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Styleworts under the microscope: a taxonomic account of *Levenhookia* (Stylidiaceae)

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Abstract

A taxonomic revision of the Australian endemic genus *Levenhookia* R.Br. (Stylidiaceae) recognises 12 species, of which *L. aestiva* Wege, **sp. nov.** from south-western Australia is newly described. *Levenhookia preissii* (Sond.) F.Muell. is lectotypified and recircumscribed as a Swan Coastal Plain endemic, resulting in its addition to the *Threatened and Priority Flora List for Western Australia*. Lectotypes are also selected for *L. dubia* Sond., *L. leptantha* Benth., *L. sonderi* (F.Muell.) F.Muell. and *L. stipitata* (Benth.) F.Muell. ex Benth. Verification of herbarium records has expanded the known distribution of *L. murfetii* Lowrie & Conran and *L. pulcherrima* Carlquist and has confirmed the widespread distribution of *L. dubia* across southern Australia including Tasmania, where it is currently listed as extinct—surveys based on information gleaned from historical collections may lead to its rediscovery in this State. Descriptions, distribution maps and photographs for all species are provided along with a key to species.

Keywords

Annual herbs, conservation, Flora of Australia, herbarium collections, taxonomy

Introduction

The Stylewort genus *Levenhookia* R.Br. (Stylidiaceae: Asterales) is endemic to the southern temperate and arid zones of Australia and comprises 12 mostly diminutive annual species (Fig. 1) with delicate and intricate flowers that are best observed

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under magnification. The genus was established by Robert Brown (1810) who aptly named it for Antony van Leeuwenhoek (1632–1723), a Dutch shopkeeper and celebrated microscopist who crafted optical lenses and bespoke microscopes and who made an extraordinary series of novel microscopic findings, including on protists, bacteria, spermatozoa and rotifers (Miall 1912; Dobell 1932). Although readily overlooked due to their size, species of *Levenhookia* can be impressive en masse, often growing in localised colonies of hundreds or thousands of plants. They are found in a wide variety of habitats, especially in south-western Australia where all but two of the species occur.

Levenhookia is the second largest genus in Stylidiaceae, a family dominated by the triggerplants (*Stylidium* Sw. ex Willd.), a diverse genus (> 300 spp.) renowned for its protandrous flowers with a touch-sensitive floral column that rapidly places pollen on, or retrieves pollen from, visiting insects (Erickson 1958; Findlay and Findlay 1975; Armbruster et al. 1994). Both genera have zygomorphic flowers with five corolla lobes, one of which (the labellum) is usually highly modified and variously ornate. In *Stylidium*, the labellum is typically reflexed and reduced in size to accommodate the column movement. In contrast, the labellum in *Levenhookia* is uniquely hooded (Fig. 2), enclosing the distal end of the column where the reproductive organs are located, and touch-sensitive (Brown 1810; Sargent 1918; Erickson 1958), springing backwards or opening when stimulated to expose the column (which can exhibit limited movement as a result). Unlike *Stylidium*, in which the column resets and retriggers after a short period of time, the movement of the labellum in *Levenhookia* and concomitant release of the column occurs just once.

Research by Brown (1810), Bentham (1837, 1868), Sonder (1845) and Mueller (1855, 1862, 1867) cumulatively led to the discovery of seven species of *Levenhookia*, three of which were originally named in the novel genus *Coleostylis* Sond. (Sonder 1845; Mueller 1855), but later transferred to *Levenhookia* (Mueller 1858, 1864). Although a further four species have since been described (Erickson and Willis 1956, 1965; Carlquist 1969; Lowrie and Conran 2011), the genus lacks a modern taxonomic account, the most recent being that of Mildbraed (1908). That said, knowledge of the genus was greatly advanced by Erickson (1958) who observed a range of species in the wild and, like Leeuwenhoek, had a keen eye for detail.

Underpinning the present taxonomic study are 1740 collections of *Levenhookia* housed at various Australian herbaria, ca. 75% of which have been collected since the publication of Erickson's (1958) popular account. Sorting and verifying this material has been an arduous task given the size of the plants and the limited number of individuals associated with some collections; however, it has led to a much improved understanding of the distribution and conservation status of the included taxa. Herbarium-based studies also precipitated the discovery of a new species (*L. aestiva* Wege sp. nov.) endemic to the far south-west of Australia, material of which had previously been included under a broad concept of *L. preissii* Sond. (Sonder 1845; Mildbraed 1908; Erickson 1958; Wheeler 1987, 2002; Lowrie and Conran 2011). *Levenhookia preissii* is now considered to have a more restricted distribution on the heavily cleared

landscape of Western Australia's Swan Coastal Plain bioregion and has recently been conservation-listed (Western Australian Herbarium 1998–). In contrast, the geographic distributions of *L. pulcherrima* Carlquist and *L. murfetii* Lowrie & Conran have been expanded through verification of herbarium records, the latter by more than 600 km (although the former remains poorly known).

Examination of historical collections has also proven invaluable, notably in the case of *L. dubia* Sond., a species widespread across southern Australia, but listed as extinct in Tasmania (with some uncertainty as to whether it ever occurred there: see Gray 2011). Specimens from Flinders Island and Pontville that were collected in the mid- to late 1800s, have been located at the National Herbarium of Victoria and not only confirm that it was indeed present in Tasmania, but can be used to provide information for future survey effort. Consideration of historical type material has also revealed several typification issues that are resolved herein to deliver a robust taxonomic framework.

Methods

This study is primarily based on the examination of herbarium material and associated spirit and photographic collections at the Western Australian Herbarium (PERTH), South Australian Herbarium (AD), Australian National Herbarium (CANB), Northern Territory Herbarium (DNA) and National Herbarium of Victoria (MEL). Specimens at the National Herbarium of New South Wales (NSW) were unavailable for study during this project. Distribution statements and maps are based on taxonomically validated specimen data, though collections of *L. dubia* from New South Wales that are housed at NSW have been included (these are likely to be correctly identified since this is the only species of *Levenhookia* recorded in this State). Type specimens at a range of additional institutions were also examined during research visitations, via specimen loans or through digital portals (indicated by image!): acronyms follow Thiers (2019). Geographic regions follow the *Interim Biogeographic Regionalisation for Australia* (Department of the Environment 2013).

Vegetative characters were mostly coded from pressed specimens, whereas floral characters were largely scored from wet collections, but supplemented with information gleaned from pressed material, field observations (mostly in south-western Australia) and photographic records. The exception is *L. preissii*, which has been described solely from pressed material and associated images, with flowers reconstituted from *G. Woodman Opp 5* (PERTH) and *B.J. Keighery 2546* (PERTH). Spirit collections from the following populations were consulted: *L. aestiva – J.A. Wege 1590* (PERTH), *J.A. Wege 1592* (PERTH), *J.A. Wege 2090* (PERTH); *L. chippendalei* F.L.Erickson & J.H.Willis – *K. Coate 372* (PERTH), *K.F. Kenneally & D.J. Edinger K 12671 E 3868* (PERTH); *L. dubia – H.S. Meyer 23* (MEL), *T.B. Muir 6742* (MEL), *J.A. Wege 376*, *R. Butcher & C. Wilkins* (PERTH), *J.A. Wege 1773 & C. Wilkins* (PERTH), *J.A. Wege 1836 & B.P. Miller* (PERTH), *J.A. Wege 2062* (PERTH); *L. leptantha – J.A. Wege 251 & N. Siemon* (PERTH), *J.A. Wege 895 & C. Wilkins* (PERTH), *J.A. Wege 1828*

& K.R. Thiele (PERTH), *J.A. Wege 2063* (PERTH); *L. murfetii – J.A. Wege 360*, *R. Butcher & C. Wilkins* (PERTH), *J.A. Wege 1829 & K.R. Thiele* (PERTH), *J.A. Wege 2060* (PERTH), *J.A. Wege 2066* (PERTH), *J.A. Wege 2067* (PERTH); *L. octomaculata* F.L.Erickson & J.H.Willis – *J.A. Wege 2074* (PERTH); *L. pauciflora* Benth. – *J.A. Wege 209 & L. Cobb* (PERTH), *J.A. Wege 380*, *R. Butcher & C. Wilkins* (PERTH), *J.A. Wege 1071 & C. Wilkins* (PERTH); *L. pulcherrima – J.A. Wege 1937* (PERTH); *L. pusilla – J.G. Eichler s.n.* (MEL 1580366), *A.S. George 11712* (PERTH), *K.A. Shepherd 1139 & J.A. Wege* (PERTH), *J.A. Wege 795* (PERTH), *J.A. Wege 1051 & C. Wilkins* (PERTH), *J.A. Wege 1749 & W.S. Armbruster* (PERTH); *L. sonderi* (F.Muell.) F.Muell. – *D.E. Murfet 3317* (AD); *L. stipitata – J.A. Wege 120* (PERTH), *J.A. Wege 156 & P. French* (PERTH), *J.A. Wege* 777 (PERTH), *J.A. Wege 1562 & B.P. Miller* (PERTH), *J.A. Wege 1688 & W.S. Armbruster* (PERTH), *J.A. Wege 1873* (PERTH), *J.A. Wege 1874* (PERTH).

Taxonomic treatment

Levenhookia **R.Br., Prodr. Fl. Nov. Holland.: 572. 1810**

Leeuwenhoekia, orth. var.: C.P.J. Sprengel, Anleit. Kenntn. Gew. ed. 2, 2(1): 300. 1818.
Levenhoekia, orth. var.: E.G. Steudel, Nom. Bot. 1: 477. 1821.
Leeuwenhookia, orth. var.: H.G.L. Reichenbach, Consp. Regn. Veg.: 91. 1828.
Leuwenhoekia, orth. var.: F.G. Bartling, Ord. Nat. Pl. 149. 1830.
Leeuwenhockia, orth. var.: E.G. Steudel, Nom. Bot., edn 2(2): 21. 1841.
Leeuvenhookia, orth. var.: F.J.H. von Mueller, Fragm. 1(1): 18. 1858.
Leewenhoekia, orth. var.: F.J.H. von Mueller, Syst. Census Austral. Pl: 86. 1882.
Coleostylis Sond. in J.G.C. Lehmann, Pl. Preiss. 1(3): 391. 1845. Lectotype, here designated: *Coleostylis preissii* Sond. [= *Levenhookia preissii* (Sond.) F.Muell.]
Coleostyles, orth. var.: G. Bentham & J.D. Hooker, Gen. Plant. 2(2): 535. 1876.

Type. *Levenhookia pusilla* R.Br.

Description. Diminutive annual herbs with simple or branched stems, usually glandular-hairy. Leaves scattered (rarely basally clustered), usually petiolate, margins entire. Inflorescence racemose, often corymbose or umbellate, sometimes reduced to a solitary flower, with a bract subtending each flower. Flowers bisexual, sometimes protandrous, zygomorphic. Calyx lobes 5, free (rarely with the anterior pair basally connate), margins entire. Corolla lobes 5, connate into a short to long tube with 4 spreading or distally recurved lobes and a smaller, highly modified labellum; labellum ventral or sometimes dorsal (rarely lateral) through rotation of the pedicel, galeiform (hooded), often ornate, covering the distal portion of the column, springing backwards or opening when stimulated to release the column; corolla outgrowths forming a column sheath at the throat, often nectariferous. Column immobile or with restricted movement upon release from the labellum; anthers 2, bilocular, pollen yellow; stigma

2-lobed. Ovary inferior, with many ovules on a free-central placenta. Nectary sometimes present on top of the ovary. Capsules dehiscent. Seeds small, brown, rugulose, sometimes papillate.

Number of species, distribution and ecology. A genus of 12 species from a variety of habitats in southern temperate Australia, extending into the arid zone in Western Australia and the Northern Territory (Fig. 1A). The only representative of the genus in Tasmania is currently listed as extinct in that State (refer to the additional information provided under *L. dubia*). Some species are disturbance opportunists that are more readily found the year following a fire.

Floral morphology and pollination. The hooded labellum is responsive to touch, usually springing backwards through rapid recurvature of its claw, releasing the column (Fig. 2A, D, F, H, I) before gradually repositioning itself at or above the level of the corolla lobes (Fig. 2B, E); it does not enclose the column or respond to

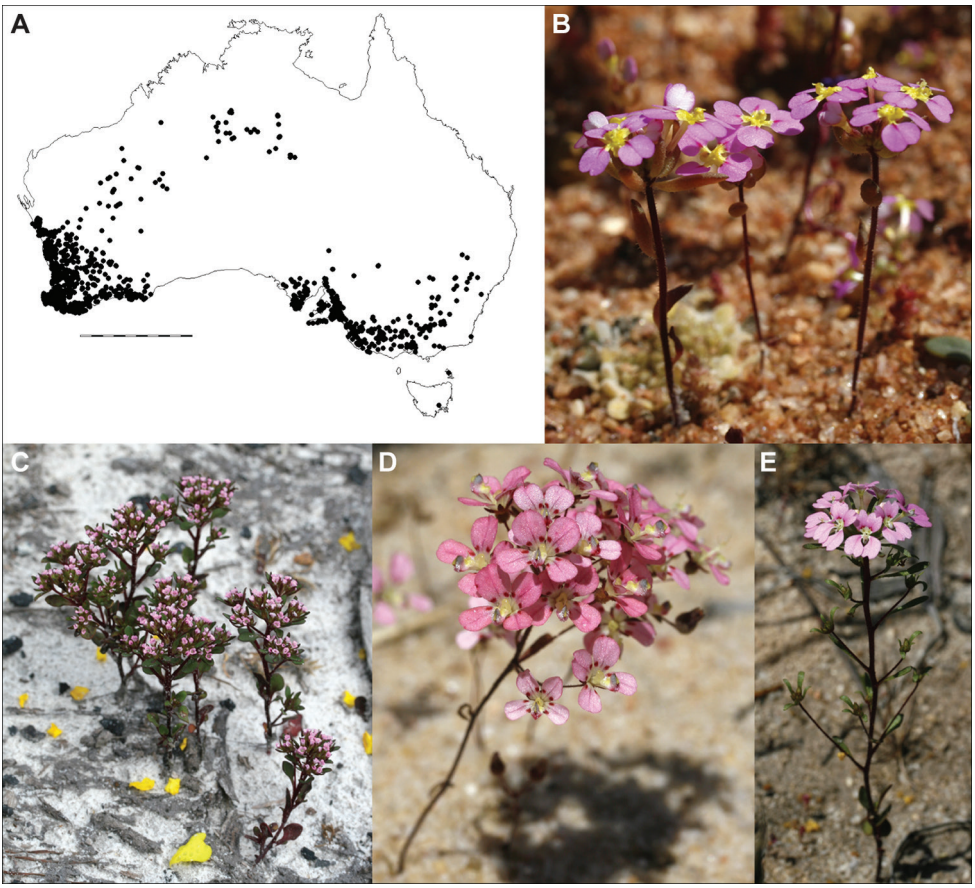

Figure 1. *Levenhookia* is a genus of annual herbs endemic to Australia **A** distribution in temperate and semi-arid regions of Australia, scale bar 1000 km **B** *L. leptantha* (*J.A. Wege 2063*) **C** *L. pusilla* (*J.A. Wege 1749 & W.S. Armbruster*) **D** *L. octomaculata* (*J.A. Wege 2074*) **E** *L. pulcherrima* (*J.A. Wege 1937*). Photos by J.A. Wege.

Figure 2. Labellum and column movement in *Levenhookia*. Black arrow = labellum hooded over column; white arrow = labellum 'triggered' to release column; yellow arrow = labellum repositioned following column release; blue arrow = column position immediately following release from labellum **A** *L. stipitata* (unvouchered, Augusta area, Western Australia) **B** *L. aestiva* (*J.A. Wege 2090*) **C–E** *L. leptantha* (*J.A. Wege 2063*), with labellum enclosing the column (C), triggered to release the column which moves to the opposite side of the flower (D) and subsequently repositioned (E) with the stigmatic lobes developed **F** *L. aestiva* (*J.A. Wege 2090*), labellum triggered with column momentum stopped by the sheath at the base of the corolla lobes **G, H** *L. pauciflora* (at *J.A. Wege 1071 & C. Wilkins*): note the unusual, distally-angled column and brush-tipped labellum **I** *L. murfetii* (*J.A. Wege 2060*): note the dorsal position of the labellum; **J, K** *L. dubia*, with the labellum opening (but not otherwise moving) to release the column (**K**). Photos by R.W. Davis (**A, B**) and J.A. Wege (**C–K**).

stimuli again. *Levenhookia dubia* is an exception since its sessile labellum opens to release the column, but does not otherwise move (Fig. 2J, K). As first noted by Erickson (1958), the exact point of stimulus varies amongst species: probing the apex of the hood or apical appendage will trigger the release of the column in *L. dubia*, *L. leptantha*, *L. murfetii*, *L. octomaculata*, *L. pusilla* and *L. stipitata*, whereas the labellum in *L. aestiva* and *L. pauciflora* is more reliably stimulated by touching the basal appendages. Erickson (1958) observed the sensitive point to be in the throat of the flower in *L. preissii*, something which I intermittently observed in *L. aestiva*. Sometimes the labellum cannot be manually triggered and it has been hypothesised that flowers await a certain stage of maturity before becoming responsive (Sargent 1918; Erickson 1958). In the absence of an external stimulus, growth of the upper-most stigmatic lobe, or apparently of the column itself, can sometimes trigger labellum movement (Erickson 1958).

The action of the labellum usually results in a degree of column movement (Fig. 2D, F, H, K), although movement is slight or lacking in both *L. murfetii* (Fig. 2I) and *L. pusilla*. These small-flowered species appear to be autogamous: the anthers dehisce within the labellum and the stigmatic lobes develop concurrently, becoming covered in pollen (Sargent 1918; pers. obsv.). In *L. leptantha*, *L. aestiva* and *L. dubia*, the column moves from the anterior to the posterior side of the flower, coming to rest against the column sheath at the base of the corolla lobes (Fig. 2D, F, K, respectively) before gradually shifting to an erect or slightly forward-arched position that maximises display of the stigmatic lobes (Fig. 2B, E). In *L. aestiva*, the column is long, free from the corolla tube and held under tension in untriggered flowers, moving rapidly when released from the labellum and coming to an abrupt stop when it hits the sheath. This catapult-like mechanism results in pollen being sprayed outwards from the anthers (and presumably onto a pollinator). In this species, the stigmatic lobes mature once pollen has been shed, thereby promoting outcrossing or geitonogamous self-pollination. The stigmatic lobes in *L. pauciflora*, *L. preissii* and *L. pulcherrima* similarly appear to mature once pollen has been shed.

In *L. leptantha*, the column is adnate to the anterior side of the corolla tube, with only the short (0.7–1.1 mm long), distal portion free to move. Despite this, a catapult-like action is still achieved. The distal portion, which is slightly forward-arched and therefore held under a degree of tension by the labellum, moves rapidly to the opposite (posterior) side of the flower when the labellum is triggered, with its forward momentum apparently halted by its attachment to the anterior side of the corolla tube (the posterior rim of the column sheath may also act as a stopper). Like *L. aestiva*, pollen is sprayed outwards from the anthers, but may also spill onto the lower stigmatic lobe which, in contrast to *L. aestiva*, develops before the upper one and usually while the column is still enclosed by the labellum. The lower stigmatic lobe, which is strongly upturned, can often be seen protruding from the labellum and this may enable it to receive pollen from a visiting insect. The upper stigmatic lobe matures once the column has been exposed from the labellum and is prominently displayed to promote outcrossing. Staggered development of the stigmatic lobes is also evident in *L. chippendalei*, *L. dubia*, *L. octomaculata* and *L. stipitata*, of which *L. dubia* is akin to *L. leptantha* in

having the column adnate to the corolla tube (a trait also shared with *L. pauciflora*, *L. pulcherrima* and possibly *L. sonderi*).

Levenhookia pauciflora has a distinct column morphology that generates a unique movement. In addition to adhering to the corolla tube, the column is attached to the anterior side of the column sheath, which further restricts its movement upon release from the labellum. Its distal end (Fig. 2H) is sharply angled towards the labellum and has a dilated tip subtended by a weak hinge. The hinge provides the tip with a degree of flexibility that may enable direct placement of pollen on an insect. Erickson (1958) noted that this species produced "a veritable shower" of pollen when triggered; however, I observed its column to move comparatively slowly into a nearly upright position without generating an obvious spray of pollen, although some pollen was transferred to the prominent tuft of hairs at the apex of the labellum, potentially functioning as a form of secondary pollen presentation.

Erickson (1958) suggested that the release of the column from the labellum in *Levenhookia* results in geitonogamous self-pollination via the catapulting of pollen between flowers on the same plant. This is at odds with my own observations, which indicate that the flowers are usually too widely spaced and pollen is not flung far enough for this to occur. Furthermore, in some species (*L. dubia*, *L. pauciflora*, *L. octomaculata* and *L. stipitata*), I observed little to no pollen spray; however, further observations are warranted, particularly given the suggestion that the column is held under increasing tension as the flower matures (Erickson 1958: 206). This suggests that variation is to be expected when studying flowers within a population or even on the same plant.

The interaction between the labellum and the column, which is difficult to investigate in the field given the size of the plants and the rapidity of the movements, remains incompletely studied. Observations are lacking for many species and pollination records are largely wanting. Erickson (1958: 203) noted woolly bee-flies actively probing flowers of *L. leptantha*, noting that pollen grains were "sprayed about the head and under the body". I have only made two incidental observations: a small native bee on *L. pulcherrima* (at *J.A. Wege 1937*), moving rapidly between flowers while foraging for pollen and a large wasp repeatedly visiting *L. octomaculata* (at *J.A. Wege 2074*), although it was unclear whether it was transferring pollen between flowers.

Other notes. Erickson (1958: 200) notes that *Levenhookia* flowers close at night by folding the four main corolla lobes together. I have observed this phenomenon in *L. aestiva*, *L. dubia*, *L. leptantha* and *L. octomaculata*; however, this trait is not universally exhibited, with the small flowers of *L. murfetii* and *L. pusilla* remaining open.

Mildbraed (1908) recognised three sections based on labellum and column sheath morphology (at which time only six species were recognised). A revised infrageneric classification will be considered once a robust molecular phylogenetic framework is available, although this is unlikely to be warranted given the size of the genus.

