (30 –)33–35 µm wide. The cell contains numerous disc-like chloroplasts, probably without pyrenoids. The surface of the lorica in this taxon from Ďáblík pond is punctate and covered with well-developed hollow, sharp spines (see Fig. 3A–D), most of which are slightly curved and cover the body of the lorica. The caudal region contains very long, curved spines, and only a few narrow, conical spines surround the apical pore, which has a collar (see Fig. 3B, marked with arrows). The collar of the lorica is short, with an undulated edge (see Fig. 3D, marked with arrow). This taxon has always been found during the spring at shallow sites with populations of *Nitella flexilis* near the banks of the pond. These findings suggest that *Trachelomonas bituricensis* var. *lotharingia* is probably a benthic or metaphytic taxon.

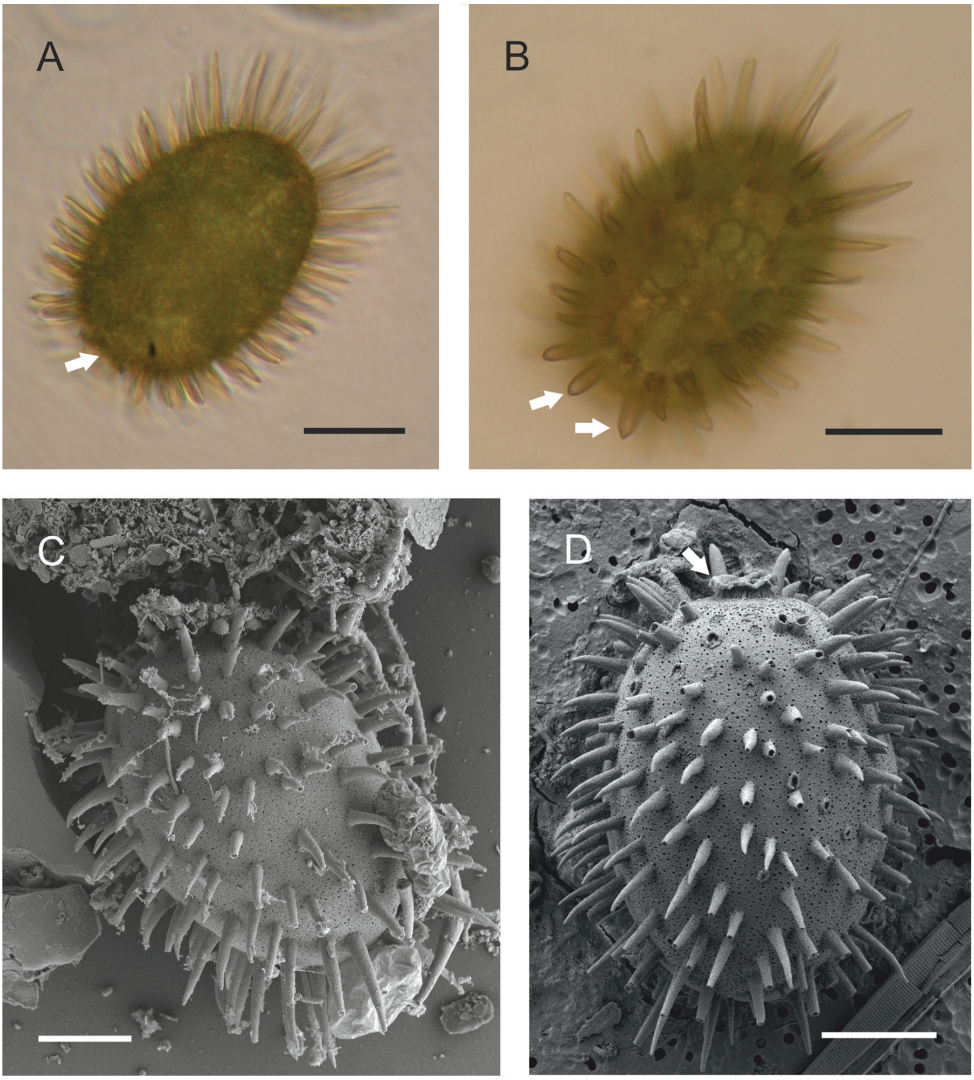

Figure 3. Visualisation of the morphology of *Trachelomonas bituricensis* var. *lotharingia* by optical and electron scanning microscopy. **A** Overall appearance of lorica under an optical microscope, with a short collar with undulated edge (marked with arrow) **B** Detailed image of the lorica surface with three types of spines: long, curved spines at the antapical part of the lorica; shorter spines on the lorica's body; and several straight spines near the apical pore (marked with arrows). Note the numerous disc-like chloroplasts in the cell **C, D** Loricas viewed by scanning electron microscopy, with clearly visible punctuation at the surface, and short collar with undulated edge (marked with arrow). Scale bars = 10 μm.

A comparison of a typical variety of *Trachelomonas bituricensis*, the variety described by Poucques (1952) and the material found in Ďáblík pond is presented in Table 1.

Table 1. Comparison of morphological data about *Trachelomonas bituricensis* taxa.

Feature	Wurtz (1947)	Poucques (1952)	This study
Shape		ellipsoidal to ovoid	ellipsoidal
Length*	40 µm	40 µm	(41 –)45–46 µm
Width*	20 µm	30 µm	(30 –)33–35
Spine length			
- conical spines	N/A	4–6 µm	4–5 µm
- posterior part	N/A	12–14 µm	8–13 µm
Collar	slightly enlarged, with thickening at the base	short, large, regular undulated edge	short collar with undulated edge
Chloroplasts	N/A	N/A	numerous, discoid
Ecology	fishpond; plankton	wetland; plankton	mesotrophic pond; benthos, metaphyton

*without spines

Discussion

These two taxa (*Trachelomonas bituricensis* and *Trachelomonas bituricensis* var. *lotharingia*) are commonly mentioned in works about euglenophytes (e.g., Huber-Pestalozzi 1955, Popova 1966, Starmach 1983 and Vetrova 1986). These taxa have distinct morphology that is easy to distinguish from that of other species, the descriptions of which are commonly used in taxonomic keys. However, data about the occurrence of these taxa are very limited. A typical form of *Trachelomonas bituricensis* was only recently reported to occur in several places, including benthos in a fishpond in Poleski National Park, Poland (Kočárková et al. 2002) and two rivers in Kosovo (Kurteshi et al. 2013a, 2013b). The second reported location of *lotharingia* variety was a bog in the Russian taiga, where this taxon was found in a wetland containing saw grass (*Carex* sp.) (Safonova 1987). In addition, Vetrova (1986) identified this variety among algal flora of Ukraine. Perhaps the most recently reported occurrence of this taxon was in the Southeastern US, where it was rarely observed in ditches, lakes and ponds (Wolowski and Walne 2007).

Several species of *Trachelomonas* have the similar morphology as *Trachelomonas bituricensis*. The most resembling taxa are *Trachelomonas horrida*, which was first described by Palmer (1905), as well as *T. megalacantha* (DaCunha, 1914) and *T. spectabilis* (Deflandre, 1926). All of these species have loricas covered with well-developed long, sharp spines, but their spines are straight, unlike the curved spikes on the loricas of *Trachelomonas bituricensis*. Huber-Pestalozzi (1955) argued that *Trachelomonas bituricensis* var. *lotharingia* is highly similar to *Trachelomonas spinosa*, which is found in ponds containing aquatic plants (Stokes 1890), and that it probably represents a larger form of these taxa. Stokes' (1890) description of the surface and shape of the *Trachelomonas spinosa* lorica is similar to that of *Trachelomonas bituricensis*, whereas its collar is described as a "… *short, smooth, truncate extension*", with no mention of the undulated edge or additional cylindrical spines. In addition, Tell and Conforti (1986) described

Trachelomonas spinosa from Argentina as having a similar morphology, with an apical pore with a short, thick neck surrounded by spines; again, an undulated edge is not mentioned. Vetrova (1986) noted the similarity between *Trachelomonas bituricensis* and *lotharingia*-variety with *T. horrida* and *T. spinosa*, although they did not mention the taxonomy of *Trachelomonas bituricensis* taxa in a subsequent report and the validity of this variety could be discussed. Finally, Wolowski and Walne (2007) reported that *Trachelomonas bituricensis* var. *lotharingia* from the US has a dentate collar.

The high morphological variability of the genus *Trachelomonas* makes classification based only on morphology (e.g., shape, surface, absence or presence of various forms of collar and sometimes colour of the lorica) quite difficult and has led to the description of morphologically similar forms as separate taxa. As a result of morphological variability, the traditional taxonomy of *Trachelomonas* based only on a description of lorica characters is problematic for several reasons. First, there are several examples of the morphology of euglenoids changing depending on environmental conditions. This variability in shape was observed in several euglenoid genera in culture (Conforti 1998) and those cultivated in situ under natural conditions (Bauer et al. 2012). The cells of these taxa exhibited morphological changes depending on the level of organic carbon in the medium or the environment. Pringsheim (1953) and Singh (1956a, b) found that in some *Trachelomonas* species, the loricas of cells in clonal culture (i.e., descendants of a single cell) have morphological diversity in shape and surface, which probably depends on their specific ontogeny. This diversity represents the main problem with classification based solely on morphology. Indeed, in discussing *Euglena* taxonomy, Pringsheim (1956) noted that, "Certain authors could not resist the temptation to give a name to every minor deviation from the 'type' previously described or prevailing at the same or at similar places". This comment accurately describes the state of taxonomy of the genus *Trachelomonas*. Therefore, the large number of currently described taxa within the genus *Trachelomonas* likely reflects the morphological variability created by environmental conditions. Many of these taxa may instead be recognised as "eco-morphs" of the typical form. Furthermore, Pringsheim (1953, 1956) claimed that unless individual species are cultured separately, the effects of external factors affecting heritable morphological traits cannot be distinguished. In light of these findings, perhaps *Trachelomonas bituricensis* var. *lotharingia* is only an eco-morph of the typical forma, or perhaps it represents a *bituricensis* eco-morph of *Trachelomonas spinosa*. Alternatively, this alga may represent a complex of species. More detailed morphological studies are needed to solve this taxonomic puzzle, including basic morphometric analysis and especially molecular analysis.

Many reports about euglenoid taxonomy based on morphological and molecular data (e.g., Karnkowska-Ishikawa et al. 2010, 2011, 2012, 2013 and Kosmala et al. 2005, 2007a, 2007b, 2009) show that several species or other intraspecific taxa may instead only represent eco-morphs or ontogenetic stages of individual species, as discussed in a report about *Monomorphina* genus taxonomy (Kosmala et al. 2007b). Unfortunately, similar studies about the taxonomy of the genus *Trachelomonas* remain to be performed. Several recent works (e.g., Nejmová et al. 2011, Škaloud et al. 2015 and

Veselá et al. 2012) about species concept in algae reflect a combination of molecular and morphological data. Therefore, a combination of ecological, morphological and molecular data can be used to define the species concept of a genus with worldwide distribution such as *Trachelomonas*. However, this issue requires further study.

Conclusion

This report describes what is likely the third record of *Trachelomonas bituricensis* var. *lotharingia* in Europe and the first record of this taxon in the Czech Republic. The description of this taxon is morphologically and ecologically similar to the original description. The taxonomic validity of this taxon remains to be validated, as it may represent part of a complex of morphologically similar species together with *T. spinosa* and *T. horrida.* Nonetheless, the discovery of this taxon sheds light on the distribution of algae of the Czech Republic and European algal flora in general.