A key to the species of *Levenhookia*

Note that column length can be estimated on pressed material by measuring from the tip of an exposed column to the base of the calyx lobes.

1 Stem with glandular hairs and minute (< 0.1 mm) papillae (the latter readily visible towards the stem base); corolla lobes predominantly creamy white with a fine red mid-vein on the undersurface, posterior pair acuminate, acute or apiculate [W.A.] ..... **7. *L. pauciflora***

– Stem glabrous or glandular-hairy, papillae absent; corolla lobes predominantly white and without a coloured midvein, or predominantly pink and rarely with a dark pink midvein, posterior pair obtuse, retuse, emarginate or bluntly pointed **2**

2 Corolla tube longer than the longest calyx lobes..... **3**

– Corolla tube ± equal to or shorter than the longest calyx lobes **7**

3 Labellum 0.6–2 mm long, sessile or with a short claw to ca. 0.2 mm long, apical appendage absent, to 0.5 mm long or with a tuft of white hairs; column adnate to corolla tube, with the top 0.5–2 mm free; flowering Aug–Nov **4**

– Labellum 3–6.5 mm long with a claw 1.2–2.5 mm long, apical appendage 0.7–2 mm long; column free to base; flowering late Oct-early Apr..... **6**

4 Corolla tube 1–3 mm long, ± equal to or just longer than the calyx lobes; column 1.3–2.5 mm long; corolla lobes white or pale pink, 1.2–3 mm long; labellum without an apical appendage or tuft of hairs [W.A, S.A., N.S.W., Vic., Tas.]..... **4. *L. dubia***

– Corolla tube 3–9 mm long, exserted well beyond the calyx lobes; column 4.2–10 mm long; corolla lobes usually bright pink (rarely white), 1.8–5.5 mm long; labellum apical appendage or hair tuft present **5**

5 Calyx lobes 0.8–2 mm long; labellum with rounded basal appendages and a small, papillate apical appendage; column sheath yellow, fused with the posterior corolla lobes to form a flat pad [W.A.] ..... **5. *L. leptantha***

– Calyx lobes 1.8–3.5 mm long; labellum with linear-subulate basal appendages and a tuft of hairs at the apex; column sheath creamy white, with a narrowly triangular lobe to 1 mm high on the posterior side [W.A.]..... **6. *L. pulcherrima***

6 Corolla tube 2–4.5 mm long; labellum 3–4.2 mm long with rounded basal appendages; column 4.5–7.2 mm long; column sheath white, lopsided, fused to posterior corolla lobes [W.A.] ..... **8. *L. preissii***

– Corolla tube 5.5–8 mm long; labellum 4.5–6.5 mm long with oblong-subulate basal appendages; column 7.5–11 mm long; column sheath pink, entire, distinct from corolla lobes [W.A.] ..... **9. *L. aestiva***

7 Stem glabrous or with glandular hairs restricted to the distal portion **8**

– Stem glandular-hairy throughout length (rarely sparse toward the base)..... **9**

8 Primary stem axis glabrous; outermost floral bracts glabrous; corolla lobes pink with a white base (rarely all white) [W.A., S.A., Vic.] ..... **1. *L. pusilla***

– Primary stem axis glandular-hairy near the inflorescence; outermost floral bracts glandular-hairy abaxially towards the base; corolla lobes white or pink with pink-red markings near the base [W.A.] ..... **2. *L. murfetii***

9 Labellum 0.7–1.2 mm long, sessile or with a short claw to 0.2 mm long, lacking an apical appendage; column 1–2.5 mm long **10**

– Labellum 2–6 mm long with a claw 0.9–2 mm long, apical appendage present; column 2–4 mm long **11**

10 Labellum hood yellow to whitish or sometimes with pinkish red markings, basal appendages absent or rudimentary; calyx lobes ± equal length, acute; corolla tube ± equal to or longer than the calyx lobes; hypanthium glandular-hairy [W.A., S.A., N.S.W., Vic., Tas.] ..... **4. *L. dubia***

– Labellum hood dark red-purple (especially when dried), basal appendages linear-subulate; calyx lobes unequal in length, obtuse or subacute; corolla tube shorter than the longest calyx lobes; hypanthium with both glandular and eglandular hairs [S.A., Vic.] ..... **3. *L. sonderi***

11 Stem usually much-branched near base (rarely simple); leaves basal and cauline; labellum 4–6 mm long with a prominent, emarginate or incised, glabrous apical appendage [W.A., NT] ..... **12. *L. chippendalei***

– Stem simple or branched along length; leaves cauline; labellum 2–3.7 mm long, with a small, blunt, papillate apical appendage **12**

12 Floral bracts glabrous or with a few glandular hairs near the base; calyx lobes with very sparse glandular hairs mostly near the base; corolla lobes with 2 dark red-pink, ± rounded to elliptic markings toward the base (rarely faint or lacking?); column sheath up to half the length of the column [W.A.] ..... **11. *L. octomaculata***

– Floral bracts glandular-hairy on the abaxial surface and margins; calyx lobes moderately to sparsely glandular-hairy throughout length; corolla lobes without markings or sometimes with 2 red-pink, ± oblong to linear markings toward the base; column sheath more than half the length of the column [W.A.] ..... **10. *L. stipitata***

1. *Levenhookia pusilla* R.Br., Prodr. Fl. Nov. Holland. 573. 1810
Figs 1C, 3B

Leeuwenhoekia pusilla, orth. var.: A.P. De Candolle, Prodr. 7: 338. 1839.
Leeuwenhookia pusilla, orth. var.: O.W. Sonder in J.G.C. Lehmann, Pl. Preiss. 1(3): 392. 1845.
Leewenhoekia pusilla, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Type. Australia. Western Australia: near the observatory, Princess Royal Harbour, King George's Sound, 21 Dec 1801, *R. Brown s.n.* [Bennett No. 2613] (lectotype, designated by Wege (2017: 231): BM 001041273; isolectotype: BM 000948765).

Description. Annual herb 1–10 cm high. Glandular hairs ca. 0.1–0.2 mm long. Stem dark red, simple or branched to varying degrees with porrect lateral branches, mostly glabrous, a few glandular hairs sometimes present distally on the lateral branches. Leaves cauline, scattered, green adaxially, dark red or purplish red abaxially; lamina oblanceolate to narrowly oblanceolate, reniform, ovate or elliptic, 1.5–15 mm long including the petiole, 1–6.5 mm wide, obtuse or subacute, glabrous or scarcely papillate. Flowers in corymbs, usually crowded amongst the bracts, 1–500^{+} per plant; bracts narrowly oblanceolate to oblanceolate or linear, 1.8–9 mm long, usually glabrous, sometimes scarcely papillate on the margins, the upper-most bracts sometimes with a few glandular hairs abaxially towards the base; pedicels 0.3–2.5 mm long, sparsely glandular-hairy. Hypanthium globose, ellipsoid or ovoid, 0.7–1 mm long, 0.6–0.9 mm wide, with glandular hairs throughout and eglandular hairs 0.2–0.6 mm long distally. Calyx lobes subequal (with the anterior pair scarcely longer than the rest), 1–1.7 mm long, acute or subacute, glabrous or sparsely glandular-hairy towards the base, sometimes scarcely papillate apically. Corolla pink with a white base or occasionally all white, glabrous; lobes evenly arranged or sometimes ± paired vertically, distally recurved, obovate, ± equal in size or with the anterior pair scarcely longer than the posterior ones, 0.9–1.5 mm long, 0.6–0.9 mm wide, rounded or scarcely apiculate; tube white, 0.3–0.6 mm long, shorter than the calyx lobes. Labellum dorsal or sometimes ventral (rarely lateral), 0.7–0.8 mm long including a 0.1–0.2 mm long claw; hood dark red-pink or red-purple, usually sparsely glandular-hairy abaxially, minutely papillate adaxially along the margins; appendage at the cleft apex red-pink, ca. 0.1–0.2 mm long, papillate; basal appendages white, linear-subulate, ca. 0.3 mm long. Column sheath creamy white, glabrous, irregularly lobed, to 0.3 mm high, pendulous appendages absent. Column white, often tipped red-pink, free, 1–1.5 mm long, distally broadened and angled toward labellum, glabrous; stigmatic lobes to 0.4 mm long, developing while the column is hooded, erect to incurved. Capsule ovoid, 1.3–3 mm long excluding calyx lobes. Seeds 0.4–0.7 mm long, 0.3–0.4 mm wide.

Diagnostic features. *Levenhookia pusilla* has a dark red and glabrous primary stem axis, glabrous or scarcely papillate leaves and outermost bracts that are usually green adaxially and dark red or purplish red abaxially, and tiny flowers with a pink and white (occasionally all white) corolla with lobes 1–1.5 mm × < 1 mm.

Phenology. Flowering from mid-September to early December; fruiting from October to early January.

Distribution. *Levenhookia pusilla* has a disjunct distribution in southern Australia (Fig. 3A). In south-western Australia, it is common in the Jarrah Forest, Warren and Swan Coastal Plain bioregions and scattered across the southern Avon Wheatbelt, Mallee and Esperance bioregions, with one outlying record from the Geraldton Sandplains.

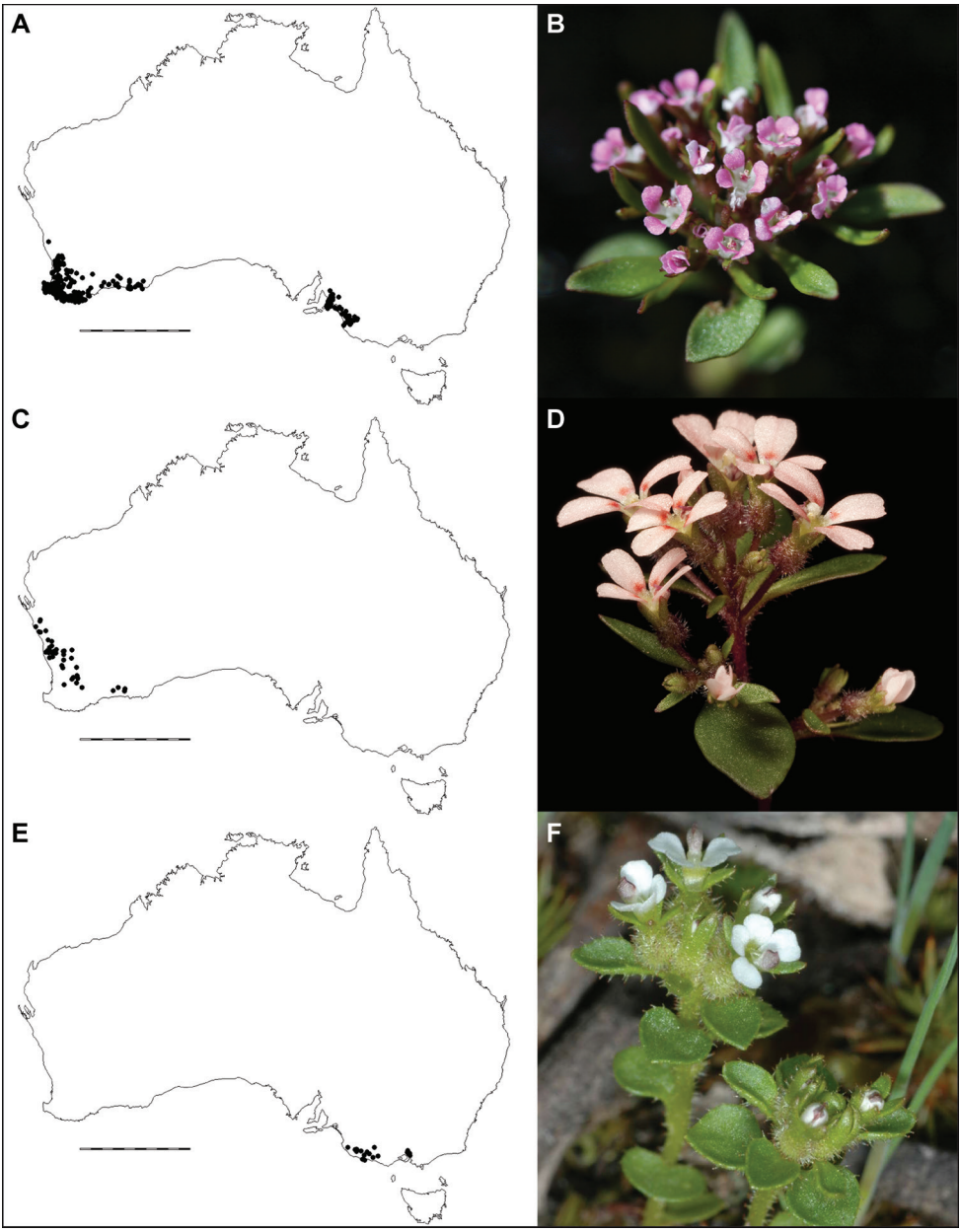

Figure 3. Comparative distributions and floral morphologies **A, B** *Levenhookia pusilla*, with a disjunct distribution in Western Australia and South Australia and a dense inflorescence of pint-sized flowers (unvouchered, Mt Clarence, Albany, Western Australia) **C, D** *L. murfetii*, a Western Australian endemic with discrete markings at the base of the corolla lobes (*J.A. Wege 1829*) **E, F** *L. sonderi*, a rarity from South Australia and Victoria with red-purple markings on the labellum that are especially prominent in pressed material (unvouchered, from near St Andrews, Victoria). Photos by J.A. Wege (**B**), K.R. Thiele (**D**) and C. Lindorff (**F**). Scale bar on maps 1000 km.

In south-eastern Australia, it is restricted to the Flinders Lofty Block, Eyre York Block, Murray Darling Depression, Naracoote Coastal Plain and Kanmantoo bioregions in south-eastern South Australia, extending into Victoria at Little Desert National Park near the South Australian border.

Habitat. This species grows in sand or loamy sand on ridges, hill-slopes, plains or dune swales, often with lateritic gravel or in association with granite outcropping; it is more rarely recorded growing in clay or clay loam in depressions or seasonally-wet flats. Associated vegetation is varied and includes tall *Eucalyptus* woodland or forest, low open woodland with *Eucalyptus*, *Allocasuarina* or *Melaleuca*, shrubland or scrub with *Banksia*, *Melaleuca* or emergent mallees, and low heath. It commonly co-occurs with *L. stipitata* in Western Australia and is often abundant on firebreaks and along track edges.

Conservation status. *Levenhookia pusilla* is widespread and locally abundant across most of its range (IUCN (2012): Least Concern), but it is listed as Vulnerable in Victoria (Department of Environment and Primary Industries, Victoria 2014), where it is restricted to Little Desert National Park.

Etymology. From the Latin *pusillus* (very small); an aptly named plant given its tiny flowers and diminutive habit.

Vernacular name. Midget Stylewort (Erickson 1958).

Notes. *Levenhookia pusilla* is morphologically allied to *L. murfetii* (refer to the comparative notes under that species) and the two species are known to grow near one another in Western Australia's Avon Wheatbelt. It often has a dorsally positioned labellum, a feature shared with *L. murfetii* and achieved through rotation of the pedicel; however, a ventral or lateral labellum has also been observed in instances where the crowded flowers and bracts prevent rotation or full rotation of the pedicels.

A specimen of *L. pusilla* from the Geraldton Sandplains bioregion near Warradarge (*M. Hislop 1492*, PERTH) is a northern outlier: further collections and observations from this region would be of interest, particularly given the widespread occurrence of *L. murfetii* in this area.

A subset of individuals on the following three specimens of *L. pusilla*, which are from three separate locations in South Australia, have been infected by a smut: *R. Bates 51370* (AD), *A.G. Spooner 1619* (AD) and *D.J.E Whibley 10106* (AD). A smut has also been detected on collections of *L. sonderi* (refer to the notes under that species). No smuts have been formally identified on Stylidiaceae to date (Shivas et al. 2014).

Illustrations. F. Bauer, Ill. Fl. Novae Holl., t. 15. 1816 [corolla lobes inaccurately depicted]; R. Erickson, Triggerplants 201, Pl. 57, No. 1. 1958; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 765, No. 3. 1982; H.R. Toelken in J.P. Jessop & H.R. Toelken, Fl. South Austral. 1419, fig. 639b. 1986; E.J. Raulings in N.G. Walsh & T.J. Entwisle, Fl. Victoria 4: 583, fig. 111a. 1999 [the only cited illustration to correctly depict the presence of both eglandular and glandular hairs on the hypanthium]; J. Wheeler, N. Marchant & M. Lewington, Fl. South West 2: 902. 2002.

Selected specimens examined. Australia. Western Australia: Mt Merivale, 20 km E of Esperance, 29 Nov 1997, *B. Archer 911* (MEL); Brixton Street Wetlands,

Kenwick, 10 Oct 2007, *K.L. Brown & G. Paczkowska KLB 673* (PERTH); Tutanning Reserve, SE of Pingelly, 7 Oct 1973, *A.S. George 11712* (PERTH); Julimar forest, corner West Boundary Rd and 7 Mile Rd, 1 Oct 2001, *M. Hislop 2319* (PERTH); Bramley National Park, NW Margaret River, off Burnside Rd, 19 Nov 2008, *G.J. Keighery 17437* (PERTH); Mira Flores Ave, off Millinup Rd, near Porongurup Range, ca. 3 km W of Porongurup, 31 Oct 1995, *T.R. Lally 821* (PERTH); Torbay Hill, West Cape Howe National Park, 16 Nov 1995, *T.R. Lally & B.J. Lepschi 913* (PERTH); 50 m N on track off Quartz Rd, ca. 400 m from Coronation Rd, W of Manjimup, 9 Nov 2002, *J.A. Wege 795* (PERTH); Near inlet campsite, Waychinicup National Park, 28 Oct 2003, *J.A. Wege 1051 & C. Wilkins* (PERTH); Margaret River Rd, E of Great N Rd, E of Margaret River, 8 Nov 2009, *J.A. Wege 1749 & W.S. Armbruster* (K, MEL, PERTH); 1.1 km W of Stan Rd on Blue Lake Rd, SW of Mt Barker, 24 Oct 2018, *J.A. Wege 2072 & C. Wilkins* (MEL, PERTH); **South Australia:** Noolook Forest Reserve, 15 Oct 1984, *N.N. Donner 10273* (AD, MEL); Myponga Conservation Park, 14 Oct 1986, *D.E. Murfet 228* (AD); Newland Head Conservation Park, 29 Sep 2009, *D.E. Murfet 6603* (AD); Cox Scrub Conservation Park, 27 Sep 2008, *K.A. Shepherd & J.A. Wege KAS 1139* (PERTH); **Victoria:** Little Desert, 11 Oct 1989, *J.G. Eichler s.n.* (MEL).

2. *Levenhookia murfetii* Lowrie & Conran, J. International Triggerplant Society 1(2): 14–16, figs 16–19, 48I. 2011

Figs 2I, 3D

Levenhookia pusilla auct. non R.Br.: R. Erickson, Triggerplants 207–209 (1958), *p.p.*

Type. Australia. Western Australia: Brand Highway near Marchagee Road turn-off, Coomallo, 11 Sep 2007, *A. Lowrie 3553 & J.G. Conran* (holotype: PERTH 08298262; isotype: MEL 2385577).

Description. Annual herb 1–9 cm high. Glandular hairs 0.1–0.4 mm long. Stem dark red, simple or branched to varying degrees with porrect lateral branches, glabrous basally, glandular-hairy distally. Leaves cauline, scattered, green adaxially, reddish or green abaxially; lamina oblanceolate to narrowly oblanceolate, reniform or ovate, 2.5–13 mm long including the petiole, 1–5 mm wide, obtuse or subacute, glabrous or scarcely papillate, the uppermost leaves sparsely glandular-hairy abaxially towards the base. Flowers in corymbs, 1–ca. 40 per plant; bracts narrowly lanceolate to lanceolate or linear, 2.5–10 mm long, sparsely glandular-hairy abaxially towards the base, sometimes scarcely papillate on the margins; pedicels 1–4 mm long, sparsely glandular-hairy. Hypanthium depressed globose, globose or ovoid, 0.7–1.2 mm long, 0.7–1.4 mm wide, with glandular hairs throughout and sparse eglandular hairs 0.15–0.5 mm long distally. Calyx lobes subequal (with the anterior pair scarcely longer than the rest), 0.9–1.7 mm long, acute to subacute, sparsely glandular-hairy in lower 1/2–2/3, usually scarcely papillate apically. Corolla pale to medium pink or white, with red-pink throat markings and a white or yellowish green throat, glabrous; lobes ± paired vertically to somewhat

evenly arranged, spreading to scarcely recurved, rounded to scarcely emarginate or apiculate; anterior (upper) lobes elliptic to narrowly obovate, slightly inwardly curved, ± equal to or a little shorter than the posterior lobes, 1–1.8 mm long, 0.6–1.2 mm wide; posterior lobes obovate, 1.2–2 mm long, 0.8–1.3 mm wide; tube white or yellowish, 0.5–0.7 mm long, shorter than the calyx lobes. Labellum dorsal, 0.7–0.8 mm long including a 0.1–0.2 mm long claw; hood dark red-pink, usually sparsely glandular-hairy abaxially, minutely papillate adaxially along the margins; appendage at the cleft apex bright pink, ca. 0.1–0.3 mm long, papillate; basal appendages white to yellowish, linear-subulate, 0.2–0.3 mm long. Column sheath creamy white to yellowish, glabrous, lopsided, with a narrowly triangular posterior lobe to 0.3 mm high and slightly smaller lateral lobes, pendulous appendages absent. Column whitish, free, 1–1.4 mm long, distally broadened and angled towards labellum, glabrous; stigmatic lobes to 0.5 mm long, developing while the column is hooded, erect to incurved. Capsule ovoid, 1.3–2.2 mm long excluding calyx lobes. Seeds 0.4–0.5 mm long, 0.3–0.4 mm wide.

Diagnostic features. *Levenhookia murfetii* has a stem that is glabrous basally and glandular-hairy distally, bracts with glandular hairs restricted to the undersurface, and a pink or white corolla with small lobes (1–2 mm long) bearing a small red-pink marking towards the base.