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PhytoKeys 61: 93–99 (2016)
doi: 10.3897/phytokeys.61.7082
http://phytokeys.pensoft.net

RESEARCH ARTICLE

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Eremogone ali-gulii (Caryophyllaceae), a new species from Turkey

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Academic editor: *A. Calvente* | Received 4 November 2015 | Accepted 15 February 2016 | Published 25 February 2016

Citation: Koç M, Hamzaoğlu E (2016) *Eremogone ali-gulii* (Caryophyllaceae), a new species from Turkey. PhytoKeys 61: 93–99. doi: 10.3897/phytokeys.61.7082

Abstract

Eremogone ali-gulii (Caryophyllaceae) is described as a new species of *Eremogone* in Turkey. The specimens were collected from Kop Mountain (Erzurum). The new species is endemic of the Irano-Turanian region and is related to *Eremogone scariosa* and *E. armeniaca*. The differences on sterile shoots, habit, sepals and capsules between these species are discussed. Description, distribution, illustration and conservation status of the new species are given.

Keywords

New species, *Eremogone*, Taxonomy, Turkey

Introduction

Caryophyllaceae is a very large family mainly found in the northern hemisphere and includes 88 genera and 3000 species (Rabeler and Hartman 2005). The family has often been divided into three subfamilies namely *Alsinoideae* Burnett, *Caryophylloideae* Arn., and *Paronychioideae* A.St. and five tribes (Bittrich 1993). However, recent molecular studies have illustrated that these groups are polyphyletic (Fior 2006). For instance, Harbaugh et al. (2010) evaluated the *Mat*K, *trn*L-F and *rps*16 sequences of 146 species of Caryophyllaceae and recognized 11 tribes, including the newly described *Eremogoneae* Rabeler & W.L.Wagner (Harbaugh et al. 2010).

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Eremogone was described by Fenzl in 1833, then it was later described as a subgenus of *Arenaria* by Fenzl in 1842. Molecular phylogenetic studies carried out in recent years suggest that species previously placed in *Arenaria* subgen. *Eremogone* (approximately 70 species), *Arenaria* subgen. *Eremogoneastrum* Williams (22 species) and *Minuartia* subgen. *Spergella* (Fenzl) McNeill (3 species) comprise the genus *Eremogone* (Fenzl 1833, McNeill 1967). *Eremogone* is a natural group consisting of 95 species with leaves narrowly linear to filiform and capsules splitting apically into six teeth or three bifid valves (Dillenberger and Kadereit 2014, Sadeghian et al. 2015). The Turkish name for *Eremogone* is "İğnekumotu". There are 18 taxa of *Eremogone* in Turkey, 11 of which are endemic (McNeill 1967, Dinç 2012). In the flora of Turkey (McNeill 1967), *Eremogone* is treated as a subgenus of *Arenaria* (Fenzl 1833, McNeill 1967). This work describes *Eremogone ali-gulii*, a new species of *Eremogone* found in Turkey.

Material and methods

Authors collected *Eremogone* specimens from Kop mountain (Erzurum) during a project (KBAG-113Z260-TUBITAK) to revise Turkey *Minuartia* taxa (Caryophyllaceae). These specimens were compared with related species or photographs in the herbaria of E, ANK, GAZI, Bozok University Herb., and with records in the literature (McNeill 1963, Rechinger 1964, Zohary 1966, McNeill 1967, Halliday 1976, Rechinger 1988, Shishkin 1995, Bojňanský and Fargašová 2007, Rabeler and Wagner 2015). The studies showed that these specimens are representatives of a species new to science.

This study is based on literature and field observations of living plants. The materials were examined using an Olympus SZ61 microscope. Mature seeds were collected from capsules of the holotype. Measurement of vegetative characters was made with a ruler accurate to 0,5 mm and floral characters were measured with an ocular micrometre.

Taxonomic treatment

***Eremogone ali-gulii* Koç & Hamzaoğlu, sp. nov.**
urn:lsid:ipni.org:names:77153392-1
Fig. 1

Diagnosis. *Eremogone ali-gulii* is similar to *Eremogone scariosa* (Boiss.) Holub and *E. armeniaca* (Boiss.) Holub, but differs in having fasciculate sterile shoots, a tufted habit and shorter sepal and capsules.

Type. TURKEY, Erzurum province, between Bayburt and Aşkale, Kop mountain, 40°00'N-040°32'E, 2150 m, serpentine stony slopes, 24 June 2014, Koç 1723 & Hamzaoğlu (holotype ANK, isotype Bozok Univ. Herb., ANK, GAZI).

Description. Tufted, perennial herb. Stems erect or ascending, 10–18 cm long and 0.7–0.9 mm in diameter, glabrous below, glandular-puberulent above. Rosette leaves

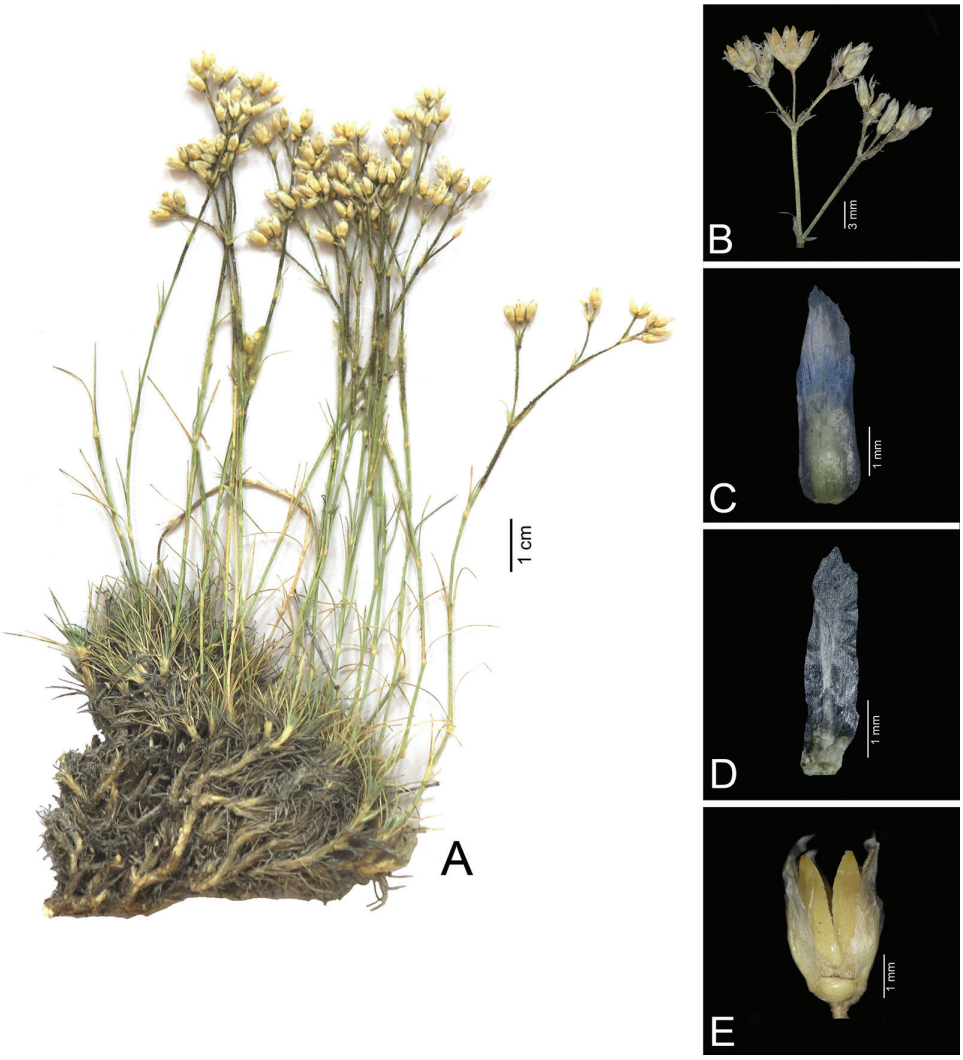

Figure 1. *Eremogone ali-gulii* (Koç 1723). **A** Habit **B** Inflorescence **C** Sepal **D** Petal **E** Capsule.

setaceous, 1.5–2.5 cm, fasciculate; stem leaves linear-setaceous, 0.6–15 × 0.5–0.8 mm, smooth, glabrous, 3–5 pairs, apex acute to acuminate, leaf sheath membranous, 0.1–0.2 mm, glabrous. Bracts oblong-lanceolate, 2.5–5 × 0.8–1.2 mm, glandular hairy, obscurely 3-nerved, apex acute to acuminate. Inflorescences usually terminal, 3–10-flowered, panicles, the peduncles and pedicels sparsely to densely glandular-puberulent; bracts oblong-lanceolate, 4–6 × 0.5–0.8 mm, apex setaceous-acuminate, margins scarious never extending right to the tip; pedicels 1–4 mm long. Flower sepals oblong-lanceolate, 2.8–4.5 × 1.2–1.7 mm, glabrous, obscurely veined, membranous at the base, scarious above, the apex obtuse to acute; petals white, linear-oblong, 3–5 × 0.8–1.2 mm, slightly longer than sepals, the apex obtuse to acute; stamens 10, the filaments 2–3.5 mm long;

styles 3, more or less erect, 1.5–2 mm long; staminal glands deeply bifurcate, appearing as 10, distinct, alternating with the stamens. Capsules 2.5–4 × 0.8–1.2 mm, ovoid to elongate-ovoid, glabrous, opening by 6 recurved teeth, containing only a few seeds. Seeds 1.9–2.4 mm long, oblong, tuberculate on the rim and the sides with low, elongate tubercles, black to dark brown. Flowering in June and July.

Ecology. *Eremogone ali-gulii* grows on serpentine, which is the most widespread of the non-calcareous soils in between the cities of Erzurum and Erzincan in Turkey. It occurs in stony slopes habitat with *Achillea biebersteinii* Afan, *Pimpinella rhodantha* Boiss., *Inula heterolepis* Boiss., *Arenaria pseudoacantholimon* Bornm., *Arenaria serpyllifolia* L., *Dianthus crinitus* Sm. var. *crossopetalus* Boiss., *Helichrysum plicatum* DC. subsp. *polyphyllum* (Ledeb.) Davis & Kupicha.

Conservation status. The species is currently known from two populations: in the location of Kop mountain in Erzurum and another location between Erzurum-Erzincan, around Karasu village. Both populations are vulnerable to anthropogenic impact. Informal grazing and land-use changes could have a detrimental impact in the future. On the basis of IUCN red list categories and criteria (IUCN 2012), *Eremogone ali-gulii* covers an area (AOO) of about 300 km^2. The new species is here assessed as Endangered [EN, B2ab(iii)].

Etymology. The species is named in honour of the eminent Turkish hydrobiologist Prof. Dr. Ali Gül (Gazi Faculty of Education, Gazi University, Ankara).

Results

The specimens introduced here as the new species in this study were collected from Erzurum province, Kop mountain. At first glance, these specimens resemble *Eremogone armeniaca* and *E. scariosa*. Yet, comprehensive studies that were subsequently carried out revealed that they belonged to a new species.

Distinction from other taxa

Eremogone ali-gulii is similar to a group of five Irano-Turanian *Eremogone* species previously placed in Arenaria sect. *Scariosae* by McNeil (1967): 2 from Northern Iran - *E. polycnemifolia* (Boiss.) Holub and *E. zargariana* (Parsa) Holub; and 3 species from eastern Turkey - *E. armeniaca*, *E. scariosa* and *E. pseudoacantholimon* (Bornm.) Holub. All of them share spiny or setaceous leaves, coriaceous or scarious sepals, and petals of similar size. *Eremogone ali-gulii* is more similar to *E. armeniaca and E. scariosa* due to the scarious margins of the sepals never extending right to the tip and to the deeply bifurcate staminal glands, appearing as 10, distinct, alternating with the stamens (McNeill 1962). However, *Eremogone ali-gulii* differs markedly from both species due to its fasciculate sterile shoots, tufted habit, sepals 2.8-4.5 mm long and capsules 3-4 mm long. The diagnostic features of these three species are listed in Table 1.