Phenology. Flowering from late August to early October; fruits have been collected in October.

Distribution. *Levenhookia murfetii* is endemic to south-western Australia (Fig. 3C) where it occurs in the Geraldton Sandplains, Avon Wheatbelt and Mallee bioregions, from Eurardy Station to east of Grass Patch.

Habitat. This species usually grows in sand or sandy loam (rarely in clay loam), often with lateritic gravel (rarely with decomposed granite). It is commonly recorded in low heath, mallee shrubland, tall *Allocasuarina* or *Melaleuca* shrubland, and *Eucalyptus wandoo* woodland. It is often abundant on firebreaks or near the base of open shrubs.

Conservation status. This widespread species is locally abundant at a range of sites (IUCN 2012: Least Concern).

Etymology. Honours Denzel E. Murfet, who is affiliated with the State Herbarium of South Australia and has made more than 650 Stylidiaceae collections from across Australia (AVH 2019).

Vernacular name. Kwongan Stylewort.

Notes. Lowrie and Conran (2011) described *L. murfetii* from a limited number of specimens collected from north and north-east of Perth. Examination of collections at PERTH indicate a much broader geographic range and reveal that some of the features they used to separate it from *L. pusilla* are not taxonomically informative, most notably whether the stem is simple or branched, labellum morphology and inflorescence structure. The simplest way to distinguish pressed material of these two species is by examining the distal portion of the stem and the abaxial surface of the outermost floral bracts, which are always glandular-hairy in *L. murfetii* and glabrous in *L. pusilla*. *Levenhookia murfetii* mostly flowers earlier in the season (from late August to early October cf. late September to early December) and its flowers tend to have more

openly-spread corolla lobes (compare Fig. 3B, D) with discrete red-pink markings near the base (Fig. 2I) (markings absent in *L. pusilla*). While individual plants of *L. murfetii* often produce fewer flowers than in *L. pusilla*, flower number cannot be used to reliably separate these two species. They are largely geographically separated, although an apparent mixed collection from the Bolgart area (*R. Erickson s.n.*, PERTH 02769182) suggests that they may occur in sympatry. They are known to grow in proximity to one another in the Tarin Rock and Toodyay areas and probably also near Warradarge (refer to the notes under *L. pusilla*).

Illustrations. R. Erickson, Triggerplants 208, Pl. 58, Nos. 1–7. 1958, as *L. pusilla*.

Selected specimens examined. Australia. Western Australia: junction of Yerina Springs Rd and Ogilvie Rd, 15 km NNE of Gregory, 11 Sep 2004, *R.K. Brummitt 21236*, *A.S. George & E.G.H Oliver* (PERTH); due E of N end of Corry Rd, W of Corrigin, 24 Sep 2007, *M. Hislop & M. Griffiths WW 209 – 27* (PERTH); 21 miles [33.8 km] N of Geraldton, Moresby Range, 25 Aug 1974, *D. & N. McFarland 1137* (PERTH); Mt Lesueur National Park, 9 Sep 2008, *D.E. Murfet & A. Lowrie DEM 6345* (AD, PERTH); SE corner of Reserve 24952, 23 Sep 1998, *E.M. Sandiford 326* (PERTH); 750 m E along Hills Rd from the Lake Grace – Dumbleyung Rd, Tarin Rock Nature Reserve, 21 Sep 1997, *J.A. Wege 360*, *R. Butcher & C. Wilkins* (PERTH); 6.9 km S of Coorow – Greenhead Rd on Midlands Rd, Marchagee Nature Reserve, 16 Sep 2011, *J.A. Wege 1829 & K.R. Thiele* (PERTH); Elphin Nature Reserve off Waddington – Wongan Hills Rd, 11 Sep 2018, *J.A. Wege 2060* (CANB, MEL, PERTH); ca. 4.4 km E of First North Rd on Eneabba – Three Springs Rd, Wotto Nature Reserve, 13 Sep 2018, *J.A. Wege 2066* (PERTH); 2.5 km W from Brand Hwy on Coorow – Greenhead Rd, 14 Sep 2018, *J.A. Wege 2067* (CANB, MEL, PERTH).

3. *Levenhookia sonderi* (F.Muell.) F.Muell., Fragm. 1(1): 18. 1858, as *Leeuwenhookia*

Fig. 3F

Coleostylis sonderi F.Muell., Second systematic index of the plants of Victoria. Victoria, Parliamentary Paper no. A 18: 13. 1854, *nom. nud.*

Coleostylis sonderi F.Muell., Definitions of rare or hitherto undescribed Australian plants 13. 1855 [see O. Seberg, Taxon 35: 267 (1986) for publication date].

Coleostylis sonderi F.Muell., Trans. Philos. Soc. Victoria 1: 46. 1855, isonym.

Leewenhoekia sonderi, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Levenhookia dubia var. *sonderi* (F.Muell.) Mildbr. in H.G.A. Engler, Pflanzenr. 35: 27. 1908.

Type. Australia. Victoria: Violet Creek, *C. Wilhelmi s.n.* (lectotype, here designated: MEL 1617988 [the individual mounted on the sheet together with those in the large, cream, rectangular packet annotated "Levenhookia Sonderi, Mueller's"]; isolectotypes: K 000060054, MEL 1617989, MEL 2256398, TDC [3 individuals on right]).

Description. Annual herb 1–10 cm high. Glandular hairs 0.1–0.7 mm long. Stem pale, green, straw brown or more rarely reddish brown, simple or occasionally with porrect lateral branches, sparsely glandular-hairy. Leaves cauline, scattered, pale green; lamina ovate or orbicular, 1–8 mm long including the petiole, 1–4.5 mm wide, subacute or obtuse, sparsely glandular-hairy abaxially and on the margins. Flowers usually in corymbs or umbels, sometimes in short racemes, 1–ca. 23 per plant; bracts with an ovate or lanceolate lamina, 1–7 mm long including the petiole, glandular-hairy like the leaves; pedicels 0.5–10 mm long, sparsely glandular-hairy. Hypanthium globose, ovoid or ellipsoid, 0.7–2 mm long, 0.7–2 mm wide, with glandular hairs throughout and sparse eglandular hairs 0.4–0.8 mm long distally. Calyx lobes unequal (with the anterior pair longer than the rest), 0.7–1.7 mm long, obtuse or subacute, sparsely glandular-hairy. Corolla white with a yellowish green throat; lobes ± evenly arranged or with the upper (posterior) ones ± paired vertically, rounded or scarcely retuse, sparsely glandular-hairy abaxially; anterior lobes obovate, slightly longer and broader than the posterior pair, ca. 1.2–1.3 mm long, 0.8–0.9 mm wide; posterior lobes elliptic or obovate, ca. 0.7–1 mm long, 0.7–0.8 mm wide; tube yellowish green, 0.8–1.3 mm long, shorter than the longest calyx lobes, sparsely glandular-hairy distally. Labellum ventral, 0.8–1.2 mm long including a ca. 0.2 mm claw; hood dark red-purple, with sparse glandular hairs abaxially, lacking an appendage at the cleft apex; basal appendages white, linear-subulate, 0.3–0.4 mm long. Column sheath yellowish green, glabrous, to 0.3 mm high and irregularly lobed on anterior side, scarcely visible on posterior side, pendulous appendages absent. Column white, seemingly adnate to the anterior side of the corolla tube, 1.8–2.5 mm long with the top ca. 1 mm free, distally angled toward the labellum, glabrous; stigmatic lobes to ca. 0.5 mm long, apparently developing while the column is hooded, erect to scarcely incurved. Capsule globose, ovoid or ellipsoid, 2–3.5 mm long excluding calyx lobes. Seeds 0.6–1 mm long, 0.5–0.6 mm wide.

Diagnostic features. *Levenhookia sonderi* has a pale, sparsely glandular-hairy stem, leaves with an ovate or orbicular lamina, glandular and eglandular hairs on the hypanthium, unequal calyx lobes with obtuse to subacute apices, and a red-purple labellum (appearing very dark on pressed material) with white, linear-subulate basal appendages. Its seeds are the largest in the genus.

Phenology. Flowering September–December; fruiting October–December.

Distribution. *Levenhookia sonderi* is endemic to South Australia and Victoria (Fig. 3E), where it is has been recorded from the Naracoote Coastal Plain, Southern Volcanic Plain, Victorian Midlands and South Eastern Highlands bioregions, extending from Reedy Creek (South Australia) in the west to the Dandenong Ranges (Victoria) in the east.

Habitat. This species grows in damp sandy loam or clayey sand on hill-slopes or more commonly in lowland areas, including near the margins of swamps. It favours open patches or lightly-disturbed areas in open woodland with *Eucalyptus camaldulensis*, *E. macrorhynca*, *E. polyanthemos* or *E. goniocalyx*, or near stands of *Kunzea phylicoides*, and grows in association with other diminutive herbs including *L. dubia*, *Stylidium beaugleholei*, *S. despectum* and *S. perpusillum*.

Conservation status. *Levenhookia sonderi* is listed as Rare in Victoria (Department of Environment and Primary Industries, Victoria 2014) and Vulnerable (Schedule 8) in South Australia (Government of South Australia 2018) and may warrant listing at the national level under the *Environment Protection and Biodiversity Conservation Act 1999*. Populations of this species are isolated and appear highly localised, with the reproductive capacity of some individuals from locations in South Australia and Victoria impacted by a species of smut (see notes below).

Etymology. Honours German apothecary and botanist Otto Wilhelm Sonder (1812–1881), who described a suite of new taxa as part of his account of Stylidiaceae in Lehmann's *Plantae Preissianae* (Sonder 1845).

Vernacular name. Slender Stylewort (Erickson 1958).

Typification. MEL 1617988, which is annotated by Mueller and was viewed by Bentham (1868) for *Flora Australiensis*, comprises a mounted individual and an envelope housing five separate packets that represent more than one gathering. The mounted individual and the numerous additional plants in the large, cream, rectangular packet annotated "Levenhookia Sonderi, Mueller's" have been selected as an appropriate lectotype. This material is comparable to that of K 000060054, MEL 1617989 and MEL 2256398—they are at the same flowering stage and bear white mycelia, presumably from being poorly dried following their collection—and showcases the distinctive, dark labellum, which Mueller notes on the label ("labellum atropurpureum!"). Material at TCD is also interpreted as being part of this gathering.

The remaining material on MEL 1617988 is not treated herein as type material. There is a blue, rectangular packet annotated "Coleostylis sonderi Portland" that contains a single flowering plant, which Mueller may have separated from MEL 2256407 to send to Bentham. There is a smaller blue packet annotated "Leeuwenhoekia sonderi" that contains flower fragments, but it is unclear to which gathering they belong. Finally, there are two packets containing seeds and withered corolla fragments that must be from a separate collection to that of the type gathering, which is not in fruit. It is unknown whether these seeds are from the type population or from a different locality or, indeed, two separate localities. It is of note that there are no fruiting specimens at MEL that predate the publication of this species and Mueller did not describe seed in the protologue. Seed is also inexplicably present in the packet attached to Portland's flowering collection (MEL 2256407).

Notes. *Levenhookia sonderi* is most likely to be confused with *L. dubia*, a species with which it can co-occur (there have been mixed collections made of the two (e.g. *D.J. Van Bockel 195A* and *195B*, MEL; *H.B. Williamson s.n.*, MEL 2256403). Their superficial similarity led Mildbraed (1908) to treat *L. sonderi* as a variety of *L. dubia*, but it was reinstated as a distinct species by Erickson (1958) on account of its dark red-purple labellum hood (cf. cream to yellow or pale pinkish red), green stems (cf. reddish) and shorter corolla tube (0.9–1.3 mm long and shorter than the longest calyx lobes cf. 1.5–3 mm long and ± equal to or longer than the calyx lobes). While stem colour cannot be used to reliably separate the two species, labellum colour and corolla tube length are informative and can be observed on pressed

material. *Levenhookia sonderi* can be further separated from *L. dubia* by its unequal and obtuse or subacute calyx lobes (cf. equal and acute), hypanthium indumentum of both glandular and eglandular hairs (cf. glandular-hairy), linear-subulate basal appendanges on the labellum (cf. appendages lacking or rudimentary and rounded) and larger seed (0.6–1 mm long cf. 0.25–0.4 mm). It also tends to have more rounded leaf apices than *L. dubia*.

The column of *L. sonderi* appears to be adnate to the corolla tube like that of *L. dubia*, although this requires verification given the limited spirit material available for study. In one dissected flower, both stigmatic lobes were developed under the labellum hood with copious pollen observed. Like *L. pusilla* and *L. murfetii*, this suggests autogamy; *L. sonderi* is certainly akin to these two species, with all three sharing an indumentum of both eglandular and glandular hairs on the hypanthium.

Some individuals on the following collections of *L. sonderi* from South Australia and Victoria are infected by a smut that proliferates in the ovary, preventing the production of flowers and seed: *R. Bates 32191* (AD); *D. Hunt 2229* (AD); *D. Hunt 2241* (AD, MEL); *H.B. Williamson s.n.* (MEL 2256399, MEL 275679).

Illustrations. E.J. Raulings in N.G. Walsh & T.J. Entwisle, Fl. Victoria 4: 583, fig. 111b. 1999.

Selected specimens examined. Australia. South Australia: [localities obfuscated for conservation reasons] N of Mt Gambier, 8 Nov 1964, *D. Hunt 2229* (AD); N of Mt Gambier, 5 Dec 1964, *D. Hunt 2241* (AD, MEL); Reedy Creek, 1 Oct 1998, *D.E. Murfet 3317* (AD); Reedy Creek, 27 Oct 2011, *D.E. Murfet 7404* (AD); [E of Nangwarry], 3 Nov 2013, *D.E. Murfet 7624* (AD); **Victoria:** S of Crawford River, 20 Nov 1964, *A.C. Beauglehole ALB 43334* (MEL); Dandenong Range, 20 Oct 1977, *M.G. Corrick 5976* (MEL); Hawkesdale, Nov 1899, *H.B. Williamson s.n.* (MEL 2256403A); Warrandyte, 23 Oct 1983, *J.Z. Yugovic s.n.* (MEL).

4. *Levenhookia dubia* Sond., in J.G.C. Lehmann, Pl. Preiss. 1(3): 392. 1845, as *Leeuwenhookia*

Figs 2J, K, 4B

Levenhookia creberrima F.Muell., Fragm. 3(21): 121. 1862, as *Leeuwenhoekia*. Type. Australia. South Australia: St Vinc[ent] Gulf, 1851, *F. Mueller s.n.* (syntype: MEL 2257614); Gipps Land, [no date] *F. Mueller s.n.* (syntype: K 000060105); Victoria, [no date] *F. Mueller s.n.* (possible syntype: GH 00033478 image!, MEL 2254071).

Leewenhoekia dubia, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Type. Australia. Western Australia: In sublimosis humidis prope Bassandeen [Bassendean] ad fluvium cygnorum, [1838–1842] *L. Preiss 2252* (lectotype, here designated: MEL 2257601; isolectotypes: FI 006941, G 00358739 image!, G 00358740 image!, LD 1730835 image!, MEL 2412198, MEL 2257599, P 00712438 image!, S 06-3637, W); Swan River [1841], *J. Drummond 516* (syntypes: BM 000948743,

G 00358738 image!, K 000060096, K 000060108, OXF, MEL 2257600, MEL 2257596, W [2 sheets])

Description. Annual herb 1.2–9 cm high. Glandular hairs 0.1–0.5 mm long. Stem dark red or pale reddish to greenish brown, simple or with porrect lateral branches, glandular-hairy. Leaves cauline, scattered, green or reddish; lamina ovate, oblanceolate, lanceolate or elliptic, sometimes narrowly so, 1–10 mm long including the petiole, 0.5–3 mm wide, subacute to acute, glandular-hairy abaxially and on the margins, sometimes also adaxially near the base. Flowers in short racemes or corymbs, 1–40(–ca. 70) per plant; bracts oblanceolate, lanceolate or elliptic (sometimes narrowly so), 1.2–9 mm long, glandular-hairy like the leaves; pedicels 0.5–5(–10) mm long, glandular-hairy. Hypanthium depressed globose to globose, ellipsoid or obovoid, 0.7–2.2 mm long, 0.7–1.8 mm wide, glandular-hairy. Calyx lobes ± equal, 0.7–2.2 mm long, acute, glandular-hairy. Corolla white or more rarely pale pink, with a yellow throat, rarely with faint red-pink markings at the base the lobes; lobes ± equal and evenly arranged or with the anterior (lower) lobes scarcely longer and broader than the posterior pair, spreading to scarcely recurved, obovate or elliptic, 1.2–3 mm long, 0.8–2 mm wide, retuse or rounded, glabrous or with a few glandular hairs abaxially towards base; tube 1–3 mm long, ± equal to or up to 1.2 mm longer than the calyx lobes, white, sparsely glandular-hairy distally. Labellum ventral, 0.6–1 mm long, ± sessile; hood yellow to whitish, sometimes with pinkish red markings, sparsely glandular-hairy abaxially, without an appendage at the cleft apex; basal appendages absent or rudimentary and obtuse. Column sheath yellowish, glabrous, reduced to a scarcely lobed rim to ca. 0.2 mm high on the anterior side, connate with the posterior corolla lobes forming a smooth, thickened pad, pendulous appendages absent. Column creamy yellow, adnate to the anterior side of the corolla tube, 1.3–2.5 mm long with the top 0.5–0.8 mm free and gently forward-arched when enclosed by the labellum, glabrous; stigmatic lobes to ca. 0.3 mm long, the lower-most sharply upturned and developing while the column is hooded, the upper lobe incurved and developing later. Capsule globose, ovoid or obovoid, 1.2–2.2 mm long excluding calyx lobes. Seeds 0.25–0.4 mm long, 0.2–0.3 mm wide.

Diagnostic features. *Levenhookia dubia* has a glandular-hairy stem, acute calyx lobes, a corolla tube roughly equal to or a little longer than the calyx lobes, and a ±sessile labellum that lacks an apical appendage.

Phenology. Flowering from August to November, with fruits recorded from mid-September to November.

Distribution. *Levenhookia dubia* is widespread across southern mainland Australia, with records spanning near coastal areas to the semi-arid interior (Fig. 4A). There are several historical collections from mainland Tasmania and Flinders Island from the 1800s (see additional information under 'Conservation status').

Habitat. *Levenhookia dubia* grows in sand, sandy loam or clay loam, often in depressions or shallow drainage areas, near creek-lines or in damp soils associated

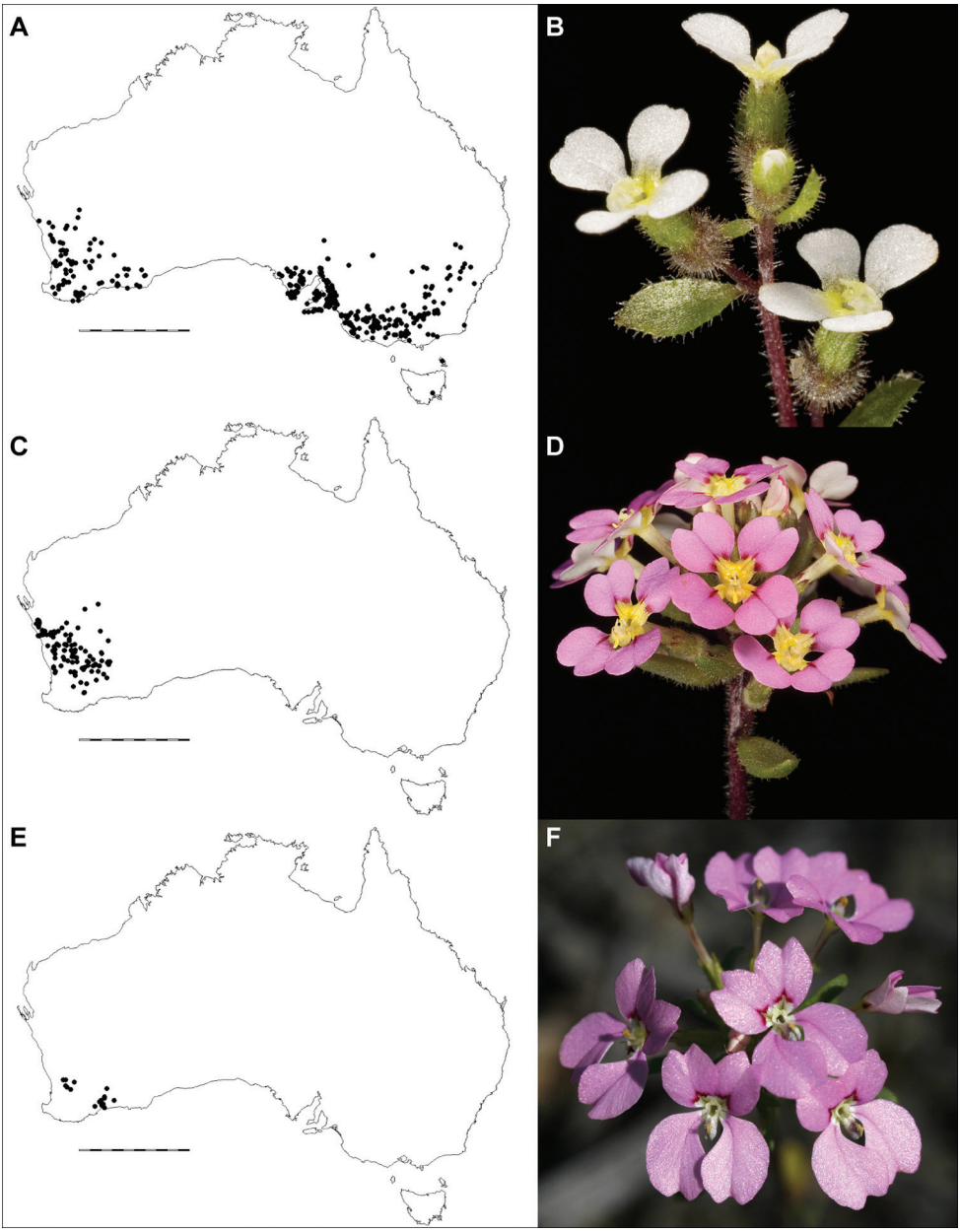

Figure 4. Comparative distributions and floral morphologies **A, B** *Levenhookia dubia*, with a widespread distribution across southern Australia and flowers with acute calyx lobes and a simple, sessile labellum (*K.R. Thiele 3360*) **C, D** *L. leptantha*, a widespread Western Australian endemic with an exserted corolla tube and fleshy bracts (*J.A. Wege 1828*) **E, F** *L. pulcherrima*, a poorly-known Western Australian endemic with an exserted corolla tube and distinctive corolla lobe shape and markings (*J.A. Wege 1937*). Photos by K.R. Thiele (**B, D**) and J.A. Wege (**F**). Scale bar on maps 1000 km.

with rocky outcropping including granite monoliths. It commonly grows with other ephemeral herbs, often in open *Eucalyptus* forest or mallee woodland, or shrubland with *Acacia*, *Allocasuarina*, *Callitris* or *Melaleuca*.