Table 1. Diagnostic characters of *Eremogone ali-gulii* compared with other similar species.

Characters	*E. ali-gulii*	*E. armeniaca*	*E. scariosa*
Habit	tufted	suffruticose	suffruticose
Stem	10–18 cm long	20–30 cm long	10–20 cm long
Rosette leaves	fasciculate	imbricate	imbricate
Inflorescence	panicle	terminal cluster enclosed by glumaceous bracts	panicle
Pedicels	2–4 mm long	1–2 mm long	2–6 mm long
Sepals	2.8–4.5 mm long, membranous at the base, scarious at the apex	(4.5)6–9 mm long, membranous at the extreme apex	6–8 mm long, membranous at the base, scarious at the apex
Petal shape	linear-oblong	oblanceolate	linear-oblong
Capsule	3–4 mm long	4–7 mm long	5–7 mm long

Key to closely related *Eremogone* species

1 Sepals with coriaceous herbaceous median strip, very gradually narrowing to the tip; staminal glands 5, indistinct, at the base of the outer whorl of stamens (Series *Polycnemifoliae*)

– Sepals with scarious margins never extending right to the tip; staminal glands deeply bifurcate, appearing as 10, distinct, alternating with the stamens (Series *Scariosae*)

2 Sepals 6–8 mm long; bracts 7–8 mm long ..... ***E. zargariana***

– Sepals 3.5–5.5 mm long; bracts 3–5 mm long

3 Stem leaves 1–2 pairs; rosette leaves 1–2 cm, stiff, aristate; sepals ovate-lanceolate; petals as long as sepals .....***E. pseudacantholimon***

– Stem leaves 3–9 pairs; rosette leaves 10–15 cm, not stiff, acute to acuminate; sepals oblong-lanceolate; petals slightly longer than sepals....***E. polycnemifolia***

4 Habit tufted; sterile shoots fasciculate, sepals 2.8–4.5 mm long; capsules 3–4 mm long.....***E. ali-gulii***

– Habit suffruticose; sterile shoots imbricate, sepals (4.5)6–9 mm long; capsules 4–7 mm long

5 Inflorescence a terminal cluster enclosed by glumaceous bracts; sepals membranous at the extreme apex; petals slightly longer than sepals ..... ***E. armeniaca***

– Inflorescence paniculate; sepals membranous at the base, scarious above; petals slightly shorter than sepals .....***E. scariosa***

Specimens examined

Eremogone ali-gulii (Paratype), TURKEY - B8 Erzurum: between Erzurum-Erzincan, Karasu village around, 1600 m, 15.06.2007, E.Hamzaoğlu 4662 (Bozok Univ. Herb.!). – ***Eremogone scariosa*** (Boiss.) Holub, TURKEY - B5 Bayburt: Between Bayburt and İspir, Karşıgeçit village, 1460 m, 12.07.2009, Koç 589, Ü.Budak and E.Hamzaoğlu (Bozok

Univ. Herb.!); Bayburt: SE of Bayburt, 1500-1700 m, 13.06.2002, E.Hamzaoğlu 2960 (Bozok Univ. Herb.!); Bayburt: Between Bayburt and Pazaryolu, 23.06.2002, E.Hamzaoğlu 3009 (Bozok Univ. Herb.!); Gümüşhane: Yukarıalıçlı village, 1500 m, 14.07.2007, E.Hamzaoğlu 4819 and A.Aksoy (Bozok Univ. Herb.!); A7 Gümüşhane: Kovans, ca. 1800 m, 02.08.1957, P.H.Davis and I.C.Hedge (ANK-31937); A8 Bayburt: Darıca village, Çoruh valley, 1720-1850 m, 26.08.1991, T.Ekim, M.Koyuncu, H.Karaca and A.Güner 9707 (GAZI!); A7 Gümüşhane: Köse-Gümüşhane bei Kirikli, 1300 m, 12.07.1984, M.Nydegger (E, E00074746-photo!). – ***Eremogone armeniaca*** (Boiss.) Holub, TURKEY - A6 Sivas: Zara-Suşehri, 20 km from Suşehri, 1300 m, 23.07.1960, A.Stainton and D.M.Henderson (E, E00567097-photo!); A7 Giresun: N of Şebinkarahisar, 40°20'N-038°26'E, 24.07.2010, Hamzaoğlu 5896 and Koç (Bozok Univ. Herb.!); A7 Gümüşhane: Sorda, nr. Teke, P.E.E.Sintenis 1894 (E, E00567094-photo!); A8 Erzurum: Tortum around, 1500 m, 17.07.1990, Z.Aytaç 3149, T.Ekim and H.Duman (GAZI!); A8 Erzurum: Tercan-Ilıca, 1900 m, 10.07.1957, P.H.Davis 30843 and I.C.Hedge (E, E00567095-photo!); A8: Bayburt: Maden, between Masat-Yanıkköprü, 1910 m, 17.07.2007 Hamzaoğlu 4893 and Aksoy (Bozok Univ. Herb.!); A8 Erzurum: W of Kandilli, 1520 m, 17.08.1966, J.C.Archibald (E, E00567098-photo!); B7 Erzincan: Erzincan to Kelkit, 1650 m, P.H.Davis 31885 and I.C.Hedge (E, E00567096-photo!); B7 Erzincan: Between Tercan-Aşkale, Yakacık village, 1570 m, 02.07.2013 Hamzaoğlu 6786 and Koç (Bozok Univ. Herb.!); B8 Erzurum: Between Erzurum-İspir, 40°09'N-041°01'E, 2010 m, 02.07.2013, Hamzaoğlu 6788 and Koç (Bozok Univ. Herb.!). – ***Eremogone pseudacantholimon*** Bornm., TURKEY - B7 Erzincan: between Erzincan-Refahiye, 39°55'N-039°08'E, 24.08.2012, Hamzaoğlu 6623 and Koç (Bozok Univ. Herb.!); B7 Erzincan: between Erzincan-Kelkit, 39°52'N-039°23'E, 2095 m, 13.07.2010, Koç 1277 and Hamzaoğlu (Bozok Univ. Herb.!); B7 Tunceli: between Tunceli-Pülümür, 39°31'N-039°52'E, 1850 m, 09.06.2011, Koç 1330 and Hamzaoğlu (Bozok Univ. Herb.!); B8 Erzurum: between Çat-Bingöl, Kirişli pass, 2320 m, 16.07.2007, Hamzaoğlu 4863 and Aksoy (Bozok Univ. Herb.!). – ***Eremogone polycnemifolia*** Boiss., IRAN – Shahkuh, Mazenderan, 10000 ft, 17.07.1940, W.Koelz (E, E00194277-photo!); Arak: Streamside and stagnant pools, 25.07.1963, N.Jardine (E, E00567090-photo!); Tehran: Elburz mts, W. of Firuzkuh, 7000 ft, 23.06.1960, P.Furse and P.Synge (E, E00567089-photo!); Mazandaran: Lar valley, by Lar river, 2500 m, 03.07.1974, P.Wendelbo and M.Assadi (E, E00567089-photo!). – ***Eremogone zargariana*** Boiss., IRAN – Montes Elburz: In saxosis summi montis Kuh Dashteh c. 30 km Tehran, 2400-2500 m, 28.06.1977, K.H.Rechinger (E, E00567093-photo!); Tehran: East of Rudehan, semi-desert country, 1520 m, 03.07.1966 J.C.Archibald (E, E00567092-photo!).

Acknowledgements

We wish to thank TÜBİTAK (Project number: KBAG-113Z260) for financial support and the Curators of the Herbaria E, GAZI and ANK, who allowed us to study their *Eremogone* specimens.

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PhytoKeys 61: 101–124 (2016)
doi: 10.3897/phytokeys.61.6260
http://phytokeys.pensoft.net

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Two new combinations in *Euploca* Nutt. (Heliotropiaceae, Boraginales) and a conspectus of the species of the Guiana Shield area

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Academic editor: *S. Knapp* | Received 9 April 2014 | Accepted 24 January 2016 | Published 25 February 2016

Citation: Feuillet C (2016) Two new combinations in *Euploca* Nutt. (Heliotropiaceae, Boraginales) and a conspectus of the species of the Guiana Shield area. PhytoKeys 61: 101–124. doi: 10.3897/phytokeys.61.6260

Abstract

Heliotropium foliatum and *Tournefortia humilis* are transferred to *Euploca* Nutt. respectively as *Euploca foliata* **comb. n.** and *Euploca humilis* **comb. n.** A collection from Guyana has been recently identified as *Euploca humistrata*, a species previously considered a Brazilian endemic. A collection from French Guiana documents for the first time the species in that country. A key to the species of the Guiana Shield area is given. The species of *Euploca* from the Guiana Shield are listed with synonymy and a brief description: *E. filiformis*, *E. humilis*, *E. humistrata*, *E. lagoensis*, *E. polyphylla*, *E. procumbens*.

Keywords

Boraginales, Brazil, *Euploca*, Guiana Shield, Guianas, Heliotropiaceae, Venezuela

Introduction

The genus *Euploca* Nuttall (1836: 189) was created for the new *E. convolvulacea* Nutt. (1836: 190). Between 1848 and 1951, four species and two infra specific names were published that are currently considered to be synonyms of *E. convolvulacea*. *Euploca convolvulacea* was transferred to *Heliotropium* L. (Linnaeus 1753, 1: 130) by Gray (1857: 403). Recently Hilger and Diane (2003) reevaluated the classification of the Heliotropiaceae Schrad. (Schrader 1819: 192) on the base of molecular data of nuclear ITS1

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and plastidal *trn*LUAA intron sequences. One of their conclusions is that *Heliotropium* sect. *Orthostachys* (R.Br.) G.Don (Brown 1810: 493; Don 1838: 361), *Schleidenia* Endl. (Endlicher 1839: 646), and *Hilgeria* Förther (1998: 132) constitute a separate genus whose earlier available name is *Euploca*. Their analysis indicates that *Ixorhea* Fenzl (1886: 287) is sister to the rest of the family consisting of two clades: one composed of *Euploca* and genus *Myriopus* Small (1933: 1131) resurrected to accommodate the species of *Tournefortia* sect. *Cyphocyema* I.M.Johnst. (Johnston 1930: 72), the other one of *Heliotropium* and *Tournefortia* L. (1753, 1: 140). Morphologically *Euploca* and *Myriopus* differ from *Heliotropium* and *Tournefortia* by the shape and structure of the fruits and their curved embryo. *Euploca* species are herbs or subshrubs and have usually dry fruits, in contrast *Myriopus* species are shrubs or passive climbers and have 4-lobed fleshy fruits. Hilger and Diane (2003: p. 47–49) made 20 new combinations in *Euploca*. Melo and Semir (2006; 2009) described three new species and made 12 new combinations. More new combinations were made: one by Luebert (Luebert et al. 2011), four by Degen and Melo (2012), and two by Feuillet (2012). There are probably more than 45 species of *Heliotropium* and *Schleidenia* awaiting a transfer to *Euploca*. Nevertheless, the nomenclature of the species of *Euploca* in the Guiana Shield region should be stable after the new combination *E. humilis* given below.