Conservation status. This widespread species is not currently considered to be at risk (IUCN 2012: Least Concern); however, it is currently listed as extinct in Tasmania under the *Tasmanian Threatened Species Protection Act 1995* (Tasmanian Government 2019). Although historically recorded from Brighton, Flinders Island and Mount Field (Spicer 1878; Rodway 1903), the sole collection from this State at the Tasmanian Herbarium is one by William Archer that lacks locality information; accordingly, the veracity of these early works has been questioned (e.g. Gray 2011). I have recently viewed material collected in Tasmania at the National Herbarium of Victoria, specifically, collections by William Spicer (from Pontville near Brighton: MEL 2257574, 2257575 and 2257577) and Joseph Milligan (from the Strzelecki Peaks on Flinders Island: MEL 2257576) that support a distribution that includes Tasmania and provide information for future survey efforts. Appropriately timed searches in the Strzelecki National Park that focus on herb fields, moss beds or open runoff areas associated with granite outcropping, may lead to its rediscovery. In the absence of a corresponding voucher, the Mount Field locality of Rodway (1903) cannot be confirmed and is interpreted as a likely error.

Etymology. From the Latin *dubius* (doubtful), alluding to Sonder's (1845) uncertainty with regards to its generic classification.

Vernacular name. Hairy Stylewort (Erickson 1958).

Typification. Sonder examined and annotated specimens of *L. dubia* in his personal herbarium (now at MEL), as well as material at BM and LD, all of which conform to the protologue. The designated lectotype (MEL 2257601) is the best quality material.

Notes. In south-eastern Australia, *L. dubia* may be confused with *L. sonderi* (refer to the comparative notes under that species).

Illustrations. F. von Mueller, Pl. Indig. Victoria Pl. 48. 1865, as *Leeuwenhoekia creberrima*; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 765, no. 1. 1982; H.R. Toelken in J.P. Jessop & H.R. Toelken, Fl. S. Austral. ed. 4: 1419, fig. 639A. 1986; G.R.M. Dashorst & J.P. Jessop, Plants of the Adelaide plains and hills 138, fig. 9. 1990; E.J. Raulings in N.G. Walsh & T.J. Entwisle, Fl. Victoria 4: 583, fig. 111c. 1999; J. Wheeler, N. Marchant & M. Lewington, Fl. South West 2: 902. 2002; L.C. Stanberg in G. Harden, Fl. New South Wales 3: 12. 1992.

Selected specimens examined. Australia. Western Australia: Garden Rock 16 km along Cue and Sandstone road, 17 Aug 2003, *G. Byrne 371* (PERTH); Pigeon Rocks, Sep 1973, *S. James 73.9/13* (PERTH); Mt Willgonarinya, ca. 72 km S of Balladonia Motel, Eyre Highway, 15 Sep 1980, *K.R. Newbey 7403* (PERTH); Location 1105, ca. 22 km N of Coast at Stokes Inlet, 27 Sep 1968, *A.E. Orchard 1220* (AD, PERTH); The Humps, near Hyden, 13 Sep 1983, *R. Ornduff 9309-15* (PERTH); Woody Island, 5 Oct 2003, *E. Rippey 582* (PERTH); 100 m S of Gura-Beekeepers Road junction, 3 Oct 1988, *D. Rose 710* (PERTH); Dingo Rock, 11 km W of Manmanning, 7 Sep 2002, *B.H. Smith 2010* (MEL); Quairading Nature Reserve, 27 Sep

2007, *K.R. Thiele 3360* (PERTH); granite outcrop near Phillips River crossing on Aerodrome Road, NW of Ravensthorpe, 28 Sep 1997, *J.A. Wege 376*, *R. Butcher & C. Wilkins* (PERTH); granite apron, E side of Mt Hampton, 20 Sep 2010, *J.A. Wege 1773 & C. Wilkins* (K, MEL, PERTH); 8.9 km S of Talbot West Road on Yarra Road, WSW of York, 25 Sep 2011, *J.A. Wege 1836 & B.P. Miller* (PERTH); S of Thomas River mouth, Cape Arid National Park, 10 Oct 2011, *J.A. Wege 1860 & C. Wilkins* (PERTH); N of Koorda – Cadoux Rd, just E of Rabbit Proof Fence Rd, Noorajin Soak Nature Reserve, 11 Sep 2018, *J.A. Wege 2062* (PERTH); **South Australia:** ca. 15 km W of Murray Bridge, 2 Oct 1974, *J. Carrick 3826* (AD); ca. 4 km NE of Weetulta, 29 Sep 1968, *B. Copley 2292* (AD); Waterfall Gully, ca. 9.5 km SE of Adelaide, 14 Oct 1957, *Hj. Eichler 14309* (AD); Carappee Hill Conservation Park, 24 Sep 2003, *P.J. Lang & P.D. Canty BS128-2267* (AD); Rockleigh Bushland Conservation Reserve, 22 Sep 2013, *D.E. Murfet 7615* (AD); Gosse-Ritchie Rd, 4.4 km N of South Coast Rd, Kangaroo Island, 8 Oct 1990, *B. Overton 1302* (AD); North Wilpena Creek, Wilpena Pound, Flinder's Ranges, 22 Sep 1973, *A.J.A. Sikkes 788* (AD, CANB, PERTH); Manning Reserve near MacLaren Flat, 30 Oct 1963, *D.J.E. Whibley 1297* (AD); **New South Wales:** E side of Cuttabri Rd, 6.7 km due SW of Cuttabri, 18 Oct 2016, *D.E. Albrecht 14714 & R. Jobson* (CANB); Jingellic Nature Reserve, Black Ridge Firetrail, Coppabella Creek catchment, 3.75 km N of Jingellic, 11 Nov 2003, *I. Crawford 7922* (CANB); 30 m N of Walleroobie Rd, 200 m E of intersection with Ardlethan-Coolamon road, 27 Sep 2003, *D. Mallison 680* (CANB); S end of Narrandera Range, W of Mt Bogolong, ca. 3 km N of Newell Hwy and 11 km ENE of Narrandera, 1 Oct 1978, *T.B. Muir 6074* (MEL); **Victoria:** Dookie Agricultural College Reserve (hill 4 km S of Mt Major), 30 Sep 1992, *I. Crawford 1910*, *S. Mann & D. Robinson* (CANB); 1 km SW of Chewton and 4 km ESE of Castlemaine, 6 Oct 1981, *T.B. Muir 6742* (CANB, MEL); ca. 1 km N of Tallarook, 12 Oct 1978, *H.S. Meyer 23* (MEL); Paddles Quarry Block, 29 Sep 1988, *A. Paget 469* (MEL); Grampians National Park, Golton Track, ca. 50–100 m E of Mt Zero Rd, 25 Sep 2014, *R.W. Purdie 9711* (CANB, MEL); Chiltern-Mt Pilot National Park, Junction of Woolshed Rd with Masons Track, 13 Oct 2016, *N.G. Karunajeewa 1451* (MEL); **Tasmania:** Flinders Island, Strzeleckys [sic] Peak, [1844] *J. Milligan s.n.* (MEL); Pontville, [1874–1878] *W.W. Spicer s.n.* (MEL).

5. *Levenhookia leptantha* Benth., Fl. Austral. 4: 35. 1868
Figs 1B, 2C–E, 4D

Leewenhoekia leptantha, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86 (1882).

Type. Australia. Western Australia: '*Drummond*, *n.* 128, 175, 282; Champion Bay and Murchison river, *Oldfield*; also a few specimens mixed in *Preiss's n.* 2249 from Sussex district.' Murchison River. Thicket south of Collallia [Colalya Creek], [1859–1860] *A.F. Oldfield 337* (lectotype, here designated: MEL 2257568; isolectotype: K 000060047); Champion Bay, Western Australia, *A.F. Oldfield s.n.* (syntype: MEL 2257566); Swan

River, [?1843–1844] *J. Drummond [?3:]128* (syntype: K 000060046); Swan River, [1844–1847] *J. Drummond 4: 175* (syntypes: BM 001041269, CGE, G 00358743, G 00358744, K 000060044, K 000060048, MEL 2295753, P 00712439, W); Swan River, [1842] *J. Drummond 2: 282* (syntypes: BM 001041268, CGE, G 00358741, G 00358742, K 000060042, K 000060045, OXF, MEL 2295752, P 00712440, W); districtus Sussex, 20 Dec 1839, *L. Preiss 2249* (excluded syntype: MEL 2295747 *p.p.*), = *L. aestiva* [note: this gathering is also a syntype of *L. preissii*].

Description. Annual herb 2–10 cm high. Glandular hairs 0.15–0.5 mm long. Stem reddish brown to dark red, simple (rarely once-branched at base), glandular-hairy. Leaves cauline, scattered, reddish to reddish brown; lamina succulent, usually lanceolate, ovate or elliptic, sometimes obovate or narrowly oblanceolate, 1–8 mm long including the petiole, 0.5–3 mm wide, subacute or acute, glandular-hairy abaxially and on the margins (sometimes sparsely so). Flowers usually in umbels, sometimes in short racemes, 1–30 per plant; bracts succulent, lanceolate, ovate or elliptic (sometimes narrowly so), 1–7 mm long, glandular-hairy like the leaves; pedicels 0.5–5 mm long, glandular-hairy. Hypanthium globose, ellipsoid or obovoid, 0.7–2 mm long, 0.6–1.7 mm wide, glandular-hairy. Calyx lobes ± equal, 0.8–2 mm long, acute, glandular-hairy. Corolla bright pink (rarely white) with a yellow (rarely creamy white) throat and dark pink or pink-red throat markings on each lobe (rarely absent), white abaxially; lobes evenly arranged or ± paired vertically, spreading to scarcely recurved, obovate, emarginate, retuse or incised, glabrous or with sparse glandular hairs abaxially near the base; anterior (lower) lobes ± equal in size or scarcely longer and broader than the posterior (upper) pair, 2–5.5 mm long, 2–4.5 mm wide; posterior lobes 1.8–5 mm long 1.8–4 mm wide, basally connate for 0.5–1 mm; tube creamy white or yellowish with pink longitudinal streaks, 3–9 mm long, 1.7–5 mm longer than the calyx lobes, sparsely glandular-hairy distally. Labellum ventral, 0.9–1.2 mm long including a short claw to ca. 0.2 mm long; hood yellow (rarely creamy white), usually with dark maroon markings near the cleft, sparsely glandular-hairy (mostly abaxially); appendage at the cleft apex yellow, ovate, elliptic or oblong, 0.2–0.5 mm long, minutely papillate, sometimes also with 1 or 2 glandular hairs; basal appendages yellow, rounded, 0.2–0.4 mm long, minutely papillate. Column sheath bright yellow (rarely pale greenish yellow), glabrous, with rounded anterior and lateral lobes 0.2–0.5 mm high, connate with the posterior corolla lobes forming a smooth, thickened pad, pendulous appendages absent. Column yellow, adnate to the anterior side of the corolla tube, 4.2–10 mm long with the top 0.7–1.1 mm free and slightly forward-arched when enclosed by the labellum, sparsely glandular-hairy distally on the anterior side; stigmatic lobes to ca. 0.6 mm long, the lower-most sharply upturned and developing while the column is hooded, the uppermost incurved and developing later. Mature capsules and seed not seen.

Diagnostic features. *Levenhookia leptantha* has succulent floral bracts, a long (3–9 mm) corolla tube and comparatively short (0.8–2 mm long) calyx lobes, and minute glandular hairs at the tip of the column. Its corolla lobes are usually bright pink with a yellow base and the labellum has a morphologically distinct apical appendage that can be discerned on pressed material.

Phenology. Flowering from late August to October.

Distribution. *Levenhookia leptantha* is widespread in south-western Australia (Fig. 4C), although largely absent from the high rainfall zone, with most records occurring in the Geraldton Sandplains, Yalgoo, Avon Wheatbelt and Coolgardie bioregions. There are scattered occurrences in the Murchison and Mallee bioregions and an isolated record from the Swan Coastal Plain near Muchea.

Habitat. *Levenhookia leptantha* grows in sand, sandy loam, sand over clay or clay loam on plains and gentle hill-slopes, often in association with granite outcropping, salt lakes, creek-lines or seasonally wet claypans. Associated vegetation is varied and includes open *Eucalyptus* woodland, mallee shrubland, tall shrubland or scrub with *Acacia*, *Allocasuarina*, *Melaleuca* or *Eremophila*, and halophytic dwarf shrubland. It is often found in more open areas of habitat growing with other ephemeral herbs.

Conservation status. This widespread species is not currently considered to be at risk (IUCN 2012: Least Concern).

Etymology. From the Greek *lepto-* (slender-) and *anthos* (flower): the flowers can appear narrow in pressed material due to their long and slender corolla tube.

Vernacular name. Trumpet Stylewort (Erickson 1958).

Typification. Bentham examined several gatherings when describing *L. leptantha*, including "a few specimens mixed in Preiss's n. 2249" (a syntype of *L. preissii*). MEL 2295747 bears his corresponding annotation "These specimens seem rather to belong to *L. leptantha*, the lower ones to *L. preissii*"; however, I am at a loss to explain Bentham's interpretation of this material. All individuals on this sheet appear referable to *L. aestiva* (refer to the typification section under *L. preissii*). A lectotype must therefore be selected from amongst the remaining material to fix the application of the name *L. leptantha*. MEL 2257568 has been selected since it is the best quality material with specific locality information that was viewed by Bentham. It bears a Botanical Museum of Melbourne label with the locality "Murchison River" as given by Mueller, an Oldfield label with the annotation "337. Fl. Pink. Moist places. Thicket south of Collallia" [Colalya Creek, which drains into the Murchison River east of Meekatharra] and a slip with "Gerald river Murchison" in Bentham's hand. Bentham also retained a subset of this material at K.

Illustrations. R. Erickson, Triggerplants 201, Pl. 57, No. 4 and 212, Pl. 59, Nos. 1–5. 1958 [only the free, distal portion of column depicted]; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 766, no. 5. 1982.

Selected specimens examined. Australia. Western Australia: Bolgart, 40 km N of Perth, 29 Sep 1949, *R. Erickson s.n.* (PERTH); ca. 100 km E of Southern Cross, 26 Sep 1997, *B.A. Fuhrer 97/19* (PERTH); 29 miles [46.7 km] W of Mount Magnet, 11 Sep 1966, *A.S. George 79676* (PERTH); Gayon Station, Cue Road, Mullewa, 19.4 km NE of Courin Hill, 8 Oct 2004, *F. Hort*, *J. Hort & J. Shanks 2340* (PERTH); Emu Rock, Holland Track, 6 km SW from Hyden Norseman Rd, 22 Sep 2005, *R.W. Purdie 6097* (CANB, PERTH); Avon Loc, 19405, 1 mile [1.6 km] SW of Manmanning, 7 Oct 1988, *B.H. Smith 1101* (BRI, CANB, MEL); 850 m S along Wicherena Rd from Geraldton - Mt Magnet Rd, 12 Sep 1996, *J.A. Wege 194A & K.A. Shepherd* (PERTH);

ca. 3.2 km E of Yellowdine on Great Eastern Highway, 13 Sep 2003, *J.A. Wege 895 & C. Wilkins* (PERTH); E of Canna Siding, 14 Sep 2011, *J.A. Wege 1828 & K.R. Thiele* (MEL, PERTH); ca. 3.1 km E of Great Northern Hwy on Goodlands Rd, NE of Jibberding Rocks, 12 Sep 2018, *J.A. Wege 2063* (MEL, PERTH); Bungabandi Creek on Eurardy Station, N of the Murchison River, 30 Aug 2003, *Wildflower Society of WA EURA 525* (PERTH).

6. *Levenhookia pulcherrima* Carlquist, Aliso 7(1): 62–64, figs 118, 119. 1969
Figs 1E, 4F

Type. Australia. Western Australia: Ongerup – Ravensthorpe Highway [precise locality withheld for conservation reasons], 8 Nov 1967, *S. Carlquist 4027* (holotype: RSA 0006328 image!; isotypes: AD 97031212 image!, AD 97133089 image!, B_10_0278639 image!, B_10_0278640 image!, BISH 1005114 image!, BRI-AQ0083605, CANB 195627, CHR 198044 image!, CHR 207972 image!, DAO 000457402 image!, E 00279220 image!, E 00279219 image!, GH 00033479 image!, K 000060049, K 000355298, L 0001769 image!, MEL 2295755, MEL 2295756, MICH 1192769 image!, MO-797445 image!, NCU 00000328 image!, OSC 0001733 image!, PERTH 01000284, PERTH 01000292, RM 0004403 image!, UC *n.v.*, US *n.v.*).

Description. Annual herb 3–16 cm high. Glandular hairs 0.15–4 mm long. Stem dark red, often paler distally, simple or with porrect or ascending lateral branches, glandular-hairy. Leaves cauline, scattered, green adaxially, green or reddish abaxially; lamina oblanceolate to narrowly oblanceolate, lanceolate, ovate or elliptic, 4–22 mm long including the petiole, 1–5 mm wide, obtuse to subacute, sparsely glandular-hairy near the base on the margins and abaxial surface. Flowers in umbels, corymbs or a more elongated raceme, (1)3–ca. 100 per plant; bracts narrowly oblanceolate to almost linear, 4–20 mm long, glandular-hairy like the leaves; pedicels 0.5–4 mm long, glandular-hairy. Hypanthium depressed globose to globose or ellipsoid, 0.8–1.5 mm long, 0.7–1.3 mm wide, glandular-hairy. Calyx lobes subequal (with the anterior-most a little longer than the rest), 1.8–3.5 mm long, acute, sparsely to moderately glandular-hairy. Corolla bright to pale pink with a white throat (more rarely all white) and prominent dark pink markings on the posterior (upper) lobes; lobes paired vertically, spreading to scarcely recurved, obovate, incised or emarginate, usually with a few glandular hairs abaxially towards the base; anterior (lower) lobes slightly inwardly curved, a little longer and broader than the posterior (upper) lobes, 3.2–5 mm long, 2.5–3.6 mm wide; posterior lobes 3–4.5 mm long, 2.2–3.5 mm wide; tube 4.8–8 mm long, 2.5–5 mm longer than the calyx lobes, creamy white with pink-red longitudinal streaks, sparsely glandular-hairy distally. Labellum ventral, 1.3–2 mm long including a claw 0.2–0.4 mm long; hood purplish-red hood (drying dark red-maroon) with pinkish markings near the cleft, sparsely glandular-hairy abaxially, papillate adaxially along the margins of the cleft, cleft apex with a tuft of yellowish or whitish hairs; basal appendages creamy white, linear-subulate, 0.5–0.6 mm long. Column sheath creamy

white, glabrous, with a narrowly triangular, obtuse, posterior lobe to 1 mm high and rounded anterior and lateral lobes 0.5–0.8 mm high, pendulous appendages absent. Column creamy-white, adnate to the anterior side of the corolla tube, 6.5–9 mm long with the top 1.5–2 mm free and angled toward the labellum, faintly constricted below the anthers, glabrous; stigmatic lobes to 1.2 mm long, apparently developing once the column has been exposed, the lowermost arching downwards, the uppermost straight to incurved. Capsule ovoid or globose, 2.5–4 mm long excluding calyx lobes. Seeds ca. 0.5 mm long, 0.3 mm wide.

Diagnostic features. *Levenhookia pulcherrima* has an exserted corolla tube that is 4.8–8 mm long, incised or emarginate corolla lobes with dark pink marking near the base of the upper pair, and a shortly-stalked labellum with linear-subulate basal appendages and a small tuft of hairs at the tip.

Phenology. Flowering from September to November; fruiting recorded from late October and November (and presumably extending into December).

Distribution. *Levenhookia pulcherrima* is endemic to south-western Australia (Fig. 4E), where a small number of populations have been recorded from the central Avon Wheatbelt between Northam, Kellerberrin and Pingelly, and the Esperance Plains, Mallee and Coolgardie bioregions, from near Ravensthorpe to east of Forrestania.

Habitat. This species grows in sand or loamy sand on floodplains, outwash hillslopes or adjacent to granite outcropping. Associated vegetation includes *Acacia acuminata* woodland, *Allocasuarina* shrubland or scrub, mallee woodland or heath, or low open heath.

Conservation status. This species is listed as Priority Three under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–) (equivalent to IUCN (2012): Data Deficient). It remains poorly-known despite the discovery of seven new populations through assessment of herbarium collections and recent field surveys. Obtaining population data for this species is difficult since it is most abundant following fire (e.g. *J.A. Cochrane 6906 & B. Davis*, PERTH; *D.J. Edinger 935*, PERTH; *G.J. Keighery 466*, PERTH). A new population was surprisingly discovered in 2014 in a botanically well-surveyed nature reserve in the Avon Wheatbelt (*J. Borger & N. Moore MC 9-1*, PERTH) growing in unburnt habitat adjacent to experimental patch burns, suggesting that the smoke from these fires may have triggered germination. It is not known how long the soil seed bank remains viable and, as such, inappropriate fire regimes may represent a threat to this species.

Etymology. From the Latin *pulcherrimus* (prettiest).

Vernacular name. Beautiful Stylewort.