Methods

I studied the literature and type specimens. In the citation of types, "photo" refers to a print deposited in herbaria and "scan" refers to a picture posted online, available directly through herbarium sites, or sites like JSTOR or Europeana.

For the purpose of this paper, the Guiana Shield area is defined as the Venezuelan Guayana, the Guianas (Guyana, Surinam and French Guiana), and the part of Brazil north of the Amazon River and east of the Rio Negro.

Nomenclature and new combinations

Euploca Nutt., 1836

Euploca Nutt., Trans. Amer. Phil. Soc., ser. 2, 5: 189. 1836.

Heliotropium [unranked] *Orthostachys* R.Br., Prodr.: 493. 1810.

Type species. *Heliotropium foliatum* R.Br. (lectotype designated by Johnston 1928, pg. 46) [= *Euploca foliata* (R.Br.) Feuillet, PhytoKeys 61: 103. 2016.].

Preslaea Mart., Nov. Gen. Sp. 2: 75, t. 164. 1827; non *Preslia* Opiz 1824 (LAMIACEAE).

Type species. *Preslaea paradoxa* Mart. [= Euploca paradoxa (Mart.) J.I.M.Melo & Semir].

Orthostachys (R.Br.) Spach, Hist. Nat. Vég. 9: 32. 1838. ["1840" see Stafleu and Cowan (1985: TL2 vol. 5: 767)]

Type species. Based on *Heliotropium* [unranked] *Orthostachys* R.Br.

Heliotropium sect. *Orthostachys* (R.Br.) G.Don, Gen. Syst. 4: 361. 1838.
Type species. Based on *Heliotropium* [unranked] *Orthostachys* R.Br.
Schleidenia Endl., Gen. Pl. 646. 1839.
Type species. Based on *Preslaea* Mart.
Heliotropium subgen. *Orthostachys* (R.Br.) Rchb., Deut. Bot. Herb.-Buch: 112. 1841.
Type species. Based on *Heliotropium* [unranked] *Orthostachy*s R.Br.
Heliotropium sect. *Euploca* (Nutt.) A.Gray, Proc. Amer. Acad. Arts 10: 49. 1874.
Type species. Based on Euploca Nutt.
Heliotropium sect. *Orthostachys* subsect. *Axillaria* I.M.Johnst., Contr. Gray Herb. 81: 47. 1928.
Type species. *Heliotropium paradoxum* (Mart.) Gürke, in Engl. and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893; non Vatke 1875. (lectotype designated by Förther 1998, pg. 135) [= Euploca paradoxa (Mart.) J.I.M.Melo & Semir].
Heliotropium sect. *Orthostachys* subsect. *Bracteata* I.M.Johnst., Contr. Gray Herb. 81: 47. 1928.
Type species. *Heliotropium bracteatum* R.Br., Prodr.: 493. 1810.
Heliotropium sect. *Orthostachys* subsect. *Ebracteata* I.M.Johnst., Contr. Gray Herb. 81: 47. 1928.
Type species. *Heliotropium procumbens* Mill., Gard. dict.. ed. 8: 10. 1768; non Kunth 1818. [= Euploca procumbens (Mill.) Diane & Hilger].
Hilgeria Förther, Sendtnera 5: 132. 1998.
Type species. *Hilgeria hypogaea* (Urb. & Ekman 1929: 105) Förther [= Euploca hypogaea (Urb. & Ekman) Diane & Hilger].

Type species. *Euploca convolvulacea* Nutt.

Description. Herbs or subshrubs. Leaves alternate, simple, entire. Trichomes on a pedestal of distinctly enlarged foliar epidermis cells. Inflorescences of single, scorpioid cymes, or flowers solitary. Flowers perfect; calyx 5–toothed or 5–lobed, persistent; corolla white, small, 5–merous, lobe's margin involute; stamens 5, included; nectar disc at the base of the ovary; ovary functionally 4–locular, locules 1-seeded, style terminal, undivided, or absent, the stigma cryptically or clearly apically 2- or 4-fid. Fruit a schizocarp, lobed or unlobed, dry, 2–4 bony 1-seeded nutlets, embryos curved.

Distribution. North America to Argentina, Africa, Arabian Peninsula to Indochina, Australia.

***Euploca foliata* (R.Br.) Feuillet, comb. nov.**
urn:lsid:ipni.org:names:77153393-1

Heliotropium foliatum R.Br., Prodr.: 493. 1810.
Type. Australia. Northern Territory: Carpentaria mainland opposite Grote Eyland, 4 Jan 1803, *R. Brown 2932* (lectotype, designated by Craven 1996, pg. 630: BM n.v. [scan!]; isotypes: K!, MEL n.v., NSW n.v.).

Type. Based on *Heliotropium foliatum* R.Br.

Notes. When they resurrected *Euploca*, Hilger and Diane (2003: 42) said that "summarizing all urges a formal taxonomic recombination of EUPLOCA, including all species of *Heliotropium* section *Orthostachys*, *Schleidenia*, and *Hilgeria* into the genus *Euploca*, the oldest available generic name in this group." *Heliotropium foliatum* is the type of *H.* sect. *Orthostachys* (Johnston 1928: 46). Although it is recognized as a good species (example: Förther 1998: 195), *Heliotropium foliatum* was not transferred to *Euploca* until now. Robert Brown did not cite a type collection, only mentioning "v. v." (=seen alive).

***Euploca humilis* (L.) Feuillet, comb. nov.**
urn:lsid:ipni.org:names:77153394-1

Tournefortia humilis L., Sp. Pl.: 141. 1753.

Type. "*Tournefortia foliis lanceolatis*" pl. by Plumier, in Burman, Pl. Amer., 224, t. 227, f. 2. 1760 (lectotype designated by Miller in Cafferty and Jarvis 2004, pg. 804). Epitype: FRANCE. Martinique: Case Pilote, Feb 1868, *L. Hahn 416* (designated by Miller in Cafferty and Jarvis 2004, pg. 804: BM n.v.).

Type. Based on *Tournefortia humilis* L.

Notes. When Melo and Semir (2009: 289) transferred *Heliotropium ternatum* Vahl (1794, 3: 21) to *Euploca*, they did not cite synonyms and they overlooked the case of *Tournefortia humilis* L. There had been a doubt about the exact identity of the Linnean species (Johnston 1949: 136; Förther 1998: 190), but the typification of *Tournefortia humilis* L. by Miller (in Cafferty and Jarvis 2004: 804) placed clearly that species in the synonymy of *Heliotropium ternatum* Vahl (non *H. humile* Lam.). The epithet of *T. humilis* could not be transferred to *Heliotropium*, but there is no previous *Euploca humilis* and the priority rule dictates the adoption of the new combination (McNeill et al. 2012: Art. 11.4).

Because the name *T. humilis* L. or/and *H. humile* (L.) R.Br. ex Roem. & Schult. (1819, 4: 37; non Lam., 1791: 393) have been used in synonymy (Johnston 1928: 69; 1949: 135; and especially the recent revision of *Heliotropium* Förther 1998: 190, 234; and the typification Miller, in Cafferty and Jarvis 2004: 804); because it is a Linnean name; and because the authors of the new combination *Euploca ternata* (Melo and Semir 2009: 289) should have been aware of that name, there are little chances to make a successful proposal to conserve *Euploca ternata*.

Conspectus of *Euploca* for the Guiana Shield region

The last treatment of *Heliotropium* (including *Euploca*) for the Guianas (Johnston 1935) included four of the six species treated below: *H. filiforme*=*E. filiformis*, *H. lagoense*=*E. lagoensis*, *H. procumbens*=*E. procumbens*, *H. ternatum*=*E. humilis*. Since then *E. humistrata*

has been identified from a seasonally flooded savanna in Guyana, the distribution area of *E. lagoensis* includes French Guiana. Besides, *E. polyphylla* not present in the Guianas occurs in the Venezuelan Guayana (State of Bolívar). The species present in the Guiana Shield region are usually found on sand near water or in seasonally dry localities.

Key to the species of *Euploca* in the Guiana Shield

1 Flowers solitary; pedicels 1–3 mm long; corolla white and yellow **2**

– Inflorescences 1–18 cm long; flowers sessile or sub-sessile, or pedicels obvious; corolla white or yellow..... **3**

2 Stem glabrous or puberulent; leaf blades glabrous or puberulent; corolla white, yellow at throat, lobes elliptic ..... ***E. lagoensis***

– Stem villose; leaf blades with long, stiff trichomes; corolla tube yellow, lobes white, ovate .....***E. humistrata***

3 Petiole 4–15 mm long; raceme mostly geminate or ternate, ebracteate; stigma sessile, base as wide as the apex of the ovary, forming together a blunt cone.... .....***E. procumbens***

– Petiole 0.3–2 mm long; raceme single or paired, bracteate; stigma morphologically clearly separate from the ovary, looking together like a mushroom or like a head with a hat or with a clear style **4**

4 Leaf blade Inflorescences always single; bract filiform to narrowly elliptic; calyx length greater than or less than half the corolla tube; corolla white; style 0.3–0.5 mm long..... **5**

– Inflorescences usually single and paired on the same plant; bracts ovate; calyx nearly as long as the corolla tube; corolla yellow; style 0.5–1 mm long..... .....***E. polyphylla***

5 Stem relatively coarse and stiff; leaves drying rather light colored; inflorescences up to 20 cm long, with 1–2 cm long peduncle; calyx shorter than half the corolla tube; corolla 4–6 mm long, salverform; anthers apically joined; stigma on a short style..... ***E. humilis***

– Stem wiry, very slender; leaves usually drying dark colored; inflorescences epedunculate, up to 10 cm long; calyx longer than the corolla tube; corolla 2–2.5 mm long, tube urceolate; anthers not joined at apex; stigma sessile..... .....***E. filiformis***

***Euploca filiformis* (Lehm.) J.I.M.Melo & Semir, 2009**

Euploca filiformis (Lehm.) J.I.M.Melo & Semir, Kew Bull. 64: 289. 2009.
Heliotropium filiforme Lehm., Gött. Gel. Anz. 3(152): 1515. 1817.

Type. Venezuela. Near Orinoco, *Bonpland and Humboldt 1202* [an error, most likely for *1203*] (lectotype, designated by Förther 1998, pg. 195: B-W 3246/1 n.v.

[scan!]; isotypes MEL 233288 n.v., P! [2 sheets; scans!], P-Bonpl! [scan!]). [same type collection as next, but different holotype]

Heliotropium filiforme Kunth, Nov. Gen. Sp. (quarto ed.) 3: 86, t. 204. 1818, nom. illeg. non *H. filiforme* Lehm. 1817.

Type. Venezuela. Near Orinoco, *Bonpland and Humboldt 1203* (holotype P-Bonpl! [scan!]; isotypes B-Willd 3246/1 n.v. [scan!], MEL 233288 n.v., P! [2 sheets; scans!]. [same type collection as previous, but different holotype]

Heliotropium tenue Roem. & Schult., Syst. Veg. 4: 737. 1819.

Type. Brazil. Pará, *Sieber for Hoffmannsegg s.n.* (holotype B-WILLD-3248!; isotypes HAL n.v., MEL 233189 n.v., P!).

Preslaea stenostachya A.St.-Hil., Voy. Distr. Diam. 2: 434. 1833.

Type. Brazil. "Ad ripas fluminis Parahyba", *St.-Hilaire B228* (lectotype, designated by Förther 1998, pg. 235: P! [scan!]; isotypes K!, M n.v., MPU!, P! [scan!]).

Heliotropium littorale Mart. ex Colla, Herb. Pedem. 4: 226. 1835.

Type. Brazil. "In arenosis maritimis", *Martius s.n.* (holotype TO n.v.; isotype BM n.v.).

Note. placed in the synonymy fide Förther 1998 who saw the isotype at BM.

Heliotropium pusillum Colla, Herb. Pedem. 4: 227. 1835.

Type. Brazil. *Martius s.n.* (holotype TO n.v.).

Heliotropium helophilum Mart., Flora 21(2), Beibl. 4: 85. 1838.

Type. Brazil. "Propre Cujaba", 1837, *Herb. Fl. Bras. 165, n°267* (lectotype, designated by Förther 1998, pg. 199: BR n.v. [scan!]; isotypes E n.v. [scan!], FI-W!, G-DC!, GH n.v., L! [2 sheets], LE n.v. [2 sheets], M n.v., P! [2 sheets; scans!], W n.v.).

Schleidenia stenostachya (A.St.-Hil.) DC., Prodr. 9: 558. 1845.

Type. Based on *Preslaea stenostachya* A.St.-Hil.

Schleidenia filiformis (Lehm.) Fresen., Fl. Bras. 8(1): 40. 1857.

Type. Based on *Heliotropium filiforme* Lehm.

Heliotropium stenostachyum (A.St.-Hil.) Gürke, in Engler and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893.

Type. Based on *Preslaea stenostachya* A.St.-Hil.

Type. Based on *Heliotropium filiforme* Lehm.

Description. Annual herb or subshrub, up to 0.25 m tall. Stems slender, erect or decumbent, up to 0.4 m long, sparingly strigose. Leaves: petiole 0.1–0.2 cm long, slender; lamina linear or elliptic or lanceolate or oblanceolate, 1–2.5 × 0.15–0.35 cm, apex acute, base acute, margin entire, both surfaces sericeous to strigose. Inflorescences epedunculate, slender scorpioid cymes, up to 15 cm long, bearing scattered bracts, filiform or subulate, 0.1–0.2 cm long, glabrescent. Flower sub–sessile: calyx longer than the corolla tube, lobes, 1.5–2 mm long at anthesis, glabrescent; corolla white, tubular, outside strigose, inside glabrescent, tube narrowed in the middle, lobes ovate with broadly open sinuses, about 1 mm long; stamens sessile, anther with an apical appendage, weakly coherent; ovary subglobose or globose, strigose; style lacking or nearly so; stigma sessile or sub–sessile, fertile base much wider than the apex of the ovary. Fruit on 0.5–1 mm long pedicel, depressed–globose; nutlets almost 1.5 mm long.

Distribution. Venezuela (Amazonas, Bolívar), Guyana, Surinam, French Guiana, Brazil (Amapá, Amazonas, Pará, Roraima); also in Belize, Mexico, southeastern USA and from Trinidad to eastern Bolivia and Paraguay.

Selected specimens studied. Guyana: Cuyuni River, Matope Falls, 4 June 1952, *Forest Department 6940 (Fanshawe 3376)* (K, NY); Upper Takutu-Upper Essequibo, Dadanawa, 24 Oct 1957, *Cook 22* (K, NY). **Surinam**: near Coppename River, Central Suriname Nature Reserve, 4°25'N, 56°31'W, 50–75 m, 22 Feb 2004, *Clarke 11037* (US); near Ulemari River, 13 km upstream from confluence with Litani River, 3°13'N, 54°15'W, 150 m, 2 Apr 1998, *Hammel 21275* (MO, US). **French Guiana**: Itany River, Saut upstream from Touinké, 26 Nov 1977, *Cremers 5119* (CAY); Oyapock River, Sauts Fourmi, 18 Nov 1984, *Granville 6916* (CAY, P).

***Euploca humilis* (L.) Feuillet, comb. nov.**
urn:lsid:ipni.org:names:77153394-1

Tournefortia humilis L., Sp. Pl. 1: 141. 1753.
Type. "*Tournefortia foliis lanceolatis*" in Plumier in Burman, Pl. Amer., 224, t. 227, f. 2, 1760 [http://biodiversitylibrary.org/page/779658] (lectotype designated by Miller in Cafferty and Jarvis 2004: 804). Epitype: France. Martinique: Case Pilote, Feb 1868, *L. Hahn 416* (designated, by Miller in Cafferty and Jarvis 2004, 804: BM n.v.)).

Heliotropium ternatum Vahl, Symb. Bot. 3:21. 1794.
Type. [Jamaica], "*in India occidentali*" (holotype C n.v. [scan!; microfiche 37: I, 3; photo GH!]).

Heliotropium hirtum Lehm., Neue Schriften Naturf. Ges. Halle 3(2): 10. 1817.
Type. Venezuela. Cumana, *Humboldt and Bonpland s.n.* (lectotype, designated by Förther 1998, pg. 199: B-WILLD 3247!; isotypes MEL 233292 n.v., P! [scan!], P-Bonpl! [scan!]) [same type collection as *H. hispidum* Kunth (see below), but a different holotype].

Heliotropium demissum Roem. & Schult., Syst. Veg. ed 15bis 4: 37. 1819.
Type. nom. illeg. renaming of *Tournefortia humilis* L.

Heliotropium humile (L.) R.Br. ex Roem. & Schult., Syst. Veg. ed 15bis 4: 37. 1819; non Lam. 1791.
Type. nom. illeg. in syn. of previous.

Heliotropium hispidum Kunth, Nov. Gen. Sp. (quarto ed.) 3: 87. 1818; illeg. not Lehm. 1817.
Type. Venezuela. near Cumana, Sep, *Humboldt and Bonpland s.n.* (holotype P-Bonpl! [scan!]; isotypes B-WILLD 3247!, MEL 233292 n.v., P! [scan!]) [same type collection as *H. hirtum* Lehm. (see above), but a different holotype].

Pioctonon ternatum (Vahl) Raf., Sylva Tellur.: 88. 1838.
Type. Based on *Heliotropium ternatum* Vahl

Pioctonon antillanum Raf., Sylva Tellur. 88. 1838.
Type. nom. illeg. renaming of *Tournefortia humilis* L.

Tournefortia incana (G.Mey.) G.Don, Gen. Hist. 4: 368. 1838; non Lam. 1791.
Type. Based on *Messerschmidia incana* G.Mey.; nom. inval.
Tournefortia meyeri DC., Prodr. 9: 530. 1845.
Type. Renaming of *Messerschmidia incana* G. Mey.; nom. inval.
Heliotropium fruticosum var. *ternatum* (Vahl) DC., Prodr. 9: 542. 1845.
Type. Based on *Heliotropium ternatum* Vahl
Heliotropium oaxacanum DC., Prodr. 9: 543. 1845.
Type. Mexico. Oaxaca, Aug 1834, *Andrieux 205* (holotype G-DC !; isotypes FI-W n.v. [fragment GH n.v.], P!, W n.v.).
Heliophytum passerinoides Klotzsch, in Rich. Schomburgk, Reis. Br.-Guiana 3: 1152. 1849 ["1848"]; nom. nud.
Type. Based on Guyana. Rupununi: May 1842, *Schomburgk 573* (B†).
Schleidenia hispida (Kunth) Fresen., Fl. Bras. 8(1): 37. 1857.
Type. Based on *Heliotropium hispidum* Kunth
Schleidenia fumana Fresen., in Mart.: Fl. Bras. 8, 1: 40. 1857.
Syntype. Brazil. Minas Gerais, *Vauthier s.n.* (G n.v.). Type : Brazil. "ad Formigas et Ribeirao Catinga", *Pohl 565 (= 3081 bzw. distr. nr. 1588)* (lectotype, designated by Förther 1998, pg. 235: W n.v., photo MSB-55474; isotypes B† [photo F-17322, GH!, NY!, US!], F-874797 n.v. [scan!], GH, K!, M n.v., [as s.n.] W n.v.).
Heliotropium fumana (Fresen.) Gürke, in Engler and Prantl: Nat. Pflanzenf. 4, Abt. 3a: 97. 1893.
Type. Based on *Schleidenia fumana* Fresen.
Heliotropium mexicanum Greenm., Proc. Amer. Acad. Arts 33(25): 484. 1898; illegitimate: not Sessé & Moç. 1888.
Syntypes: Mexico. *Dugès s.n.*; *Pelmer 31, 98*; *L.C. Smith 209, 391*; *Alvarez 750*; *Pringle 672*6. Type. Mexico. Iron Mtn, near Durando, June 1897, *Palmer 141* (lectotype, designated by Frohlich 1981, pg. 100: GH n.v.; isotypes BM n.v., F n.v., M n.v., MICH n.v. [scan!], MO!, NY!, S n.v., US!).
Heliotropium strictissimum sensu N.E. Br. 1901; not A. DC. 1845.
Heliotropium ternatum var. *fumana* (Fresen.) I.M.Johnst., J. Arnold Arb. 16:62. 1935.
Type. Based on *Schleidenia fumana* Fresen.
Heliotropium greenmanii Wiggins, Contr. Dudley Herb. 4:22. 1950.
Type. Based on *Heliotropium mexicanum* Greenm.
Euploca ternata (Vahl) J.I.M.Melo & Semir, Kew Bull. 64: 289. 2009.
Type. Based on *Heliotropium ternatum* Vahl

Type. Based on *Tournefortia humilis* L.

Description. Suffrutescent herbs up to 30 cm tall; stems stiff, erect or decumbent, 10–50 cm long, with abundant, loosely appressed trichomes. Leaves: petiole subnul–2 mm long, thin; lamina lanceolate to linear, revolute, 0.5–3 × 0.1–0.8 cm, apex acute, base acute, margin +/- revolute, adaxially sericeous, abaxially tomentose, trichomes base very large and looking calcified. Inflorescences terminal or axillary, up to 20 cm long, stiff scorpioid cymes, single, peduncle 1–2 cm long, with scattered linear or narrowly elliptic bracts, 2–3 mm long, sericeous. Flower subsessile: pedicel 0.5–1 mm

long, calyx 2–3 mm long, deeply lobed, lobes unequal, shorter than 1/2 the length of the corolla tube, becoming twice as large at maturity, sericeous in and out; corolla white, strigose outside, tube narrow, 2–2.7 mm long, throat yellow, lobes spreading, 1.3–2 mm long, ovate, sinuses rounded and plicate; stamens subsessile, anthers ovate with short, obtuse, hairy, apical long appendages which are apically joined; ovary globose, 0.3–0.4 mm diam., glabrous; style short but obvious, about 0.5 mm long; stigma about as large as the ovary, split at apex. Fruit depressed globose, 4–lobed, 1.5–1.8 mm diam., strigose or hirsute; nutlets 1–1.5 mm long.

Distribution. Venezuela (Bolívar) and Guyana; also Central America, Mexico, and the West Indies Southward to southern Brazil.

Selected specimens studied. Guyana: Potaro-Siparuni, Iwokrama, Kurupukari Falls, 4°40'N, 58°40'W, 100 m, 9 Dec 1994, *Mutchnick 595* (BRG, CAY, L, MO, NY, US); Upper Takutu-Upper Essequibo, near Sand Creek, Baboon Hill, 3°00'N, 59°31'W, 120–150 m, 21 June 1989, *Gillespie 1801* (BRG, CAY, L, MO, US); near Sand Creek, Sep 1948, *Wilson-Browne 128* (NY).

***Euploca humistrata* (Cham.) J.I.M.Melo & Semir, 2009**
Fig. 1

Euploca humistrata (Cham.) J.I.M.Melo & Semir, Kew Bull. 64(2): 288. 2009
Heliotropium humistratum Cham., Linnaea 4: 462. 1829.
Type [fide Förther 1998: 200]: Brazil. Minas Gerais: Faz de Piedade, 1818, *Sellow s.n.* (holotype LE n.v.; isotypes B† [fragment GH n.v.; photo F-17325, GH, NY, US], G-DC!, HAL n.v. [scan!], K!).
Schleidenia humistrata (Cham.) Fresen., Fl. Bras. 8(1): 34. 1857.
Type: Based on *Heliotropium humistratum* Cham.