Notes. Several collections of *L. pulcherrima* were previously misidentified as *L. leptantha*, a species with a similarly long corolla tube. Pressed material of *L. pulcherrima* can be separated from *L. leptantha* by its mostly longer calyx lobes (1.8–3.5 mm cf. 0.8–2 mm) and morphologically distinct labellum, which has linear-subulate basal appendages and an apical tuft of hairs (cf. with rounded basal appendages and a small, glabrous apical appendage). *Levenhookia pulcherrima* lacks the succulent leaves and bracts that characterise *L. leptantha* and the posterior side of its column sheath has a

prominent triangular lobe (cf. sheath connate with the posterior corolla lobes to form a smooth, yellow pad).

A small, fast-moving, solitary native bee was observed gleaning pollen at *J.A. Wege 1937*.

Illustrations. B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 766, no. 4. 1982 [anterior corolla lobes mislabelled as "posterior petals" and vice versa].

Selected specimens examined. Australia. Western Australia: [localities obfuscated for conservation reasons] W of Ravensthorpe, 11 Oct 1974, *S. Carlquist 6000* (PERTH); Phillips River, 27 Nov 2007, *J.A. Cochrane & B. Davis JAC 6906* (PERTH); Northam, Oct 1973, *G.J. Keighery 73.10/10* (PERTH); E of Lake King on Norseman Track, 27 Oct 1975, *G.J. Keighery 466* (PERTH); Phillips River, 27 Oct 1997, *B.J. Lepschi & B.A. Fuhrer BJL 3755* (CANB, MEL, PERTH); ENE of Lake King, 14 Nov 1979, *K.R. Newbey 6533* (PERTH); SE of Tammin, 19 Sep 2014, *J.A. Wege 1937* (MEL, PERTH); towards Ravensthorpe, 26 Oct 1968, *J.W. Wrigley s.n.* (CANB).

7. *Levenhookia pauciflora* Benth. in S.F.L. Endlicher, E. Fenzl, G. Bentham & H.W. Schott, Enum. Pl.: 74. 1837

Figs 2G, H, 5B

Leeuwenhoekia pauciflora, orth. var.: A.P. De Candolle, Prodr. 7: 338. 1839.

Levenhookia stylidiodes F.Muell., Fragm. 6(43): 77. 1867, as *Leeuwenhoekia*. Type. Australia. Western Australia: "In Australia occidentali a sinu regis Georgii saltem usque ad montes Stirling's Range. F.M." King George's Sound, Oct 1867, *F. Mueller s.n.* (syntypes: K 000060051, K 000060052, MEL 2257553, MEL 2257555, MEL 2257556, MEL 2257557, MEL 2257558, MEL 2257559, MEL 2257560); Albany, Oct 1867, *F. Mueller s.n.* (syntype: MEL 2257551); King George's Sound, [no date] *F. Mueller s.n.* (probable syntype: MEL 2257557).

Leewenhoekia pauciflora, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Levenhookia stylidioides, orth. var.: B.D. Jackson, Index Kew. 2(3): 75. 1894.

Type. Australia. Western Australia: King George's Sound, [Jan 1834] *K. von Hügel s.n.* (holotype: W 0047174).

Description. Annual herb 2–12 cm high. Glandular hairs 0.1–0.3 mm long. Stem dark red, sometimes paler reddish-brown distally, simple (rarely branched at base), glandular-hairy and papillate. Leaves cauline, scattered, green, sometimes tinged red; lamina broadly to narrowly ovate or occasionally reniform, 1.2–8 mm long including the petiole, 0.8–4 mm wide, obtuse or rounded, sparsely glandular-hairy abaxially near the base and on the margins, sometimes apparently glabrous. Flowers in short racemes or umbels, 1–15 per plant; bracts narrowly oblanceolate to oblanceolate or linear, 1–8 mm long, sparsely glandular-hairy abaxially and on the margins; pedicels 1–5(8) mm long, glandular-hairy. Hypanthium depressed globose or globose, 0.7–2.5 mm long, 0.8–2 mm wide, glandular-hairy. Calyx lobes equal or subequal (with the ante-

rior pair scarcely longer than the rest and rarely connate at base), 1–3 mm long, obtuse to subacute, sparsely glandular-hairy. Corolla creamy white prominent red markings towards the base of the lobes at the tips of the upper lobes, abaxial surface with a fine red midvein, throat yellow; lobes paired vertically, sparsely glandular-hairy abaxially; anterior (lower) lobes narrowly oblanceolate, geniculate, longer and broader than the posterior pair, 3–7 mm long, 1.3–3.5 mm wide, apiculate or obtuse; posterior (upper) lobes lanceolate or elliptic, 2.5–4.5 mm long, 0.9–2.2 mm wide, acuminate, acute or apiculate; tube 2–3.5 mm long, ± equal to or up to ca. 1.2 mm longer than the calyx lobes, sparsely glandular-hairy distally. Labellum ventral, 1.5–3 mm long including a 0.2–0.6 mm claw; hood dark reddish maroon with yellow markings near the cleft, sparsely glandular-hairy abaxially, with a brush-tipped appendage 0.9–1.3 mm long at the cleft apex; basal appendages creamy white, linear to linear-subulate, 0.7–1.2 mm long. Column sheath yellow, lopsided, pendulous appendages absent; posterior side with 4 basally connate lobes 0.3–0.8 mm high, the lateral pair tipped with glandular hairs; anterior side adnate to the column, with 1 or 2 minute lobes visible on the anterior side of the column. Column creamy yellow, 3.2–6.5 mm long, adnate to the anterior side of the corolla (including the tube, lobes and column sheath) with the top 1.5–3 mm free and sharply angled towards the labellum, constricted below a dilated tip, glabrous; stigmatic lobes to ca. 1 mm long, developing once the column has been exposed, straight to incurved. Capsule globose or ovoid, 2–3 mm long excluding calyx lobes. Seeds 0.3–0.5 mm long, 0.2–0.4 mm wide.

Diagnostic features. *Levenhookia pauciflora* has a stem with both glandular hairs and minute papillae, creamy white corolla lobes with a fine red midvein on the undersurface, upper corolla lobes with pointed tips, and a brush-tipped appendage at the apex of the labellum cleft. Its column and column sheath morphology are diagnostic but less readily viewed on pressed material.

Phenology. Mostly flowering from September to early November (rarely in January as per type gathering); fruits have only been collected in October.

Distribution. *Levenhookia pauciflora* is widespread in south-western Australia (Fig. 5A), extending from Badgingarra and Watheroo National Parks in the Geraldton Sandplains bioregion, south to Scott River National Park in the Warren bioregion, and east to Cape Arid National Park in the Esperance bioregion, with numerous records from the central Avon Wheatbelt and Mallee bioregions.

Habitat. *Levenhookia pauciflora* is found on plains or hill-slopes in sand or clayey sand, sometimes with surface gravel or in association with granite outcropping. Associated vegetation is varied and includes heath, mallee shrubland, open *Eucalyptus* or *Corymbia* woodland, and scrub with emergent *Nuytsia* or *Banksia*.

Conservation status. This is a widespread species that is not currently considered to be at risk (IUCN 2012: Least Concern).

Etymology. From the Latin *paucus* (few) and *-florus* (-flowered).

Vernacular name. Deceptive Stylewort (Erickson 1958). The corolla lobes of this species are reminiscent of some triggerplants including *Stylidium petiolare* Sond., with which it can co-occur.

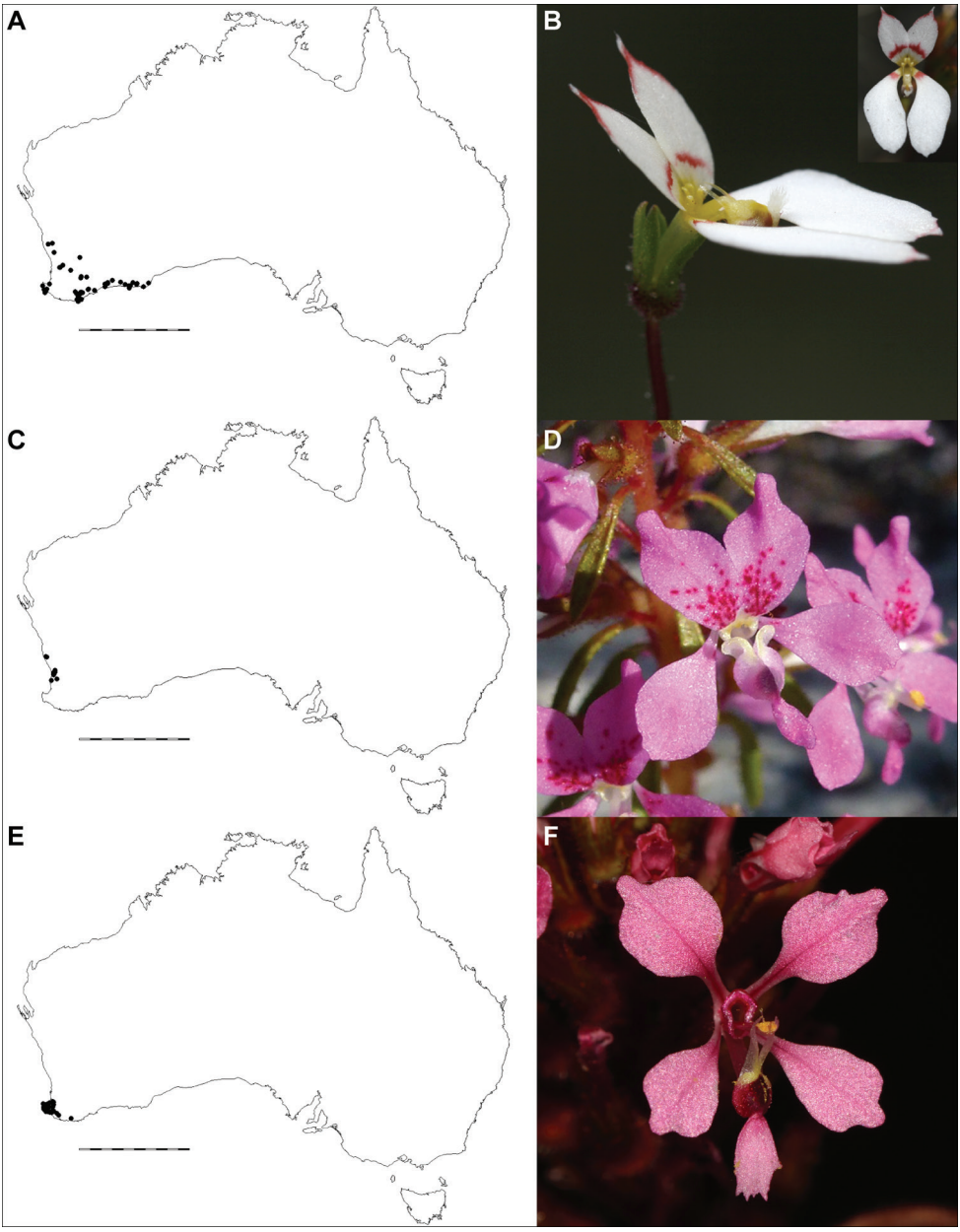

Figure 5. Comparative distributions and floral morphologies **A, B** *Levenhookia pauciflora*, a Western Australian endemic with a brush-tipped labellum and distinctive corolla shape (*J.A. Wege 1071 & C. Wilkins*) **C, D** *L. preissii*, a poorly-known Western Australian endemic with distinctive corolla makings, rounded basal labellum appendages and a white, lopsided column sheath (unvouchered, from NW of Cooljarloo) **E, F** *L. aestiva*, a Western Australian endemic with oblong-subulate basal labellum appendages and a pink column sheath (*J.A. Wege 2090*). Photos by J.A. Wege (**B**), M. Matsuki (**D**) and R.W. Davis (**F**). Scale bar on maps 1000 km.

Typification. I annotated W 0047174 as a syntype during a visit to the Naturhistorisches Museum Wien in 2003 but have since failed to find any other duplicates of Hügel's gathering. This sheet, which has been annotated by Bentham, is therefore regarded here as the holotype.

Illustrations. R. Erickson, Triggerplants 201, Pl. 57, No. 6 and 212, Pl. 59, Nos. 19–23. 1958 [column and sheath morphology inaccurately depicted]; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 765, no. 2(1982); J. Wheeler, N. Marchant & M. Lewington, Fl. South West 2: 902 (2002).

Selected specimens examined. Australia. Western Australia: Watheroo National Park, 12 Sep 1993, *K. Bremer & M. Gustafsson 110* (PERTH); 20 km E of Lake Grace on road to Newdegate, 14 Sep 1993, *K. Bremer & M. Gustafsson 122* (PERTH); S Stirling sandplain, S of Stirling Range, 16 Oct 1951, *R. Erickson s.n.* (PERTH); Mount Willying, N of Albany, 11 Oct 1969, *A.S. George 9694* (PERTH); Flint State Forest, Metro Rd, 6.1 km S from Brookton Hwy, 12 Oct 2009, *F. & J. Hort 3478* (PERTH); Plains S of Blackwood River, 24 Oct 1948, *R.D. Royce 2963* (PERTH); 14 km from Ravensthorpe towards Hopetoun, 12 Sep 1983, *J. Taylor 1712 & P. Ollerenshaw* (CANB); 3.7 km W along Cadda Rd from Brand Hwy, 23 Sep 1996, *J.A. Wege 209 & L. Cobb* (PERTH); 1.4 km E from NW boundary corner, Tarin Rock Nature Reserve, 21 Sep 1997, *J.A. Wege*, *R. Butcher & C. Wilkins JAW 358* (PERTH); 100 m E of Stockyard Rd on Merivale Rd, E of Esperance, 23 Sep 1997, *J.A. Wege 363*, *R. Butcher & C. Wilkins* (PERTH); 1.25 km E on Devil's Creek Rd from Gairdner River Crossing, NW of Bremer Bay, 29 Sep 1997, *J.A. Wege 380*, *R. Butcher & C. Wilkins* (PERTH); ca. 1 km N of park boundary on Chester Pass Rd, Stirling Range National Park, 30 Oct 2003, *J.A. Wege 1071 & C. Wilkins* (PERTH); 8 miles [12.9 km] W of Israelite Bay, 1 Oct 1968, *P.G. Wilson 8148* (AD, CANB, MEL, PERTH).

8. *Levenhookia preissii* (Sond.) F.Muell., Fragm. 4(27): 94, 1864, as *Leewenhoekia*
Fig. 5D

Coleostylis preissii Sond., in J.G.C. Lehmann, Pl. Preiss. 1(3): 391. 1845.
Leewenhoekia preissii, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Type. Australia. Western Australia: Swan River, [1841] *J. Drummond 1: 515* (lectotype, here designated: BM 000984007; isolectotypes: G 00342974 image!, G 00342988 image!, K 000060074, K 000060076, MEL 2295745, MEL 2295746, OXF, P 00712441 image!, P 00712444 image!, P 00712443 image!, W [2 sheets]); In arenosis cis oppidulum Guildford, 12 Jan 1840, *L. Preiss 2250* (syntypes: G 00358747 image!, G 00358748 image!, K 000060078 [as Preiss 842], LD 1730899 image!, MEL 2295748, MEL 2295750B [top individual], P 00712442 image!, TCD [as Preiss 842], W); In arenosis districtus Sussex, 20 Dec 1839, *L. Preiss 2249* (syntypes: FI 012788!, G 00358745 image!, G 00358746 image!, K 000060077 [as Preiss 895], LD 1753988 im-

age!, MEL 2295747, MEL 2295749A [2 upper individuals], MEL 2295750A [lower 3 individuals], P 00712441 image!, TCD [as Preiss 895], W [3 sheets]), = *L. aestiva* Wege.

Description. Annual herb 6–16 cm high. Glandular hairs somewhat viscid, 0.1–0.5 mm long. Stem pale greenish brown to reddish brown, simple or branched to varying degrees with porrect or ascending lateral branches, glandular-hairy. Leaves cauline, scattered, green or green with a red tinge, glandular-hairy on the margins and abaxially, with a few hairs adaxially (mostly towards the base); lamina narrowly oblanceolate to oblanceolate or narrowly lanceolate, 6–22 mm long including the petiole, 0.9–3 mm wide, acute to subacute with a blunt tip. Flowers in racemes (inflorescence corymbose in few-flowered individuals), ca. 10–200^{+} per plant; bracts narrowly oblanceolate, narrowly lanceolate or ± linear, 1.5–12 mm long, glandular-hairy like the leaves; pedicels 0.5–6 mm long, glandular-hairy. Hypanthium depressed globose to globose, ellipsoid or ovoid, 0.5–1.5 mm long, 0.4–1.5 mm wide, glandular-hairy. Calyx lobes subequal (with the anterior pair 0.5–1 mm longer than the rest and sometimes connate basally), 1.3–3 mm long, acute, glandular-hairy. Corolla pink with dark pink speckles mostly confined to the posterior (upper) lobes, paler abaxially; lobes ± paired vertically or sometimes with the lower pair spreading, ca. 3–4.5 mm long, ca. 1.5–2.5 mm wide, sparsely glandular-hairy abaxially towards the base; anterior lobes elliptic or obovate with a slender claw, ± equal in length to the posterior pair, rounded or subacute; posterior lobes obovate (with a broad but short claw?), bluntly pointed, sometimes gently recurved; tube white, 2–4.5 mm long, exserted 0.5–2 mm beyond the calyx lobes, sparsely glandular-hairy distally. Labellum ventral, ca. 3–4.2 mm long including a 1.2–1.7 mm long claw; hood pink with dark purplish (drying red-maroon) markings, minutely papillate, with a few glandular hairs abaxially; basal appendages yellow or white, ± elliptic, 0.4–0.7 mm long, rounded, minutely papillate; appendage at the cleft apex pink, elliptic to narrowly obovate, 0.7–1.5 mm long, 0.4–0.6 mm wide, obtuse, glabrous. Column sheath white, glabrous, lopsided, ca. 0.5–0.7 mm high on the anterior side, connate with the posterior corolla lobes, with a thickened rim bearing 3 pendulous appendages on the inside. Column white basally, pinkish distally, free, gently forward-arched when enclosed by the labellum, slender but slightly thickened distally, 4.5–7.2 mm long, glabrous; stigmatic lobes to 1.2 mm long, incurved, apparently maturing subsequent to pollen release. Capsule ovoid, ca. 2.5–3 mm long excluding calyx lobes. Seeds 0.4–0.5 mm long, 0.2–0.3 mm wide.

Diagnostic features. *Levenhookia preissii* has a long (2–4.5 mm) corolla tube that is exerted beyond the calyx lobes, pink corolla lobes with speckled markings, a long labellum (ca. 3–4.2 mm) with rounded basal appendages and a prominent (0.7–1.5 mm long) apical appendage, and a 4.5–7.2 mm long column subtended by a lopsided column sheath. Its racemes are usually quite elongated (especially in floriferous individuals).

Phenology. Flowering from late October to January; fruiting in December and January.

Distribution. *Levenhookia preissii* is endemic to south-western Australia (Fig. 5C), where it is restricted to the Swan Coastal Plain bioregion. It is currently known from north-west of Cataby and the Perth metropolitan area, although historical records indicate a distribution that extends south to the Pinjarra area.

Habitat. This species grows in sand in seasonally-wet habitats or near watercourses, swamps and minor drainage channels in heath or tall shrubland. Associated species include *Banksia telmatiaea*, *Beaufortia squarrosa*, *Hypocalymma angustifolium*, *Melaleuca viminea*, *M. seriata*, *Regelia ciliata* and *Verticordia densiflora*.

Conservation status. *Levenhookia preissii* was recently listed as Priority One under Conservation Codes for Western Australian Flora (Western Australian Herbarium 1998–; equivalent to IUCN (2012): Data Deficient). It is currently known from two bushland fragments in Perth and from an area north-west of Cataby that is subject to mining. Few plants have been noted with the exception of *B.J. Keighery 2546*, which was collected the year following a summer fire. The optimal time for survey and conservation assessment is during peak flowering (between mid-November and mid-December), following a summer or autumn fire.

Etymology. Honours Johann August Ludwig Preiss (1811–1883), who collected extensively in south-western Australia between 4 December 1838 and 8 January 1842 (George 2009). These collections formed the basis for Lehmann's *Plantae Preissianae*, a landmark work on Western Australian botany in which a suite of Stylidiaceae taxa were described (Sonder 1845).

Vernacular name. Preiss's Stylewort (Erickson 1958).

Typification. Sonder based his description of *Coleostylis preissii* on three separate gatherings of which *Preiss 2250* (from the Perth suburb of Guildford) and *Drummond 515* ('Swan River') are comparable; however, *Preiss 2249* (from the more southerly 'Sussex District', i.e. between Capel and Toby's Inlet: see Marchant 1990) represents a distinct species. Lectotypification is necessary to fix the application of the name *L. preissii*.

Sonder viewed material of both Preiss gatherings at LD and in his personal herbarium, which is now at MEL. The LD material is fragmentary, comprising one or two inflorescence portions. The Preiss material at MEL is more complete but difficult to interpret—there are few readily visible flowers, labelling is ambiguous and one of the sheets (MEL 2295750) contains material from both gatherings. This sheet includes four individuals, several floral dissections and Sonder's sketches and notes (which indicate that he observed differences in labellum size and appendage morphology between the two gatherings). The uppermost individual belongs to *Preiss 2250*, while the remaining three individuals appear to match *Preiss 2249*. I have not been able to confidently assign all fragments contained in the attached packet, but I have separated several that seem to be referable to *Preiss 2250*, including dissected flowers. I have been unable to find a dissection for *Preiss 2249* despite Sonder's floral sketches.

Given the difficulties associated with interpreting the Preiss material at MEL, the fragmentary nature of the duplicates at LD and, indeed, the generally poor quality of the material, I have made the pragmatic decision to lectotypify on the Drummond gathering despite its lack of precise locality. Based on our present day understanding of the species and Drummond's collecting trips (see George 2009), it is likely to have been collected from the Perth region. BM 000984007 is designated as the lectotype: it comprises four, mostly complete individuals with ample floral material, a small packet with some fragments and a pink annotation slip with the name 'Coleostylis racemiflora Sond.' in Sonder's hand (an earlier manuscript name that he also wrote on a subset of

material at LD and MEL, but subsequently amended). MEL 2295746, from Sonder's Herbarium, is interpreted as a likely duplicate given that there is an original label with the collector and number (although a photocopy of the *Preiss 2249* and *2250* label from MEL 2295750 is also affixed to this sheet). MEL 2295745 is also a duplicate—it has a label in Mueller's hand and was seen by Bentham for *Flora Australiensis*, although it does not bear Sonder's script (although is databased as belonging to Sonder's Herbarium).