Type. Based on *Heliotropium humistratum* Cham.

Distribution. Prostrate herbs. Stems villose, trichomes hyaline, somewhat ferruginous around the nodes. Leaves: petiole short; lamina lanceolate, 0.5–0.8 × 0.15–0.2 cm, apex acute, base attenuate, margin entire, both surfaces villose. Inflorescence: solitary, supra-axillary flowers, on 1–1.5 mm long pedicel. Flowers: calyx as long as the corolla tube, lobes, 2.2–2.7 mm long at anthesis, puberulent on both sides; corolla tube yellow with white lobes, outside strigose, inside pubescent, tube more or less cylindric, lobes ovate with narrow sinuses, about 1 mm long; stamens sessile, anther with a small appendage; ovary ca. 0.3 mm diam., globose, glabrous; style lacking; stigma sessile, widely conical. Fruit on 1.2–2 mm long pedicel, subglobose, 1.5 mm diam., glabrous, rostrate; nutlets about 1.2 mm long.

Distribution. Guyana; previously only known from a few localities outside the Guiana Shield, Brazil (Ceará, Goiás, Minas Gerais), Venezuela (Apure). In our area it is known only by GUYANA, Upper Takutu–Upper Essequibo, W of the Kanuku Mtns, savanna near Mountain Point, 27 Feb–5 Mar 1985, fl, *C. Feuillet 1632* (CAY).

Figure 1. *Euploca humistrata*. Guyana, Upper Takutu-Upper Essequibo, Rupununi savanna, savanna near Mountain Point, 27 Feb–5 Mar 1985, *Feuillet 1632* (CAY). Picture by Ingrid Lin at US.

Notes. Melo and Semir (2009: 288) cited the type as "*Oliveira 239* (holotype BHCB!; isotype BHMH!)". This is obviously a misunderstanding. Melo and Semir (2010: 117) cited the holotype, *Sellow s.n.*, as being at GH. In fact at GH is a fragment of the isotype, now destroyed, that was at B. Förther (1998: 200) cites the holotype at LE.

***Euploca lagoensis* (Warm.) Diane & Hilger, in Hilger and Diane, 2003**
Fig. 2

Euploca lagoensis (Warm.) Diane & Hilger, in Hilger and Diane: Bot. Jahrb. Syst. 125 (1): 48. 2003.

Schleidenia lagoensis Warm., Kjoeb. Vidensk. Meddel 1867: 15. 1868.
Type: Brazil. Minas Gerais: Lagoa Santa ad ripam lacus, 5 Nov 1864, *Warming s.n.* (holotype C n.v. [scan!; photos F-21971, M, MO]; isotypes GH n.v. [fragment], P! [scan!]).

Schleidenia subracemosa Warm., Kjoeb. Vidensk. Meddel 1867: 15. 1868.
Type: Brazil. Minas Gerais: Lagoa Santa, 28 Jan 1866, *Warming s.n.* (holotype C [photo F-21972, GH, US]; isotype P! [scan!]).

Heliotropium lagoense (Warm.) Gürke, in Engler and Prantl, Nat. Pflanzemf. 4(3a): 97. 1893.
Type: Based on *Schleidenia lagoensis* Warm.

Heliotropium trinitense Urb., Symb. Ant. 7(3): 350. 1912.
Type: Trinidad. in Piarco Savannah, 10 May 1895, *Lunt 6030* (holotype B †; lectotype, designated by Förther 1998, pg. 225: S n.v. [scan!]; isotypes [fragments of holotype GH n.v. and lectotype GH n.v.]).

Type. Based on *Schleidenia lagoensis* Warm.

Description. Annual herbs, up to 15 cm tall, stems decumbent or prostrate, up to 30 cm long, glabrous or with scattered slender appressed trichomes. Leaves: petiole about 1 mm long, glabrous; lamina oblanceolate, 0.5–1.5 × 0.1–0.3 cm, apex acute to acuminate, base attenuate, margin entire, ciliate, adaxially glabrous, abaxially glabrous to puberulent. Flowers single, extra–axillary on leafy stems: pedicel up to 3 mm long, calyx of 5 lanceolate or cuneate, unequal lobes, 1.5–2.5 mm long at anthesis, puberulent in and out; corolla white, yellow at throat, tube swollen at base, 3–4 mm long, puberulent in and out, lobes ovate, 1–1.5 mm long, with sinus rounded, occasionally plaited with a minute lobule; stamens sessile, inserted about 0.5 mm from base, anthers joined, oblong, with an hairy apical appendage nearly as large as the anther; ovary obpyriform, about 0.5 mm diam.; style lacking or confused with the apex of the ovary; stigma sessile or subsessile, much larger at base; fruit rostrate, glabrous or nearly so, about 2 mm diam., obpyriform; nutlets ca. 1.5–2 mm long.

Distribution. Venezuela (Bolívar), Surinam, French Guiana, and Brazil (Amazonas); also Greater Antilles and from Mexico to Brazil and eastern Bolivia. *Euploca lagoensis* is new to French Guiana. I have seen only few specimens from the Guiana Shield.

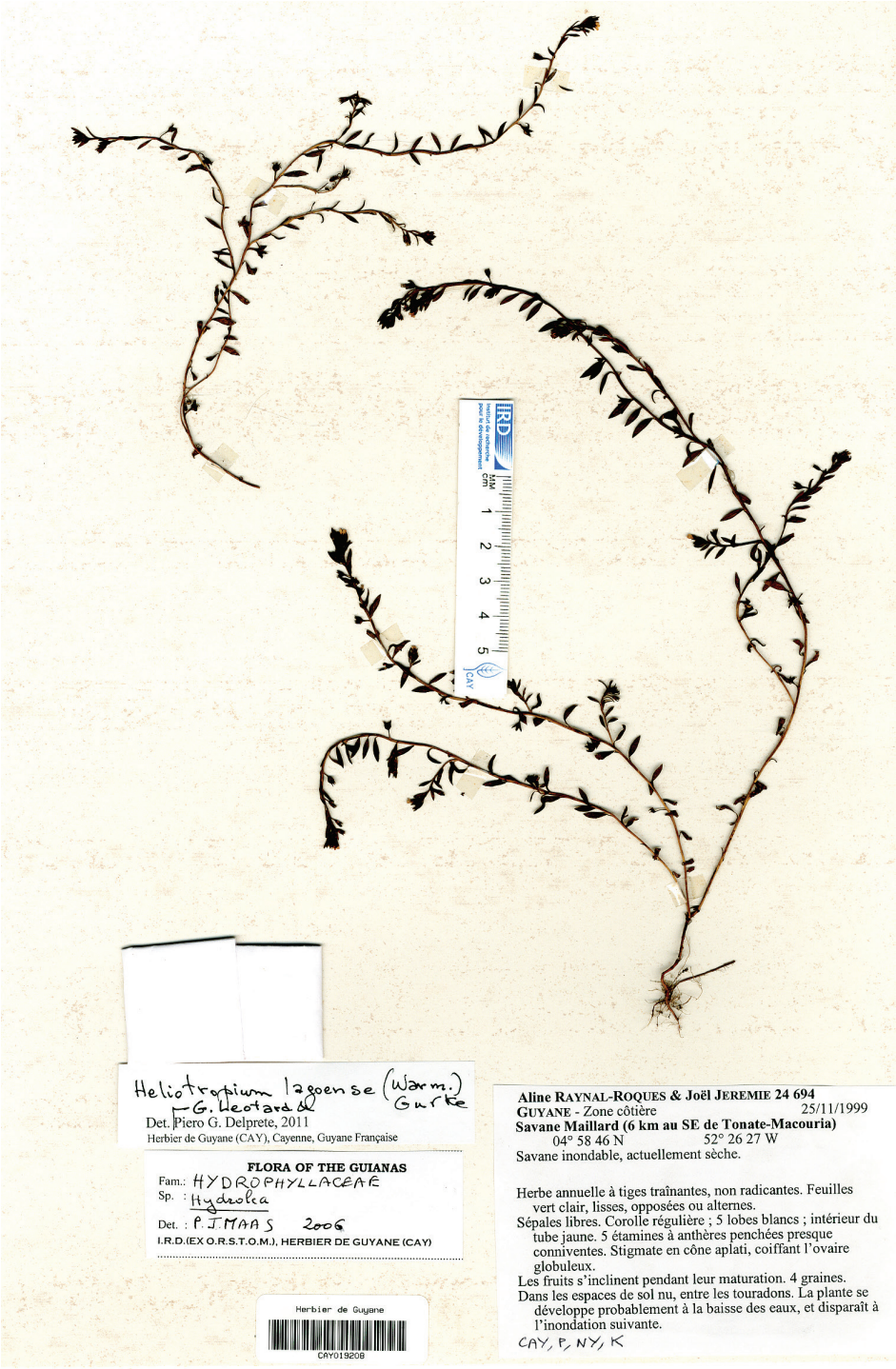

Figure 2. *Euploca lagoensis*. French Guiana, SE of Tonate-Macouria, Savane Maillard, 25 Nov 1999, *Raynal-Roques and Jérémie 24694* (CAY). (Picture by Piero Delprete at CAY).

Selected specimens studied. Venezuela, Bolívar, near San Carlos, Laguna de la Culebra, 6 Apr 1925, fl, *Pittier 11703* (P). **Surinam**, In 1885, *W.F.R. Suringar s.n.* (L); *Mennega 907* (L). **French Guiana**, Savane Maillard, 6 km SE de Tonate-Macouria, 4°58'N, 52°26'W, 25 Nov 1999, *Raynal-Roques and Jérémie 24694* (CAY, K, P, NY).

Note. Melo and Semir (2010) cited the holotype as being at M. I do not think there is a specimen at M, only a photograph. Furthermore, if Warming worked in Munich, it was about 7 years after he described *Schleidenia lagoensis*. In the 1867 he was working in Copenhagen, I do not see any reason to reject Förther's (1998) choice of the specimen at C as the holotype.

Euploca polyphylla (Lehm.) J.I.M.Melo & Semir, 2009

Euploca polyphylla (Lehm.) J.I.M.Melo & Semir, Kew Bull. 64(2): 289. 2009.

Heliotropium polyphyllum Lehm., Neue Schriften Naturf. Ges. Halle 3(2): 9. 1817.
Type (fide Förther 1998: 214). Venezuela. near Orinoco, *Humboldt s.n.* (holotype MEL 233310 n.v.; isotypes B-Willd 3252 n.v., P! [scan!], S 11-21939 n.v. [scan!]).

Heliotropium foliosum Roem. & Schult., Syst. Veg. 4: 737. 1819.
Type. Venezuela. Orinoco, Apr 1800, *Humboldt and Bonpland 808* (holotype B-WILLD 3252-01 n.v.).

Preslaea linifolia A.St.-Hil., Voy. Distr. Diam. 2: 433. 1833.
Type. Brazil. Cabo Frio, *St.-Hilaire 433* (lectotype, designated by Förther 1998, pg. 234: P!; isotypes B †, M n.v., MPU!, P! [2 sheets]).

Heliotropium bahiense DC., Prodr. 9: 544. 1845.
Syntype: Brazil. *Blanchet 92* (G n.v., NY!, P!). Type. Brazil. Bahia, 1836, *Salzmann 368* (lectotype, designated by Förther 1998, pg. 181: G-DC n.v.; isotypes B †, F n.v., H n.v., HAL n.v., K!, M n.v., MPU!, P! [4 sheets]).

Heliotropium polyphyllum var. *blanchetii* DC., Prodr. 9: 544. 1845.
Type. Brazil. Bahia, Serra Jacobina, 1837, *Blanchet 2651* (lectotype, designated by Förther 1998, pg. 214: G-DC n.v.; isotypes B† [photo F-17340, GH, NY, US], BM n.v. [fragment GH n.v.], BR n.v., F-520830 n.v. [photo F-57735], FI-W!, HAL n.v., K! [scan !], LE n.v., M n.v., NY!, P! [2 sheets], TUB n.v., US-292391!, W-118162 n.v.).

Schleidenia linifolia (A.St.-Hil.) DC., Prodr. 9: 558. 1845.
Type. Based on *Preslaea linifolia* A.St.-Hil.

Schleidenia pubescens Fresen., Fl. Bras. 8(1): 35. 1857.
Type. Brazil. Rio de Janeiro, *Gaudichaud [524]* (lectotype, designated by Förther 1998, pg. 236: P!; isotype B†).

Schleidenia polyphylla (Lehm.) Fresen., Fl. Bras. 8(1): 36. 1857.
Type. Based on *Heliotropium polyphyllum* Lehm.

Schleidenia polyphylla var. *blanchetii* (DC.) Fresen., Fl. Bras. 8(1): 36. 1857.
Type. Based on *Heliotropium polyphyllum* var. *blanchetii* DC.

Schleidenia bahiensis (DC.) Fresen., Fl. Bras. 8(1): 43. 1857.
Type. Based on *Heliotropium bahiense* DC.

Heliotropium polyphyllum var. *laevenworthii* A.Gray, Syn. Fl. N. Amer. 2(1): 185. 1878.
Syntypes: USA. Florida: Everglades, *Leavenworth s.n.*; *Palmer s.n.* (F). Type. USA. Florida: Everglades, 1877, *Garber s.n.* (lectotype, designated by Förther 1998, pg. 214: GH n.v.; isotype K n.v. [scan!]).

Heliotropium pubescens (Fresen.) Gürke, in Engler and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893.
Type. Based on *Schleidenia pubescens* Fresen.

Heliotropium linifolium (A.St.-Hil.) Gürke, in Engler and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893; illegitimate: not Lehm. 1818.
Type. Based on *Preslaea linifolia* A.St.-Hil.

Heliotropium laevenworthii (A.Gray) Small, Fl. S. E. U.S.: 1006. 1903.
Type. Based on *Heliotropium polyphyllum* var. *laevenworthii* A.Gray

Heliotropium horizontale Small, Bull. New York Bot. Gard. 3: 435. 1905.
Type. USA. Florida: 9–12 Nov 1903, *Small and Carter 742* (holotype NY! [photo GH]; isotypes F n.v., GH n.v. [fragment], US!).

Heliotropium polyphyllum var. *horizontale* (Small) R.W.Long, Rhodora 72: 33. 1970.
Type. Based on *Heliotropium horizontale* Small

Type. Based on *Heliotropium polyphyllum* Lehm.

Description. Herb or subshrub. Stems prostrate or decumbent, sericeous. Leaves alternate or subopposite: petiole 0.03–0.1 cm long, sericeous; lamina narrow lanceolate or oblanceolate, 0.6–1.3 × 0.1–0.2 cm, apex acute, base cuneate, margin entire, both surfaces sericeous. Inflorescences single or paired, cymose, 1–15 cm long, bracts ovate, 0.3–0.4 cm long, sericeous inside, glabrous outside. Flower sub–sessile: calyx slightly shorter than the corolla tube, lobes, 3–4 mm long at anthesis, glabrous inside, sericeous outside; corolla yellow or white, tubular, outside sericeous, inside sericeous at throat, tube widened in the middle, lobes ovate-deltoid, with narrow sinuses, 2.5–3 mm long; stamens subsessile, anther with a long appendage; ovary subglobose, 4-sulcate, glabrous; style 0.3–0.6 mm long; stigma conical. Fruit subglobose, entirely covered by the calyx; nutlets almost 1.5 mm diam.

Distribution. Venezuela (Bolívar), Brazil (Amapá, Amazonas, Pará); also USA (Florida), Bahamas, Venezuela, eastern Brazil.

Euploca procumbens (Mill.) Diane & Hilger, in Hilger and Diane, 2003

Euploca procumbens (Mill.) Diane & Hilger, in Hilger and Diane: Bot. Jahrb. Syst. 125 (1): 48. 2003.

Heliotropium procumbens Mill., Gard. Dict. ed. 8, Heliotropium n°10. 1768.
Type. Jamaica. *herb. Miller (coll. Houston?) s.n.* (lectotype, designated by Howard 1989, pg. 204: BM n.v. [photo GH!]).

Heliotropium americanum Mill., Gard. Dict. ed. 8, Heliotropium n°11. 1768.

Type. Mexico. Vera Cruz, 1731, *Houston s.n.* (lectotype, designated by Förther 1998, pg. 178: BM n.v.).

Heliotropium inundatum Sw., Prodr. 40. 1788.

Type (fide Förther 1998: 201). Jamaica. "insulae caribaeae", probably a *Swartz coll.* (holotype S?).

Heliotropium decumbens Lehm., Neue Schr. Naturf. Ges. Halle 3(2): 16. 1817.

Type. Venezuela. Sucre: Cumana, *Humboldt and Bonpland 57* (lectotype, designated by Förther 1998, pg. 190; B-WILLD 3239! [scan!]; isotypes MEL n.v., HAL n.v. [scan!], P! [2 sheets; scans!], P-Bonpl!) [same type collection as *Heliotropium procumbens* Kunth (below), but different holotype].

Heliotropium canescens Lehm., Pl. Asperif. Nucif. 38. 1818; illegitimate: not Moench 1794.

Type. Brazil. *Sieber pro Hoffmannsegg s.n.* (holotype B-WILLD 3242 n.v.; isotypes MEL 233279 n.v., HAL 71587 n.v. [scan!], P! [scan!], S n.v. [scan!]).

Heliotropium procumbens Kunth, Nov. Gen. Sp. (quarto ed.) 3: 88. 1818; nom. illeg. non Mill. 1768 + homotypic (different holo-) with *H. decumbens* Lehm. 1817.

Type. Venezuela. Sucre: Cumana, *Humboldt and Bonpland 57* (holotype P-Bonpl!; isotypes MEL n.v., HAL n.v., P! [2 sheets], B-WILLD 3239!) [same type collection as *Heliotropium decumbens* Lehm. (above), but different holotype].

Heliotropium canescens Kunth, Nov. Gen. Sp. (quarto ed.) 3: 88. 1818; nom. illeg. non Moench. 1794: 415.

Type. Venezuela. near Cumana, *Humboldt 58* (holotype P!; isotype B-WILLD 3240/1!).

Heliotropium cinereum Kunth, Nov. Gen. Sp. (quarto ed.) 3: 89. 1818.

Type. Venezuela. [Apure:] bank of the Apures, propre Arichuna, Mar, *Bonpland and Humboldt 1202* (holotype P-Bonpl.!; isotypes B-WILLD 3240/2!, F n.v., P! [2 sheets]). [Same type collection as *H. humboldtianum* below, but different holotype]

Heliotropium humboldtianum Roem. & Schult., Syst. Veg. 4: 737. 1819.

Type. Venezuela. [Apure:] bank of the Apures, propre Arichuna, Mar, *Bonpland and Humboldt 1202* (lectotype, designated by Förther 1998, pg. 200: B-WILLD 3240/2!; isotypes F n.v., P! [2 sheets], P-Bonpl!). [Same type collection as *H. cinereum* above, but different holotype]

Heliotropium brasilianum Roth, Nov. Pl. Sp.: 103. 1821.

Type. Brazil. *Mertens s.n.* (holotype B † [photo F-17314, GH, NY, US]).

Heliotropium riparium Mart. ex Colla, Herb. Pedem. 4: 226. 1835.

Type. Brazil. Rio Belmonte, *Martius s.n.* (holotype TO n.v.; isotypes BM n.v., BR n.v., K!).

Heliotropium willdenowii G. Don, Gen. Hist. 4: 359. 1838.

Type. A renaming of illegitimate *Heliotropium canescens* Lehm.

Heliotropium rigidulum DC., Prodr. 9: 543. 1845.

Type. Mexico. near Matamoros, July 1831, *Berlandier pl. exs. 234* (holotype G-DC n.v.; isotypes BM n.v., BP n.v., F n.v. [scan!], G-DC n.v., LE n.v., P! [2 sheets, scans!], W n.v.).

Heliotropium houstonii DC., Prodr. 9: 549. 1845; nom. illeg. renaming of *H. procumbens* Mill.

Type. Based on *Heliotropium procumbens* Mill.

Schleidenia elliptica Fresen., Fl. Bras. 8(1): 42. 1857.

Type. Brazil. Minas Gerais: near Salvado, Aug 1819, *Martius s.n.* (lectotype, designated by Förther 1998, pg. 235: M n.v.; isotype M n.v.).

Schleidenia longepetiolata Fresen., Fl. Bras. 8(1): 42. 1857.

Type. Brazil. Goyaz: Rio Maranhao, *Pohl 2352* and *2384* (sic! distributed as 1593) (lectotype, designated by Förther 1998, pg. 236: W n.v. [photo F-31909, GH, US]; isotypes F n.v. [scan!; photo F-57726], K! [scan!], W n.v.).

Schleidenia inundata (Sw.) Fresen., Fl. Bras. 8(1): 43. 1857.

Type. Based on *Heliotropium inundatum* Sw.

Schleidenia leptostachya Fresen., Fl. Bras. 8(1): 43. 1857.

Syntype: Brazil. Bahia: *Blanchet 3610* (G n.v., GH n.v. [fragments, scan!], NY!, P! [3 sheets, scans!]). Type. Brazil. Bahia: near Joazeiro, Apr 1819, *Martius s.n.* (lectotype, designated by Förther 1998, pg. 235: M [photo F-20310, NY, GH]; isotypes FI-W!, GH [fragment], M [2 sheets]).

Heliotropium ellipticum (Fresen.) Gürke, in Engler and Prantl, Nat. Pflanzenfam.. 4(3a): 97. 1893.

Type. Based on *Schleidenia elliptica* Fresen.

Heliotropium leptostachyum (Fresen.) Gürke, in Engler and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893.

Type. Based on *Schleidenia leptostachya* Fresen.

Heliotropium longepetiolatum (Fresen.) Gürke, in Engler and Prantl, Nat. Pflanzenfam. 4(3a): 97. 1893.

Type. Based on *Schleidenia longepetiolata* Fresen.

Heliotropium bridgesii Rusby, Mem. Torrey Bot. Club 4: 224. 1895.

Type. Bolivia. Cochabamba, 1891, *Bang 950* (holotype NY!; isotypes B †, BM n.v., GH n.v., K n.v., LE n.v., M n.v., MO n.v. [scan!], NY!, US! [2 sheets], W n.v.).

Heliotropium riparium Chodat, Bull. Herb. Boiss., sér. 2, 2: 817. 1902; nom. illeg. non Mart. ex Colla 1835.

Type. Paraguay. "ad ripam lacus Ypacaray", *Hassler 3893* (holotype G!; isotype P§

Type. Based on *Heliotropium procumbens* Mill.