Notes. There are several morphological features that support a narrower circumscription of *L. preissii* and the recognition of *L. aestiva* as a distinct species (refer to the comparative notes provided under *L. aestiva*). The two species are geographically separated: historical records of *L. preissii* extend as far south as the Serpentine and Murray River area near Pinjarra, while the northern-most records of *L. aestiva* are from the Preston River area east of Bunbury.

Illustrations. L. Diels & E. Pritzel, Bot. Jahrb. Syst. 35: 598, fig. 67 D–G (1905) [reproduced by J. Mildbraed in H.G.A. Engler, Pflanzenr. 35: 29, fig. 10D–G]; R. Erickson, Triggerplants 201, Pl. 57, No. 7 and 212, Pl. 59, Nos. 11–18 [column sheath not clearly depicted].

Specimens examined. Australia. Western Australia: [precise localities obfuscated for conservation reasons] Guildford, 5 Jan 1951, *Anonymous s.n.* (PERTH); Bayswater, Dec 1901, *C. Andrews s.n.* (PERTH); Bullsbrook area, 28 Dec 1971, *N.T. Burbidge 7960* (CANB); Bayswater, Dec 1900, *Dr Diels & Pritzel 409* (PERTH); Guildford, Jan 1954, *R. Erickson s.n.* (PERTH); Cannington, Oct 1898, *R. Helms s.n.* (PERTH); Perth Airport, 20 Oct 1994, *B.J. Keighery 2546* (PERTH); NW of Cooljarloo, 1 Dec 2014, *M. Matsuki 197A* (PERTH); Cannington, 14 Dec 1898, *A. Morrison s.n.* (BRI, CANB, PERTH); Bayswater, 9 Jan 1899, *A. Morrison s.n.* (PERTH); Serpentine River, 1 Dec 1877, *F. von Mueller s.n.* (MEL); Murray River district, Dec 1900, *E. Pritzel 128* (PERTH); Bayswater, 26 Dec 1924, *O.H. Sargent s.n.* (PERTH); [SE of Cervantes], 24 Nov 2005, *G. Woodman Opp 5* (PERTH); Leeming, 17 Dec 2011, *J.E. Wajon JEW 2533* (PERTH).

9. *Levenhookia aestiva* Wege, sp. nov.

urn:lsid:ipni.org:names:77209908-1
Figs 2B, 5F, 6.

Levenhookia sp. Whicher Range (J.A. Wege 2090), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 March 2020].

Diagnosis. *Levenhookia aestiva* can be identified by its long (5.5–8 mm) corolla tube, long (7.5–11 mm) column, entire column sheath with 3 pendulous appendages, and long labellum (4.5–6.5 mm) with a prominent apical appendage and oblong-subulate basal appendages.

Type. Australia. Western Australia: 1.1 km E on Sabina East Road from Sues Road, Whicher National Park, 18 Dec 2018, *J.A. Wege 2090* (holo: PERTH 09082654; iso: AD, CANB, K, MEL, NSW).

Description. Annual herb 4–15 cm high. Glandular hairs somewhat viscid, 0.2–0.6 mm long. Stem dark red or brownish red, simple or branched to varying degrees with porrect or ascending lateral branches, glandular-hairy. Leaves cauline, scattered, green or red, glandular-hairy on the margins and abaxially, with a few hairs adaxially (mostly towards the base); lamina narrowly oblanceolate to oblanceolate, elliptic or ovate, 3–25 mm long including the petiole, 1–5.5 mm wide, acute to subacute with a blunt tip. Flowers in racemes (inflorescence corymbose in few-flowered individuals), 1–ca. 300-flowered; bracts narrowly oblanceolate to oblanceolate, narrowly lanceolate or ± linear, 2–22 mm long, glandular-hairy like the leaves; pedicels 1–6 mm long, glandular-hairy. Hypanthium globose, obovoid or depressed-obovoid, 0.7–1 mm long, 0.8–1.5 mm wide, glandular-hairy. Calyx lobes subequal (with the anterior pair scarcely longer than the rest and rarely connate basally), 2.5–4.2 mm long, acute, glandular-hairy. Corolla pink, often with a dark pink midvein and with white or pale pink margins near the base of the lobes; lobes evenly arranged tending vertically-paired, elliptic or obovate with a slender claw, usually slightly recurved, sparsely glandular-hairy abaxially towards the base and along the midvein; anterior (lower) lobes slightly narrower than the posterior pair, 4.5–6.5 mm long, 2.2–3.2 mm wide, bluntly pointed or rounded; posterior (upper) lobes 4.5–6 mm long, 2.8–3.5 mm wide, bluntly pointed; tube whitish with pink longitudinal stripes distally, 5.5–8 mm long, exserted 1.5–4.5 mm beyond the calyx, sparsely glandular-hairy distally. Labellum ventral, 4.5–6.5 mm long including a 1.5–2.5 mm long claw; hood pink with dark red-purple markings adaxially, minutely papillate, sometimes with a few glandular hairs abaxially; basal appendages creamy white, pale yellow near the base, oblong-subulate, 1–2.5 mm long, acute or obtuse, sometimes papillate; appendage at the cleft apex pink, elliptic to obovate, 1.5–2 mm long, 0.8–1.4 mm wide, usually with an irregularly incised apex (rarely obtuse), glabrous. Column sheath deep pink, glabrous, 0.5–1 mm high, with an entire, thickened rim bearing 3 pendulous appendages on the inside. Column white basally, pinkish distally, free, forward-arched when enclosed by the labellum, slender but slightly thickened distally, 7.5–11 mm long, glabrous; stigmatic lobes to 1.3 mm long, incurved, apparently maturing subsequent to pollen release. Capsule depressed obovoid, 1.5–3 mm long excluding calyx lobes. Seeds 0.4–0.5 mm long, 0.2–0.3 mm wide.

Phenology. Mostly flowering from mid-November to early February, with flowering extending into March and April in swampy habitats on the south coast; mostly fruiting from mid-December to February.

Distribution. Most records of *L. aestiva* are from the south-west corner of Western Australia (Fig. 5E) between Bunbury, Pemberton, Augusta and Yallingup in the Warren, Jarrah Forest and Swan Coastal Plain bioregions. There is an outlying, but morphologically comparable record near Denmark.

Habitat. *Levenhookia aestiva* grows in sandy soils near swamps and on low lying flats, or in sandy loam with lateritic gravel in more upland habitats. It is commonly recorded from post-fire habitats and disturbed roadsides or firebreaks. Associated vegetation includes open *Eucalyptus marginata*, *Corymbia calophylla* or *C. haematoxylon* woodland with *Kingia australis* and *Xanthorrhoea preissii*, and low Myrtaceous shrub-

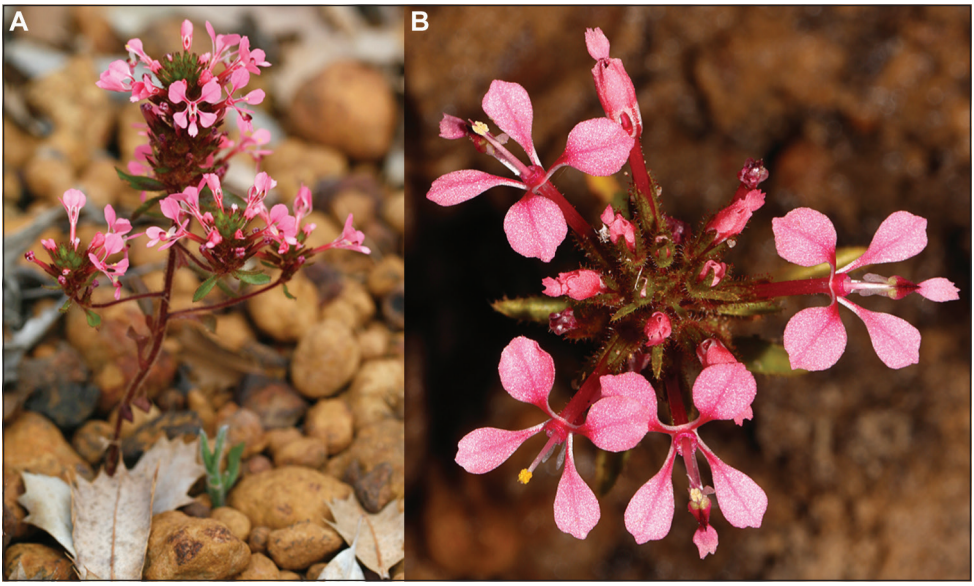

Figure 6. *Levenhookia aestiva* (*J.A. Wege 2090*) **A** annual habit showing the ascending lateral branches; **B** inflorescence as viewed from above, showing flowers with a long corolla tube and column and a pink, entire column sheath. Photos by J.A. Wege (**A**) and R.W. Davis (**B**).

land. In lateritic habitats, it may grow in sympatry with *Stylidium lateriticola* Kenneally, a species with similarly bright pink, summer-blooming flowers.

Conservation status. Despite its reasonably narrow geographic range, *L. aestiva* is locally common at numerous sites within the conservation estate (especially following a disturbance) and is not currently considered to be at risk (IUCN (2012): Least Concern).

Etymology. From the Latin *aestivus* (of summer), in reference to its flowering time.

Vernacular name. Summer Stylewort.

Notes. Specimens of *L. aestiva* have previously been placed under a broadly defined *L. preissii* (Sonder 1845, Mildbraed 1908, Erickson 1958, Wheeler 2002, Lowrie and Conran 2011); however, there are several features that support its recognition as a distinct species. Corolla tube length (5.5–8 mm cf. 2–4.5 mm in *L. preissii*) and column length (7.5–11 mm cf. 4.5–7.2 mm in *L. preissii*) are taxonomically informative and readily observed on pressed material. *Levenhookia aestiva* also has a longer labellum (4.5–6.5 mm cf. 3–4 mm) with a larger apical appendage (1.5–2 mm × 0.8–1.4 mm cf. 0.7–1.5 × 0.4–0.6 mm) and longer basal appendages (1–2.5 mm cf. 0.4–0.7 mm long). Its corolla lobes lack the speckled markings that appear characteristic of *L. preissii* (compare Fig. 5D, F) and its nectar sheath is morphologically distinct. Capsule shape may also be taxonomically informative (depressed obovoid in *L. aestiva* cf. ovoid in *L. preissii*), although few mature capsules of the latter species have been viewed. The two species are not known to overlap in distribution (refer to the notes under *L. preissii*).

Selected specimens examined. Australia. Western Australia: 6.7 km N on Black Point Rd from Wapet Track, 30 Jan 1997, *E. Bennett & B. Evans P 13.1* (PERTH);

Creek View Rd, Reserve 12492, Quindalup, 10 Dec 2003, *D. Carter 661* (PERTH); 32 km from Pemberton along road to Nannup, 21 Jan 1979, *M.D. Crisp 5350* (CANB, PERTH); 15 km E of Karridale, 15 Jan 1996, *R. Davis RD 443* (PERTH); Margaret River crossing on Rapid Rd, Whicher Range, 16 Jan 1986, *A.H. Burbidge 3966* (PERTH); Denmark Shire, Nutcracker Rd, 1 km E from junction with Stan Rd, 2 Jan 1999, *B.G. Hammersley 2150* (PERTH); 1 km along Rapids Rd from Canebreak Rd, Whicher Range, ca. 20 km S of Busselton, 13 Jan 1986, *G.J. Keighery 8046* (CANB, PERTH); Forest Grove Block, 10 km S of Margaret River, 10 Dec 1990, *G.J. Keighery 13750* (PERTH); Capel Nature Reserve, 13 Dec 1994, *G.J. Keighery 13260* (PERTH); Ambergate Regional Park, 13 km SSW of Busselton, 14 Nov 1994, *G.J. Keighery 15146* (PERTH); Joshua Brook Rd, Boyanup Forest Block, 15 Jan 1997, *G.J. Keighery 15067* (PERTH); 7.25 km SW along Sabina Rd from Vasse Hwy, S of Busselton, 29 Nov 1995, *J.A. Wege 154 & P. French* (PERTH); Sues Bridge camping area on the Blackwood River, 50–100 m W of Sues Rd, SE of Busselton, 29 Jan 2009, *J.A. Wege 1590* (PERTH); 6.1 km S of Governor Broome Rd on Milyeannup Coast Rd, N of Scott River, E of Augusta, 30 Jan 2009, *J.A. Wege 1592* (PERTH).

10. *Levenhookia stipitata* (Benth.) F.Muell. ex Benth., Fl. Austral. 4: 36. 1868

Figs 2A, 7B

Stylidium stipitatum Benth., in S.F.L. Endlicher, E. Fenzl, G. Bentham & H.W. Schott, *Enum. Pl.*: 72. 1837.

Coleostylis umbellata Sond. in J.G.C. Lehmann, Pl. Preiss. 1(3): 391. 1845, *nom. illeg.* [*Stylidium stipitatum* cited in synonymy]

Leewenhoekia stipitata (Benth.) F.Muell., Fragm. 4(27): 94. 1864, *nom. inval.*, *nom. prov.*

Leewenhoekia stipitata, orth. var.: F. von Mueller, Syst. Census Austral. Pl.: 86. 1882.

Type. Australia. Western Australia: Swan River, [1833] *K. von Hügel s.n.* (lectotype, here designated: W 0047173, all *Levenhookia* material [i.e. excluding the individual of *Centrolepis*]).

Description. Annual herb 2–18 cm high. Glandular hairs 0.1–0.5 mm long. Stem dark red to reddish brown, sometimes paler or greenish distally, simple or branched to varying degrees with porrect or ascending lateral branches, glandular-hairy. Leaves cauline, scattered, green (occasionally tinged red) or red-purple, lamina narrowly oblanceolate to oblanceolate, elliptic or ovate, 2.5–12 mm long including the petiole, 0.5–3(–4.5) mm wide, subacute to acute or obtuse, glandular-hairy on the abaxial surface and margins. Flowers in umbels, corymbs or short racemes, 1–ca. 150 per plant; bracts narrowly oblanceolate to oblanceolate, elliptic or linear, 2–10 mm long, glandular-hairy like the leaves; pedicels 3–18 mm long, glandular-hairy. Hypanthium depressed globose, globose or ellipsoid, 0.7–1.5 mm long, 0.7–1.8 mm wide, glandular-hairy. Calyx lobes ± equal or with the anterior pair scarcely longer than the rest, 1.3–2.3 mm long, acute, moderately to sparsely glandular-hairy. Corolla bright to pale pink (rarely white)

with a white throat, sometimes with two, elongated red-pink markings towards the base of each lobe near the margins; lobes evenly arranged or with the upper (posterior) ones ± paired vertically, sometimes weakly recurved, obovate or elliptic with a slender claw, rounded, scarcely apiculate or bluntly pointed, glabrous or sometimes with sparse glandular hairs abaxially; anterior lobes equal to or slightly shorter and narrower than the posterior pair, 2.5–4.5 mm long, 1.6–2.8 mm wide; posterior lobes 2.7–4.5 mm long, 1.7–3.3 mm wide; tube creamy white, 0.2–0.5 mm long, obscured by the calyx lobes, glabrous. Labellum ventral, 2–3.5 mm long including a 0.9–1.5 mm long claw; hood yellow or whitish with dark red-maroon markings, sparsely glandular-hairy abaxially, scarcely papillate adaxially along the margins, papillate abaxially with a short, blunt, dark pink-red or sometimes yellow appendage at the cleft apex; basal appendages yellowish or white, rounded, 0.4–0.6 mm long. Column sheath white or yellowish, glabrous, 1.3–2.5 mm high on the posterior side with a thickened rim and broad anterior cleft, 3 pendulous appendages present on the inner surface towards the throat. Column creamy white, free, erect, slightly thickened distally, 2–4 mm long; stigmatic lobes to ca. 1 mm long, incurved, the lower-most developing while the column is hooded, the uppermost developing later. Capsule globose or ovoid, 1–2.3 mm long excluding calyx lobes. Seeds 0.4–0.5 mm long, 0.25–0.3 mm wide.

Diagnostic features. *Levenhookia stipitata* has glandular-hairy stems, bracts and calyx lobes, long pedicels (3–18 mm), a short corolla tube (obscured by the calyx lobes), a small, blunt, papillate appendage at the tip of the labellum, and a prominent column sheath (more than half the length of column). The corolla lobes may have a pair of elongated markings near the base (see notes below).

Phenology. Flowering from September to December; fruits have been collected from late October to December.

Distribution. This species is widespread in Western Australia (Fig. 7A), occurring in all bioregions within the South-West Province as well as the adjacent Yalgoo and Coolgardie bioregions. It has a more restricted distribution in South Australia where it is mostly confined to the Eyre Peninsula between Pinkawillinie Conservation Park and Point Boston, with an outlying record from the central Yorke Peninsula.

Habitat. *Levenhookia stipitata* grows in sand, sandy loam or clayey sand over limestone or laterite, more rarely in association with granite outcropping, usually on plains and hill-slopes but sometimes in depressions or seasonally damp habitats. Associated vegetation is varied and includes heathland, woodland, *Eucalyptus marginata* and *Corymbia calophylla* forest, *Banksia*, *E. wandoo* or *E. cladocalyx* woodland, open mallee woodland or shrubland, and *Acacia* or *Melaleuca* tall shrubland.

Conservation status. This common species is not considered to be under threat (IUCN (2012): Least Concern); however, in South Australia, it is listed as Rare (Schedule 9) under the *National Parks and Wildlife Act 1972* (Government of South Australia 2018).

Etymology. From the Latin *stipitatus* (stipitate, provided with a stipe or little stalk), presumably with reference to the corolla segments.

Vernacular name. Common Stylewort (Erickson 1958).

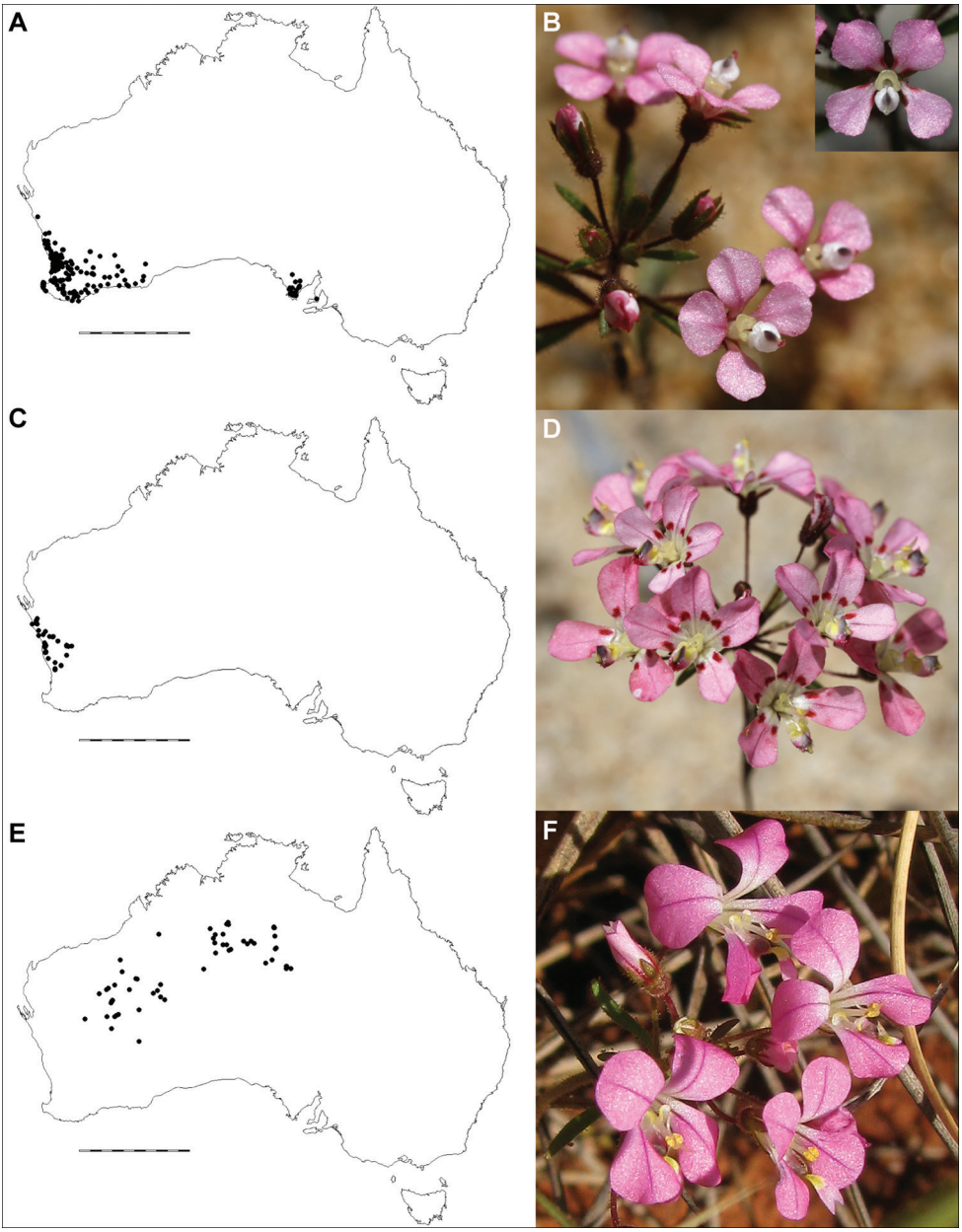

Figure 7. Comparative distributions and floral morphologies **A, B** *L. stipitata*, with a disjunct distribution in Western Australia and South Australia and flowers on long pedicels and with a prominent column sheath (*J.A. Wege 1874*). Inset showing coloured markings at the base of the corolla lobes that have been recorded for many populations (*J.A. Wege 1873*) **C, D** *L. octomaculata*, a Western Australian endemic with prominent corolla markings and a densely papillate labellum (*J.A. Wege 2074*) **E, F** *L. chippendalei*, widespread in arid areas of Western Australia and the Northern Territory, with the incised apical labellum appendage visible in the lower right flower (*N. Gibson 6559*, *S. van Leeuwen*, *M.A. Langley & K. Brown*). Photos by J.A. Wege (**B, D**) and K. Brown (**F**). Scale bar on maps 1000 km.

Typification. The only Hügel specimen that is known is held at Naturhistorisches Museum Wien (W 0047173) and bears annotations by Bentham (as '*Stylidium stipitatum*'), Sonder (as '*Coleostylis umbellulata*') and Mildbraed (as '*Levenhookia stipitata*'). The collection is mixed, comprising four individuals of *L. stipitata* (and associated fragments in the attached packets) and a single individual of *Centrolepis aristata* (R.Br.) Poir. (Centrolepidaceae) mounted with the *Levenhookia* in the centre of the sheet. All *Levenhookia* material on this sheet is designated herein as the lectotype.

Notes. Corolla markings are often absent in *L. stipitata*; however, two discrete markings at the base of each lobe can be consistently present in populations in Western Australia and South Australia (e.g. *D.E. Murfet 2270 & R.L. Taplin* (AD), *D.E. Murfet 4494 & A. Lowrie* (AD), *J.A. Wege 1562 & B.P. Miller* (PERTH), *J.A. Wege 1873* (PERTH: Fig. 7B, inset), *J.A. Wege* 2068 (PERTH)) or variably present within a population (e.g. *J.A. Wege 777*, *J.A. Wege 2077*). A comparison with *L. octomaculata*, an allied species named for its corolla markings, is provided under the notes for that species.

Illustrations. L. Diels & E. Pritzel, Bot. Jahrb. Syst. 35: 598, fig. 67 A–C. 1905 [reproduced by J. Mildbraed in H.G.A. Engler, Pflanzenr. 35: 29, fig. 10A–C. 1908]; R. Erickson, Triggerplants 201, Pl. 57, No. 2 and 208, Pl. 58, Nos. 8–14. 1958; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 766, no. 6. 1982; J. Wheeler, N. Marchant & M. Lewington, Fl. South West 2: 903. 2002.

Selected specimens examined. Australia. Western Australia: Mt Merivale, 20 km E of Esperance, 25 Oct 1995, *B. Archer 168* (MEL); Brixton Street Wetlands, Kenwick, 10 Nov 2011, *K.L. Brown 888 & G. Paczkowska* (PERTH); Darling Range escarpment, W of Walyunga Reserve, 17 Dec 1971, *N.T. Burbidge 7882* (CANB); Dryandra State Forest, NE of Congelin, at the sigma bend of Patonga Rd, 24 Oct 1991, *W. Greuter 23183* (PERTH); Sheepwash State Forest, E boundary at 'The Pass', 13 Dec 1998, *B.G. Hammersley 2137* (PERTH); Reserve 23229/1255, Brookton Hwy, Armadale, 5 km SE of Kinsella Rd, 11 Dec 2004, *F. Hort*, *J. Hort & B. Hort 2451* (PERTH); Wongamine Nature Reserve, ca. 13 km NE of Toodyay, 7 Oct 1995, *T.R. Lally & B.J. Lepschi 775* (PERTH); Sukey Hill, 3.5 km E of Cranbrook, 13 Nov 1995, *T.R. Lally & B.J. Lepschi 880* (PERTH); 1.85 km along Park Rd from Great Eastern Hwy, John Forrest National Park, 14 Nov 1995, *J.A. Wege 120* (PERTH); 20 m NE along gravel track off Del Park Rd, 6.7 km from South Western Hwy, 29 Nov 1995, *J.A. Wege 156 & P. French* (PERTH); ca. 900 m from Eagle Bay settlement on Meelup Beach Rd, 8 Nov 2002, *J.A. Wege 777* (PERTH); 1.6 km E on Cadda Rd from Brand Hwy, Badgingarra National Park, *J.A. Wege 1688 & W.S. Armbruster*, 20 Oct 2009 (PERTH); ca. 1.7 km on Canning Road from Pickering Brook Road, Korung National Park, 12 Nov 2003, *J.A. Wege 1100* (PERTH); Qualen Rd, just W of Kent Rd, Wandoo National Park, 29 Nov 2008, *J.A. Wege & B.P. Miller JAW 1562* (PERTH); 6.4 km W of Brand Hwy on Bibby Rd, SW of Badgingarra, 20 Oct 2011, *J.A. Wege 1873* (PERTH); 4.7 km E of Brand Hwy on Wanamal West Rd, Boonanarring Nature Reserve, 20 Oct 2011, *J.A. Wege 1874* (CANB, MEL, PERTH); 6.4 km E of Sundalara Rd on Tomkins Rd, NE of Eneabba, 30 Oct 2018, *J.A. Wege 2077* (PERTH); **South Australia:** Wanilla, some 25 km NW of Port Lincoln, 8 Nov 1968,

C.R. Alcock 2542 (AD, MEL); Granite outcrop NW of Lienerts/Woolford Track in Pinkawillinie C[onservation] P[ark], 3 Nov 2009, *T.S. Te 859 & T.S. Croft* (AD); Site BS162-MIN01101, Patchid 20131 [9.1 km direct ENE of Roger Corner, Yorke Peninsula], 13 Oct 2004, *L.M.B. Heard & N.R. Neagle BS162-1754* (AD); Verran Tanks Conservation Park, 10 Oct 1991, *D.E. Murfet 1299b* (AD); Murrunatta Conservation Park, 15 Oct 1995, *D.E. Murfet & R.L. Taplin 2270* (AD).

11. *Levenhookia octomaculata* F.L.Erickson & J.H.Willis, Vict. Naturalist 72: 130, figs 1–6. 1956
Figs 1D, 7D

Type. Australia. Western Australia: Bolgart, 2 Nov 1953, R. Erickson *s.n.* (holotype: MEL 2295754; isotypes: K 000060079, PERTH 01025074).

Description. Annual herb 3–12 cm high. Glandular hairs 0.1–0.2 mm long. Stem dark reddish brown, often paler distally, simple or branched to varying degrees with spreading to almost patent or ascending branches, somewhat sparsely glandular-hairy (especially towards the base). Leaves cauline, scattered, green or reddish brown; lamina narrowly oblanceolate to ± linear, elliptic or ovate, 2.5–15 mm long including the petiole, 0.5–2 mm wide, obtuse, sparsely glandular-hairy on the abaxial surface and margins towards the base. Flowers usually in umbels or corymbs or more rarely in short racemes, 1–ca. 150 per plant; bracts narrowly oblanceolate, lanceolate or ± linear, 2.5–11 mm long, glabrous or sparsely glandular-hairy like the leaves; pedicels 3–20 mm long, sparsely glandular-hairy. Hypanthium depressed globose or globose, 0.7–1.3 mm long, 0.7–1.5 mm wide, glandular-hairy. Calyx lobes ± equal or subequal (with the anterior pair scarcely longer than the rest), 1.2–2 mm long, acute or subacute, glabrous or sparsely glandular-hairy near the base. Corolla bright to pale pink (rarely white) with two, dark red-pink, ± elliptic markings near the base of each lobe (rarely faint or lacking?) and a creamy white throat, whitish on the reverse with mottled pink-red markings; lobes evenly arranged or with the upper (posterior) ones ± paired vertically, often weakly recurved, obovate with an attenuate base, glabrous or with a few glandular hairs abaxially near the base; anterior lobes slightly shorter and narrower than the posterior pair, 3.2–5 mm long, 1.5–3 mm wide, rounded or more rarely retuse; posterior lobes 3.5–5.2 mm long, 2–3.5 mm wide, rounded or bluntly pointed; tube creamy white, 0.2–0.4 mm long, obscured by the calyx lobes, glabrous. Labellum ventral, 2.5–3.7 mm long including a 1–2 mm long claw; hood dark red-maroon adaxially, pink abaxially and deep yellow near the cleft, sometimes prominently papillate, with a short, blunt point at the cleft apex, sparsely glandular-hairy abaxially; basal appendages yellowish or creamy white, rounded, 0.5–0.6 mm long. Column sheath white or yellowish, glabrous, 1.2–1.8 mm high on the posterior side with a thickened rim and broad anterior cleft, 3 pendulous appendages present on the inner surface of the sheath towards the throat. Column creamy white, free, erect, slightly thickened distally, 3–4 mm long; stigmatic lobes to ca. 1.4 mm long,

incurved, the lowermost developing while the column is hooded, the uppermost developing later. Capsule globose or ovoid, 1.5–2 mm long excluding calyx lobes. Seeds 0.4–0.5 mm long, ca. 0.3 mm wide.

Diagnostic features. *Levenhookia octomaculata* has sparsely glandular-hairy stems (especially towards the base), bracts and calyx lobes that are glabrous or sparsely glandular-hairy near the base, long pedicels (5–20 mm), a short corolla tube (obscured by the calyx lobes), and a column sheath that is usually up to half the length of the column. The corolla lobes usually have a pair of ± elliptic markings near the base and may be mottled markings on the undersurface (but see notes below).

Phenology. Flowering in October and November; fruiting in November and December.

Distribution. *Levenhookia octomaculata* is endemic to south-western Australia (Fig. 7C) where it is scattered across the Geraldton Sandplains, northern Avon Wheatbelt and northern Swan Coastal Plain bioregions, occurring from Eurardy Station in the north to the Chittering area in the south and extending into the Yalgoo bioregion at Mt Gibson Station.

Habitat. This species grows in sand or sandy loam, usually over limestone or sandstone but sometimes in association with granite outcropping, lateritic gravel or banded ironstone. Associated vegetation is varied and includes heath, mallee heath, *Acacia* and *Calothamnus* low shrubland, *Allocasuarina campestris* shrubland, *Melaleuca* scrub, and open woodland with *Eucalyptus loxophleba* or *Melaleuca preissiana*. It can grow in sympatry with *L. stipitata*.

Conservation status. *Levenhookia octomaculata* occurs in several nature reserves and national parks where it can be locally abundant. It is not currently considered to be at risk (IUCN (2012): Least Concern).

Etymology. From the Latin *octo-* (eight-) and *maculatus* (spotted): a reference to the pair of markings near the base of each corolla lobe.

Vernacular name. Dotted Stylewort (Erickson and Willis 1956).

Notes. *Levenhookia octomaculata* was named on account of the eight prominent markings in the throat of the flower which, at the time, were thought to be unique in the genus (Erickson and Willis 1956: 133); however, eight throat markings are present in many populations of *L. stipitata* which has led to a degree of taxonomic confusion. Moreover, is not known whether all populations of *L. octomaculata* possess eight throat markings; photographs associated with *G. Byrne 600* (PERTH 06908349) suggest that they may sometimes be faint or perhaps altogether lacking. *Levenhookia octomaculata* can be reliably separated from *L. stipitata* by its bracts, which are glabrous or sparsely glandular-hairy abaxially near the base (cf. glandular hairy on the abaxial surface and margins) and calyx lobes, which are glabrous or sparsely glandular-hairy near the base (cf. moderately to sparsely glandular-hairy). It also tends to have fewer hairs on the stem and pedicels, a shorter column sheath (up to half the length of the column cf. more than half the length of the column) and a more prominently papillate labellum hood. I have observed both species growing intermixed without hybridisation at a site in Beekeepers Nature Reserve (*J.A. Wege 2074* and *J.A. Wege 2075*), at which time

L. octomaculata was in full flower, whereas *L. stipitata* was in late flower or had finished flowering. At this site, *L. octomaculata* had unique speckled markings on the undersurface of the corolla lobes but, having made limited field observations of this species, I am uncertain whether these are consistently present.

Illustrations. R. Erickson, Triggerplants 201, Pl. 57, No. 3 and 208, Pl. 58, Nos. 15–19. 1958; B.J. Grieve & W.E. Blackall, How to know W. Austral. wildfl. 4: 766, no. 7. 1982 [column sheath not shown].

Selected specimens examined. Australia. Western Australia: 13 km E of Mummaloo-Wye Bubba Hill, Mount Gibson Station, 21 Nov 1992, *R.J. Cranfield 8562* (PERTH); Lesueur National Park, 1.8 km N of University track on Hakea track, E of Jurien Bay, 7 Nov 2007, *A. Crawford 1495* (PERTH); Petrudor Rock Reserve, SE of Dalwallinu, 7 Nov 1999, *M. Hislop 1858* (PERTH); Koolanooka Hills, 12 Oct 2005, *R. Meissner & Y. Caruso 548* (PERTH); Murchison River near Z-Bend, Kalbarri National Park, 9 Oct 1982, *K.H. Rechinger 58462* (PERTH); 6 km W on Beekeepers Rd from Brand Hwy, Beekeepers Nature Reserve, 30 Oct 2018, *J.A. Wege 2074* (AD, CANB, MEL, PERTH); Quadrat WEST 1 on Eurardy Station, ca. 43 km N of Kalbarri turn-off on the North West Coastal Highway and N of the Murchison River, 3 Oct 2003, *Wildflower Society of WA EURA 308* (PERTH).

12. *Levenhookia chippendalei* F.L.Erickson & J.H.Willis, Vict. Naturalist 83(5): 107, t. 2, figs 7–10. 1966

Fig. 7F

Type. Australia. Northern Territory: 39 miles [62.8 km] S of Hooker's Creek (and ± 230 miles [370.1 km] W of Banka Banka), 12 Jul 1956, *G. Chippendale s.n.* (holotype: DNA-A0002260; isotypes: CANB 55765, MEL 2295751, PERTH 01639994).

Description. Annual herb 4–35 cm high, usually with a well-developed tap root. Glandular hairs 0.1–0.3 mm long. Stem pale, green or reddish brown, much-branched near the base (rarely simple), with spreading or ascending branches, glandular-hairy. Leaves basally clustered and cauline, pale green; lamina oblanceolate or lanceolate, often narrowly so, 5–30 mm long including the petiole, 0.7–5 mm wide, acute to subacute, glandular-hairy abaxially and on the margins and sometimes on the adaxial surface towards the base. Flowers in racemes, sometimes in umbels or corymbs, 5–500^{+} per plant; bracts lanceolate to linear, 1.8–25 mm long, glandular-hairy like the leaves; pedicels 5–30 mm long, sparsely glandular-hairy. Hypanthium depressed globose or globose, 0.6–2 mm long, 0.6–2.5 mm wide, glandular-hairy. Calyx lobes equal or subequal (with the anterior pair scarcely longer than the rest), 1.2–2.5 mm long, acute, sparsely to moderately glandular-hairy. Corolla pink with a dark pink midvein and a white or yellow throat; lobes ± evenly arranged, slightly recurved, obovate with an attenuate base, rounded or scarcely apiculate, glabrous or sparsely glandular-hairy on the abaxial surface along the midvein; anterior (lower) lobes slightly shorter and narrower than the posterior pair, 3–6.5 mm long, 1.9–3.2 mm wide; posterior (upper) lobes 3.5–

7.5 mm long, 2–3.8 mm wide; tube white, 0.5–1.5 mm long, shorter than the calyx lobes, glabrous or with a few glandular hairs distally. Labellum ventral, 4–6.5 mm long including a 1–1.5 mm long claw; hood pink with purplish maroon markings, sparsely glandular-hairy abaxially, papillae absent; appendage at the cleft apex pink with a yellow or white base, 1.8–3.5 mm long, incised or emarginate, glabrous; basal appendages oblong-clavate, 0.8–1.2 mm long, revolute distally, white with a yellow, papillate tip. Column sheath white, glabrous, 0.5–0.7 mm high with a thickened rim on the posterior side and 3 pendulous appendages on the inner surface towards the throat. Column whitish tipped pale pink, free, slender, 2.5–3.8 mm long, glabrous; stigmatic lobes to 1.5 mm long, incurved, the lowermost developing while the column is hooded, the uppermost developing later. Capsule depressed globose to globose or ovoid, 1.5–3 mm long excluding calyx lobes. Seeds 0.5–0.8 mm long, 0.3–0.4 mm wide.

Diagnostic features. *Levenhookia chippendalei* has a glandular-hairy stem that is usually much-branched at the base, leaves that are clustered at the base and scattered along the stems, long pedicels (5–30 mm), a short corolla tube (obscured by the calyx lobes), and a prominent, incised or emarginate appendage at the tip of the labellum. A well-developed tap root is usually evident.

Phenology. Flowering and fruiting from May to October, depending on seasonal conditions.

Distribution. *Levenhookia chippendalei* is widespread in the arid zone in Western Australia and the Northern Territory (Fig. 7E), occurring from near Meekatharra to the Dulcie Range, north-east of Alice Springs.

Habitat. *Levenhookia chippendalei* grows on sandplains or sand dunes or near salt lakes and seasonal swamps, in sand or sandy clay or in gravelly soils near waterholes or creeklines. Associated vegetation includes *Acacia* shrubland or woodland, spinifex grassland, open low scrub with *Aluta maisonneuvei* and scattered emergent *Brachychiton gregorii*, *Acacia aneura* and *Eucalyptus gamophylla*, and *Grevillea integrifolia* or *Melaleuca* tall shrubland. It may grow in sympatry with *Stylidium desertorum* Carlquist, which has similarly bright pink flowers.

Conservation status. A widespread species that is not considered to be under threat (IUCN (2012): Least Concern).

Etymology. Honours George Chippendale (1921–2010), who made the earliest collection of this taxon while based in Alice Springs as the Northern Territory's first resident taxonomist.

Vernacular name. Arid Zone Stylewort.

Illustrations. K.F. Kenneally & A.S. George in J. Jessop, Fl. Central Austral. 363, fig. 463. 1981.

Selected specimens examined. Australia. Western Australia: 2.2 km S of Scorpion Bore near Carnegie Homestead, 8 Sep 1973, *R.J. Chinnock 891* (AD, PERTH); 1 km S of Mount Brophy Springs, Gardner Range, 190 km SE of Halls Creek, SE Kimberley, 4 Jul 1995, *K. Coate 372* (BRI, DNA, PERTH); 20.6 km N along Canning Stock Route from Well 14, 18 Aug 2007, *R. Davis 11181* (PERTH); ca. 6.6 km on a bearing of 174 degrees from Mt Methwin, Birriliburu Indigenous Protected Area,

13 Aug 2012, *N. Gibson 6559*, *S. van Leeuwen*, *M.A. Langley & K. Brown* (PERTH); S side of Lake Kerrylyn, ca. 6.7 km on a bearing of 49 degrees from Mt Methwin, Birriliburu Indigenous Protected Area, 14 Aug 2012, *N. Gibson 6560*, *S. van Leeuwen*, *M.A. Langley & K. Brown* (PERTH); 102 miles [164 km] from Billuna, Jul 1972, *C.H. Gittins 2421* (CANB); 29 km SSE of Mount Keith, Wanjarri Nature Reserve, 29 Sep 1992, *G.J. Keighery 13011* (PERTH); Site LGS 1, 31.5 km on main track from Lorna Glen Homestead to Wiluna – Granite Peaks Rd, 10 Sep 2003, *K.F. Kenneally & D.J. Edinger K 12671 E 3868* (CANB, PERTH, MEL); 72 km NE Kiwirrburra [Kiwirrkurra], SW Lake Mackay, 21 Oct 2000, *P.K. Latz 17005* (PERTH); Little Sandy Desert, 11.4 km SW of Cooma Well, 15 Aug 1997, *S. van Leeuwen 3228* (AD, BRI, CANB, DNA, MEL, NSW); **Northern Territory:** Attack Creek, Stuart Highway, Barkley Tableland, 1 Jul 1974, *A. Beauglehole 46305* (DNA); Central Mt Stuart, 1 Jul 1974, *T. Henshall 475* (AD, DNA); Neutral Junction, 4 Jul 1974, *T. Henshall 525* (DNA); Macdonald Downs Station, 23 Oct 1974, *P. Latz 5779* (DNA); Singleton Station, 26 May 1975, *P. Latz 5962* (DNA); Tanami Sanctuary, 27 May 1976, *P. Latz 6505* (DNA, MEL); 5 km NNE of Mt Frederick, NW Tanami Desert, *P. Latz 8601*, 2 Apr 1981 (DNA).

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RESEARCH ARTICLE

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Loxostigma puhoatense (Gesneriaceae), a new species from North Central Vietnam

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Abstract

Loxostigma puhoatense N.D. Do et al., **sp. nov.**, a new species of Gesneriaceae, is described and illustrated from Pu Hoat Nature Reserve, Nghe An Province, Vietnam. This species is morphologically similar to *L. dongxingensis* and *L. damingshanensis* in the plant habit, indumentum system of vegetative and reproductive characters, shape of leaf blades, calyx, pistil but differs from the latter two by the abaxially reddish-purple leaf blade with pubescent along veins, lateral veins 11–19, shorter white to pale yellowish-white corolla (3.7–3.8 cm long) with purple-spotted and glabrous inside, longer abaxial stamens in 2–2.1 cm, shorter and densely glandular-puberulent ovary in 1–1.2 cm, and sparsely glandular-puberulent style. Data on distribution, ecology, phenology, and vernacular of the new species are provided.

Keywords

Briggsia, *Didymocarpus*, Gesneriaceae, *Loxostigma*, taxonomy, Vietnam

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Introduction

The genus *Loxostigma* C.B. Clarke is in the family Gesneriaceae, with at least 11 species recognized including one species from *Didymocarpus* Wallich and three species of the former *Briggsia* Craib (Möller et al. 2014) based on molecular and morphological evidences (Pan 1988; Wu et al. 2012; Möller et al.2011; Möller et al. 2014). It is distributed mainly in Southern and Southeastern Asia, and most of the species have restricted distributions in southwestern China (Wang 1983; Wei et al. 2010; Möller et al. 2014, 2016). There are four currently known species of the genus in Vietnam, namely *Loxostigma dongxingensis* (Chun ex K.Y.Pan) Mich. Möller & Y.M.Shui, *L. fimbrisepalum* K.Y.Pan, *L. glabrifolium* D.Fang & K.Y.Pan and *L. griffithii* (Wight) C.B. Clarke (Pham 2000; Vu 2005; Do and Vu 2011; Möller et al. 2014; Do et al. 2016).