Description. Annual herbs up to 50 cm long, usually cinereous; stems erect or decumbent, sericeous, trichomes appressed. Leaves: petiole slender, 0.4–2.4 cm long; lamina elliptic, obovate or broadly oblanceolate, 1–6 × 0.3–2 cm, apex acute, mucronate, base attenuate, margin entire, both surfaces sericeous. Inflorescences terminal or axillary, peduncle 1–3 cm long, slender scorpioid cymes, mostly geminate or ternate, bractless, up to 10 cm long, sericeous. Flower subsessile: calyx deeply lobed, lobes unequal, lanceolate to linear, about 2/3 as long as corolla tube; corolla white, tube 1–1.4 mm long, throat yellow, lobes spreading ovate with rounded sinus, < 0.5 mm long; stamens subsessile, anthers ovate with a small apical appendage, free; ovary about 0.3 mm diam., style lacking; stigma sessile forming with the ovary a blunt cone. Fruit: depressed-globose, 4-lobed, strigose; nutlets up to 1 mm long.

Distribution. Venezuela (Amazonas, Bolívar, Delta Amacuro), Guyana, Brazil (Pará, Roraima); also West Indies and from Southern United States to Argentina.

Selected specimens studied. Guyana. s.l., *Appun 1762* (K); 1839, *Rob. Schomburgk 1024* (K); *Schomburgk 1026* (K); Upper Takutu-Upper Essequibo, NW Kanuku Mtns, near Nappi Village, 13 Feb 1993, *Hoffman 3743* (BRG, F, L, US).

Note. Förther (1998: 200) placed *Heliotropium humboltianum* Roem. & Schult. 1819 in the synonymy of *H. procumbens*. He designated as the lectotype *Humboldt and Bonpland [1202]*. *Humboldt 1202* is the type of *H. filiforme* (see above under *E. filiformis*).

Names not validly published

***Messerschmidia incana* G. Mey. 1818, nom. inval.**

Messerschmidia incana G. Mey., Prim. Fl. Esseq. 92. 1818, nom. inval.

Type. not designated; no original material found.

Note. The only species known from the Guianas that would agree with Meyer's description is *E. humilis*. Förther (1998: 238) lists *M. incana* as a synonym of *H. ternatum* [=*Euploca humilis*] with a question mark, but Meyer placed a synonym in the protolog of his new species, *Tournefortia sessilifolia* Poir. (1804: 360), a species described from Argentina. Because *sessilifolia* was available in *Messerschmidia*, it should have been used as the epithet. Therefore the name by Meyer is not validly published.

Acknowledgements

I want to thank the editor Sandy Knapp for her patience with my struggle with the format. I am indebted to the curators of the herbaria cited who made it easy to get loans, or to work in the collection in their care or who provided scans of types. I want to thank Ingrid Lin (US) and Piero Delprete (CAY) who scanned the specimens shown in Fig. 1 and 2, and the reviewers. I am very grateful to the Department of Botany, Smithsonian Institution, where I was welcomed from 1988 to 2014 and the Department of Botany and Plant Pathology, Oregon State University, where I do research since the summer of 2014. This is number 215 in the Smithsonian's Biological Diversity of the Guiana Shield publication series.

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List of taxa

Euploca Nutt. 1836
Euploca convolvulacea Nutt. (type of ***Euploca***)
Euploca filiformis (Lehm.) J.I.M.Melo & Semir 2009
Euploca foliata (R. Br.) Feuillet, **comb. nov.**
Euploca humilis (L.) Feuillet, **comb. nov.**
Euploca humistrata (Cham.) J.I.M.Melo & Semir 2009
Euploca hypogaea (Urb. & Ekman) Diane & Hilger
Euploca lagoensis (Warm.) Diane & Hilger 2003
Euploca paradoxa (Mart.) J.I.M.Melo & Semir
Euploca polyphylla (Lehm.) J.I.M.Melo & Semir 2009
Euploca procumbens (Mill.) Diane & Hilger 2003
Euploca ternata (Vahl) J.I.M.Melo & Semir 2009 = ***Euploca humilis***
Heliophytum passerinoides Klotzsch 1849 = ***Euploca humilis***
Heliotropium subgen. *Orthostachys* (R.Br.) Rchb. 1841 = ***Euploca***
Heliotropium sect. *Orthostachys* R.Br. 1810 = ***Euploca***
Heliotropium sect. *Orthostachys* subsect. *Axillaria* I.M.Johnst. 1928 = ***Euploca***
Heliotropium americanum Mill. 1768 = ***Euploca procumbens***
Heliotropium bahiense DC. 1845 = ***Euploca polyphylla***
Heliotropium brasilianum Roth 1821 = ***Euploca procumbens***
Heliotropium bridgesii Rusby 1895 = ***Euploca procumbens***
Heliotropium canescens Kunth 1818 = ***Euploca procumbens***
Heliotropium canescens Lehm. 1818 = ***Euploca procumbens***
Heliotropium cinereum Kunth 1818 = ***Euploca procumbens***
Heliotropium decumbens Lehm. 1817 = ***Euploca procumbens***
Heliotropium ellipticum (Fresen.) Gürke 1893 = ***Euploca procumbens***
Heliotropium filiforme Kunth 1818 = ***Euploca filiformis***
Heliotropium filiforme Lehm. 1817 = ***Euploca filiformis***
Heliotropium foliatum R.Br. 1810 (type of *Heliotropium* sect. *Orthostachys* (R.Br.) G.Don) = ***Euploca foliata***
Heliotropium foliosum Roem. & Schult. 1819 = ***Euploca polyphylla***
Heliotropium fruticosum var. *ternatum* (Vahl) DC. 1845 = ***Euploca humilis***
Heliotropium fumana (Fresen.) Gürke 1893 = ***Euploca humilis***
Heliotropium greenmanii Wiggins 1950. = ***Euploca humilis***
Heliotropium helophilum Mart. 1838 = ***Euploca filiformis***
Heliotropium hirtum Lehm. 1817 = ***Euploca humilis***
Heliotropium hispidum Kunth 1818 = ***Euploca humilis***
Heliotropium horizontale Small, Bull. 1905 = ***Euploca polyphylla***
Heliotropium houstonii DC. 1845 = ***Euploca procumbens***
Heliotropium humboldtianum Roem. & Schult. 1819 = ***Euploca procumbens***
Heliotropium humboltianum Roem. & Schult. 1819 = ***Euploca procumbens***
Heliotropium humistratum Cham. 1829 = ***Euploca humistrata***

Heliotropium inundatum Sw. 1788 = ***Euploca procumbens***
Heliotropium laevenworthii (A. Gray) Small 1903 = ***Euploca polyphylla***
Heliotropium lagoense (Warm.) Gürke 1893 = ***Euploca lagoensis***
Heliotropium leptostachyum (Fresen.) Gürke 1893 = ***Euploca procumbens***
Heliotropium linifolium (A. St.-Hil.) Gürke 1893 = ***Euploca polyphylla***
Heliotropium littorale Mart. ex Colla 1835 = ***Euploca filiformis*** (Lehm.) J.I.M.Melo & Semir
Heliotropium longepetiolatum (Fresen.) Gürke 1893 = ***Euploca procumbens***
Heliotropium mexicanum Greenm. 1898 = ***Euploca humilis***
Heliotropium oaxacanum DC. 1845 = ***Euploca humilis***
Heliotropium paradoxum (Mart.) Gürke 1893 = ***Euploca paradoxa***
Heliotropium polyphyllum Lehm. 1817 = ***Euploca polyphylla***
Heliotropium polyphyllum var. *blanchetii* DC. 1845 = ***Euploca polyphylla***
Heliotropium polyphyllum var. *horizontale* (Small) R.W. Long 1970 = ***Euploca polyphylla***
Heliotropium polyphyllum var. *laevenworthii* A. Gray 1878 = ***Euploca polyphylla***
Heliotropium procumbens Kunth 1818 = ***Euploca procumbens***
Heliotropium procumbens Mill. 1768 = ***Euploca procumbens***
Heliotropium pubescens (Fresen.) Gürke 1893 = ***Euploca polyphylla***
Heliotropium pusillum Colla 1835 = ***Euploca filiformis***
Heliotropium rigidulum DC. 1845. = ***Euploca procumbens***
Heliotropium riparium Chodat 1902 = ***Euploca procumbens***
Heliotropium riparium Mart. ex Colla 1835 = ***Euploca procumbens***
Heliotropium sect. *Euploca* (Nutt.) A. Gray 1874 = ***Euploca***
Heliotropium stenostachyum (A. St.-Hil.) Gürke 1893 = ***Euploca filiformis***
Heliotropium strictissimum sensu N.E. Br. 1901 = ***Euploca humilis***
Heliotropium tenue Roem. & Schult. 1819 = ***Euploca filiformis***
Heliotropium ternatum Vahl 1794 = ***Euploca humilis***
Heliotropium ternatum var. *fumana* (Fresen.) I.M. Johnst. 1935 = ***Euploca humilis***
Heliotropium trinitense Urb. 1912 = ***Euploca lagoensis***
Heliotropium willdenowii G. Don 1838 = ***Euploca procumbens***
Hilgeria Förther 1989 = ***Euploca***
Hilgeria hypogaea (Urb. & Ekman) Förther 1989 (type of *Hilgeria* Förther) = ***Euploca hypogaea***
Messerschmidia incana G. Mey. 1818 = ***Euploca humilis***
Orthostachys (R. Br.) Spach 1840 = ***Euploca***
Pioctonon antillanum Raf. 1838 = ***Euploca humilis***
Pioctonon ternatum (Vahl) Raf. 1838 = ***Euploca humilis***
Preslaea Mart. 1827 = ***Euploca***
Preslaea linifolia A. St.-Hil. 1833 = ***Euploca polyphylla***
Preslaea paradoxa Mart. 1827 (type of *Preslaea* Mart.) = ***Euploca paradoxa***
Preslaea stenostachya A. St.-Hil. 1833 = ***Euploca filiformis***
Schleidenia Endl. 1839 = ***Euploca***
Schleidenia bahiensis (DC.) Fresen. 1857 = ***Euploca polyphylla***

Schleidenia elliptica Fresen. 1857 = ***Euploca procumbens***
Schleidenia filiformis (Lehm.) Fresen. 1857 = ***Euploca filiformis***
Schleidenia fumana Fresen. 1857 **=** ***Euploca humilis***
Schleidenia hispida (Kunth) Fresen. 1857 = ***Euploca humilis***
Schleidenia humistrata (Cham.) Fresen. 1857 = ***Euploca humistrata***
Schleidenia inundata (Sw.) Fresen. 1857 = ***Euploca procumbens***
Schleidenia lagoensis Warm. 1868 = ***Euploca lagoensis***
Schleidenia leptostachya Fresen. 1857 = ***Euploca procumbens***
Schleidenia linifolia (A. St.-Hil.) DC. 1845 = ***Euploca polyphylla***
Schleidenia longepetiolata Fresen. 1857 = ***Euploca procumbens***
Schleidenia polyphylla (Lehm.) Fresen. 1857 = ***Euploca polyphylla***
Schleidenia polyphylla var. *blanchetii* (DC.) Fresen. 1857 = ***Euploca polyphylla***
Schleidenia pubescens Fresen. 1857 = ***Euploca polyphylla***
Schleidenia stenostachya (A. St.-Hil.) DC. 1845 = ***Euploca filiformis***
Schleidenia subracemosa Warm. 1868 = ***Euploca lagoensis***
Tournefortia humilis L. 1753 = ***Euploca humilis***
Tournefortia incana (G. Mey.) G. Don 1838 **=** ***Euploca humilis***
Tournefortia meyeri DC. 1845 **=** ***Euploca humilis***