During our recent botanical surveys of Pu Hoat Nature Reserve (NR), Nghe An, Vietnam, an unknown species of *Loxostigma* with the seeds having 1-hairlike appendage at each end was collected by the authors in 2018–2019. We conducted a critical examination of the specimens, and made a comparison with type material and protologues of presumed closely related species in Vietnam and neighboring countries (e.g. Wang 1983; Wang and Pan 1982; Pan 1988; Wang et al. 1998; Grierson and Long 2001; Li and Wang 2004; Wei et al. 2010; Sinha and Datta 2016). We discovered that these specimens were different from the other known *Loxostigma* species and presented the unknown taxon which shows similarities with *L. dongxingensis* and *L. damingshanensis* (L.Wu & B.Pan) Mich.Möller & H.Atkins in the same plant habit, indumentum of stem and shape of flower. However, it shows significant differences in its vegetative and floral structures (see Table 1) and is described here as a new species to science.

Table 1. Morphological comparison of *Loxostigma puhoatense*, *L. dongxingensis* and *L. damingshanensis*.

Characters	*L. puhoatense*	*L. dongxingensis*	*L. damingshanensis*
Stem	somewhat pubescent	densely pubescent	sparsely pubescent
Leaf blade	broadly elliptic to elliptic-ovate, abaxially reddish-purple, sparsely pubescent on both surfaces, pubescent along veins, lateral vein 11–19 pairs	elliptic to ovate or obovate, abaxially green, adaxially appressed puberulent to pubescent, abaxially pubescent, villous along veins, lateral vein 6–10 pairs	elliptic-ovate, abaxially green, sparsely pubescent on both surfaces, pilose along veins, lateral veins 5–10 pairs
Petiole	pubescent	densely pilose	sparsely pubescent
Cyme	branched	branched	unbranched
Peduncle	9.2–17.5 cm long, densely pubescent and glandular-pubescent	4–10 cm long, pubescent	4–8 cm long, sparsely glandular-pubescent
Bract	ovate to oblong-ovate, densely pubescent and glandular-pubescent, margin somewhat denticulate	narrowly ovate to narrowly oblong, pubescent, margin entire	inconspicuous or absent
Pedicel	densely glandular-pubescent	pubescent	sparsely glandular-pubescent
Calyx	outside densely glandular-pubescent	outside pubescent to villous	outside densely glandular-pubescent
Corolla	white to pale yellowish-white with purple-spotted inside, 3.7–3.8 cm long, outside densely glandular pubescent, inside glabrous	yellow, inside spotted or not, 4–5 cm long, outside sparsely pubescent, inside sparsely pubescent only on lobes of adaxial lip	yellow, inside with purple stripes, 4.8–6 cm long, outside sparsely glandular-pubescent, inside sparsely pubescent only on lobes of abaxial lip
Staminode	ca. 2 mm long, adnate 7–8 mm above corolla tube base	ca. 1 mm long, adnate to ca. 13 mm above corolla tube base	ca. 1.5 mm long, adnate to ca. 18 mm above corolla tube base
Abaxial stamens	2–2.1 cm long	ca. 1.8 cm long	ca. 1.4 cm long
Ovary	1–1.2 cm long, densely glandular-puberulent	ca. 2 cm long, glabrous	ca. 1.8 cm long, densely glandular-pubescent
Style	sparsely glandular-puberulent	glandular pubescent	glandular-pubescent

Material and methods

All measurements and description of the new species are based on living flowering material and herbarium specimens collected from the type locality, supplemented with type material from the following herbaria: HITBC, HN, IBK, IBSC, K, KUN, P, PE, VNM and VNMN (herbarium codes follow Thiers (2018)) as well as digitized specimen images of *Loxostigma* species available on the web from Muséum National d'Histoire Naturelle (https://science.mnhn.fr/), Chinese Virtual Herbarium (http://www.cvh.ac.cn/) and Jstor Global Plant (https://plants.jstor.org/). All morphological characters were studied under dissecting microscopes and are described using the terminology presented by Wang et al. (1998), Wei et al. (2010) and Beentje (2016).

Taxonomic treatment

Loxostigma puhoatense **N.D. Do, N.S. Ly, D.H. Nguyen & T.H. Le, sp. nov.**
urn:lsid:ipni.org:names:77209909-1
Figs 1, 2

Diagnosis. This species is most similar to *L. dongxingensis* and *L. damingshanensis* in the plant habit, indumentum system of stem, leaves, shape of leaf blades, calyx and pistil but differs from the latter two in the leaf blade with abaxially reddish-purple and number of lateral veins, longer peduncle, shorter white to pale yellowish-white corolla with purple-spotted inside, longer abaxially stamens that are lower adnate above corolla tube base, shorter and glandular-puberulent ovary, and sparsely glandular-puberulent style.

Type: Vietnam. Nghe An Province: Tien Phong Commune, Na Chang Village, Pu Hoat NP, 19°46'06"N, 109°55'08"E, atl. 781 m, 04 October 2018, *Do Ngoc Dai, Nguyen Danh Hung, Le Thi Huong*, *DHH 1021*(holotype: VNM, isotype: P).

Description. Epiphyte, evergreen, perennial herbs with rhizomes. Rhizome internodes up to 20 cm long, 3.5–4 mm in diam. ***Stem*** simple, borne from a node of the rhizome, shallow angular at the middle internodes, terete toward both ends, 28.5–55 cm long, 3.5–7 mm in diam., pale green, somewhat pubescent. ***Leaves*** opposite, spread along stem, unequal in a pair; petiole cylindrical, adaxially sunken, greenish to purplish, abaxially rounded and greenish, 1–3.3 cm long, 3–6 mm in diam., pubescent; leaf blade broadly elliptic to elliptic-ovate, chartaceous when dried, 4.2–25.5 × 3–15.5 cm [11.3–25.5 × 8.9–15.5 cm in larger leaves, 4.2–9.3 × 3–6.2 cm in smaller leave], adaxially light green, abaxially reddish purple, sparsely pubescent on both surface, pubescent on the midrib and lateral veins of the abaxial surface, lateral veins 11–19 pairs, base usually oblique, subcordate, margin serrate to indistinctly denticulate, apex acuminate. ***Cymes*** axillary, subterminal, 2–3-branched, 3–25-flowered; peduncle 9.2–17.5 cm long, 2–3 mm in diam., pale greenish, densely pubescent and glandular-pubescent. ***Bracts*** ovate to oblong-ovate, pale greenish-white tinted, 5–8.5 × 2.8–3.5 mm, adaxially glabrous, abaxially densely pubescent and glandular-pubescent, margin somewhat denticulate. ***Pedicel*** 1.1–1.4 cm long, ca. 1.5 mm in

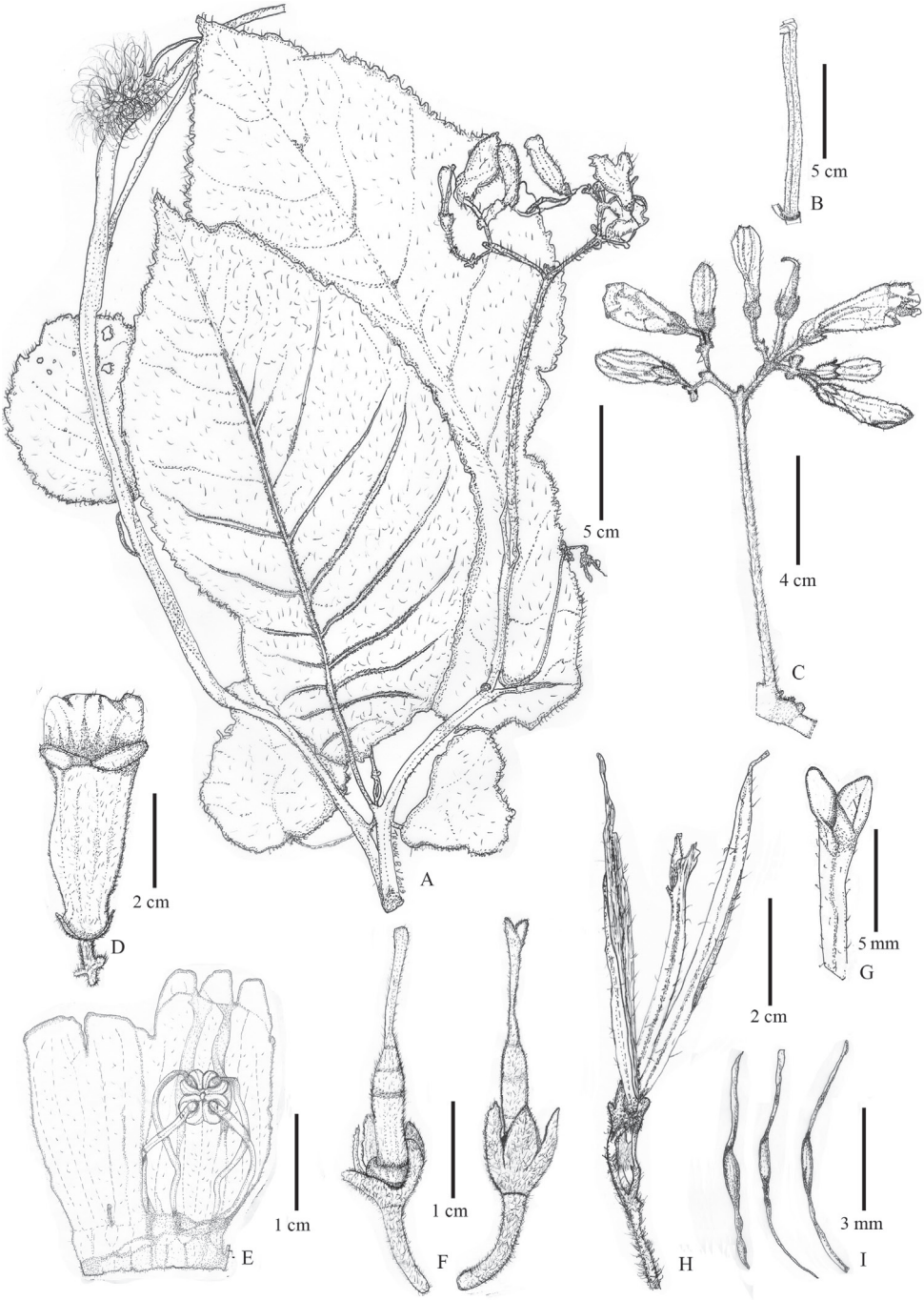

Figure 1. *Loxostigma puhoatense* (from the holotype). **A** mature plant with flowers **B** a part of stem **C** inflorescence **D** dorsal view of flower **E** opened flower showing stamens **F** gynoeciums **G** detail of stigma (from dry specimen) **H** infructescence **I** seeds. Drawn by Ba-Vuong Truong from Do Ngoc Dai, Nguyen Danh Hung, Le Thi Huong, DHH 1021.

diam., greenish-white, densely pubescent and glandular-pubescent. ***Calyx*** 5-sect from the base, segments equal, whitish, narrowly ovate, 6–7 × 2–2.5 mm, adaxially glabrous, abaxially densely pubescent and glandular-pubescent, margin entire, apex acute. ***Corolla*** somewhat campanulate, white to pale yellowish-white, gibbous abaxially, with purple spots inside, 3.7–3.8 cm long, outside densely glandular-pubescent, inside glabrous; ***corolla tube*** 2.7–2.9 × 1.4–1.6 cm; ***corolla limb*** distinctly 2-lipped, adaxial lip 5–6 mm long, 2-lobed, lobes semi-orbicular, 5–5.5 × 7–7.5 mm, deflexed, apex rounded; abaxial lip3-lobed, 10–11 mm long, lobes semi-orbicular, 4–5.5 × 4–5 mm, deflexed, apex rounded. ***Stamens*** 4, adaxial stamens adnate to 7–8 mm above corolla tube base, 15–16 mm long, abaxial ones adnate to 6–7 mm above corolla tube base, 20–21 mm long; ***filaments*** linear, white, glabrous, slightly curved; ***anthers*** sub-globose, theca coherent apically in pairs, pale cream; ***staminode*** one, adnate to 7–8 mm above corolla tube base, ca. 2 mm long. ***Disc*** ring-like, subentire, ca. 2.5mm high. ***Pistil*** 2.2–2.4 cm long; ***ovary*** oblong, greenish, 10–12 × 1.8–2 mm, densely glandular-puberulent; ***style*** linear, pale greenish, 9–10 × ca. 1 mm, sparsely glandular-puberulent; ***stigma*** 2, equal, 2-lipped, undivided. ***Capsule*** 6–6.5 cm long, 2–3mm in diam., oblong-linear, straight, not twisted, glabrous, blackish-brown, dehiscing loculicidally to base, valves 2. ***Seeds*** linear, 2–2.5 mm long, brown, with appendages on both ends of the seeds; ***appendages*** 2.5–3 mm long.

Distribution and habitat. *Loxostigma puhoatense* is currently known from a single population with eight mature plants, in tropical evergreen broad-leaf forests, Pu Hoat Nature Reserve, Nghe An Province. More data is needed to determine conservation status. It is an epiphytic plant (Fig. 2A), growing on the surface of *Ficus* sp. (Moracaeae), and is associated with fern (e.g. *Asplenium nidus* L. (Aspleniaceae), epiphytic herbs (e.g. *Aeschynanthus acuminatus* Wall. ex A. DC. (Gesneriaceae), *Pothos chinensis* (Raf.) Merr. (Araceae) and is dominated by *Beilschmiedia ferruginea* H.Liu, *Cinnamomum polyadelphum* (Lour.) Kosterm., *C. tamala* (Buch.-Ham.) T.Nees & Eberm., *Lithocarpus balansae* (Drake) A. Camus, *Syzygium grande* (Wight) Walp., *S. odoratum* (Lour.) DC., *Gordonia axillaris* (Roxb. ex Ker Gawl.) Endl…

Phenology. Flowering in October–December and fruiting November–February.

Etymology. The specific epithet "*puhoatense*" is derived from the type locality.

Other specimens examined (Paratypes). Vietnam. Nghe An Province: Pu Hoat NP, 24 February 2019, 19°46'06"N, 109°55'07"E, *Do Ngoc Dai, Nguyen Danh Hung, Nguyen Thi Huong*, DHH 1162 (VNM).

Vernacular name. Vietnamese language: Xuyến thư pù hoạt

Taxonomic notes. *Loxostigma puhoatense* is morphologically similar to *L. dongxingensis* and *L. damingshanensis* in the plant habit, somewhat pubescent stem, elliptic to ovate leaf lades, narrowly ovate calyx with margin entire, the same shape of flower. However, the new species differs from both of them in the abaxially reddish-purple leaf blade with pubescent along veins (vs green, villous of *L. dongxingensis* and pilose of *L. damingshanensis*), lateral veins 11–19 pairs (vs. 6–10 pairs and 5–10 pairs of the latter two, respectively), shorter white to pale yellowish-white corolla (3.7–3.8 cm long) with purple-spotted and glabrous inside (vs. 4–5 cm long, yellow, inside spot-

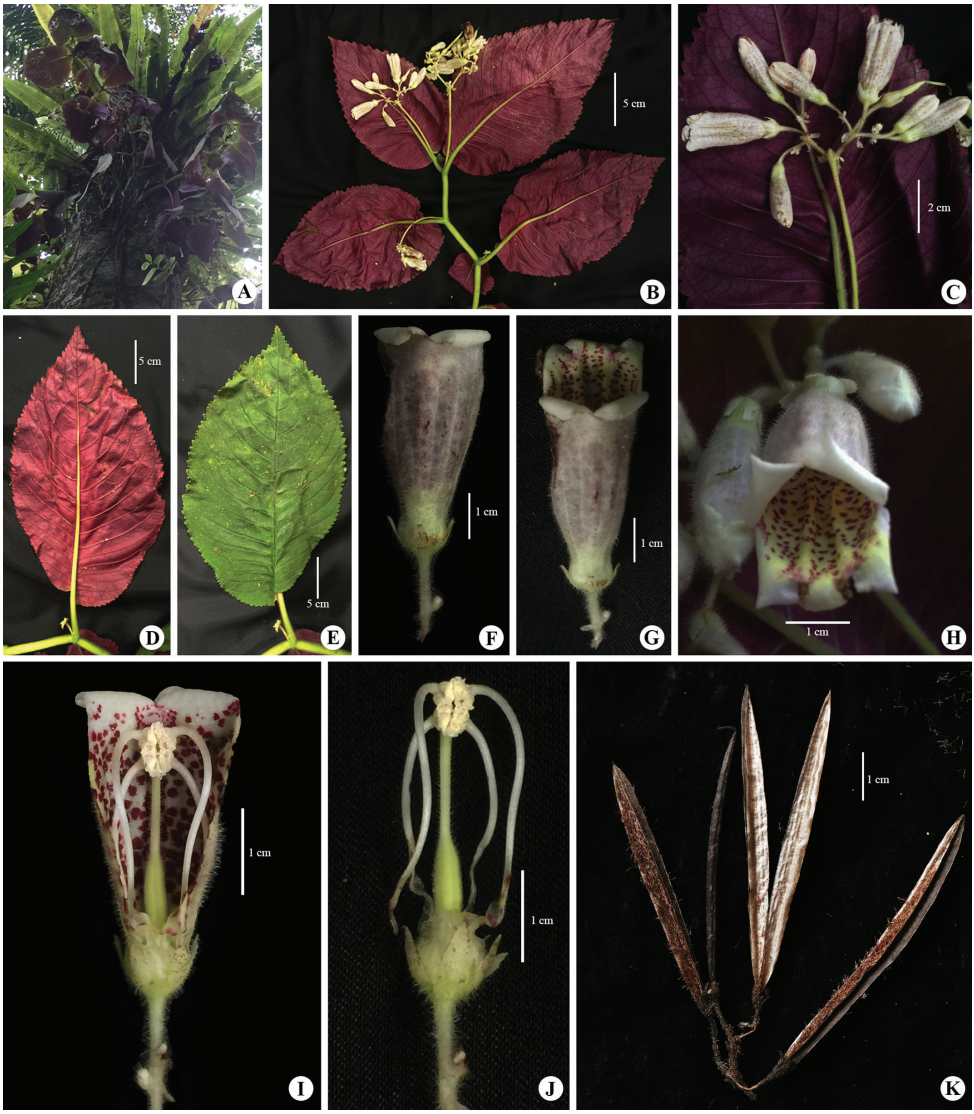

Figure 2. *Loxostigma puhoatense.* **A** plant in natural habitat **B** apical part of flowering plant showing inflorescences (with flowers and young fruits) and leaves **C** inflorescence **D** abaxial leaf **E** adaxial leaf **F** flower (from below) **G** flower (top view) **H** flower (front view) **I** longitudinal section with upper lip removed **J** stamens with gynoecium and calyxes **K** dried fruits. Photos by Ngoc-Dai Do, plate by Ngoc-Sam Ly.

ted or not and sparsely pubescent only on lobes of adaxial lip of *L. dongxingensis*, and 4.8–6 cm long, yellow, inside purple stripes and sparsely pubescent only on lobes of abaxial lip, of *L. damingshanensis*), longer abaxial stamens in 2–2.1 cm long (vs. ca. 18 cm and ca. 14 cm in the latter two, respectively), shorter and densely glandular-puberulent ovary in 1–1.2 cm long (vs. ca. 2 cm, glabrous of *L. dongxingensis* and

ca.1.8 cm, densely glandular-pubescent of *L. damingshanensis*), and sparsely glandular-puberulent style (vs. glandular-pubescent of *L. dongxingensis* and *L. damingshanensis*). The staminode of *L. puhoatense* is ca. 2 mm long (vs. ca. 1 mm of *L. dongxingensis* and ca. 1.5 mm of *L. damingshanensis*) and adnate above corolla tube base in 0.7–0.8 mm long (vs. ca. 1.3 cm of *L. dongxingensis* and ca. 1.8 cm of *L. damingshanensis*). Furthermore, the densely pilose petiole of *L. dongxinensis* is distinguished with the somewhat pubescent petiole of *L. puhoatense* and *L. damingshanensis*. The unbranched cyme and inconspicuous or absent of bract of *L. damingshanensis* are distinct with the branched cyme and 2- somewhat ovate bracts of the remained two. A detailed morphological comparison between *L. puhoatense*, *L. dongxinensis*, and *L. damingshanensis* is provided in Table 1.

A key to known species of *Loxostigma* occurring in Vietnam

1 Calyx lobes narrowly ovate. Peduncle somewhat pubescent. Stem usually less than 60 cm tall **2**

– Calyx lobes ovate to broadly ovate or oblanceolate. Peduncle somewhat puberulent. Stem usually ≥ 60 cm tall **4**

2 Stem pubescent. Leaf blades somewhat hairs on both surfaces, abaxially pubescent or villous along veins, margin denticulate to serrate. Corolla white or yellow. Staminode > 1 mm long. Abaxial stamens > 1.5 cm long. Ovary > 10 mm long **3**

– Stem sparsely puberulent or glabrescent. Leaf blades glabrous, abaxially sparsely puberulent along veins, margin denticulate to entire. Peduncle sparsely puberulent. Corolla white to yellow. Staminode ca. 0.5 mm long. Abaxial stamens ca. 1 cm long. Ovary 7–8 mm long..... ***L. glabrifolium***

3 Leaf blades abaxially reddish-purple, sparsely pubescent on both surfaces; lateral veins 11–19 pairs; petiole pubescent. Margin of bract denticulate. Corolla white to pale yellowish-white with purple-spotted inside, 3.7–3.8 cm long. Abaxial stamens 2–2.1 cm long. Staminode ca. 2 mm long. Ovary 1–1.2 cm long, densely glandular-puperulent ..... ***L. puhoatense***

– Leaf blades green; adaxially appressed puberulent to pubescent, abaxially pubescent, villous along veins; lateral vein 6–10 pairs; petiole densely pilose. Margin of bract entire. Corolla yellow, inside spotted or not, 4–5 cm long. Abaxial stamens ca. 1.8 cm long. Staminode ca. 1 mm long. Ovary ca. 2 cm long, glabrous ..... ***L. dongxingensis***

4 Leaves ovate to broadly elliptic, margin repand to serrulate. Margin of bract denticulate to repand. Calyx ovate. Corolla white-lilac, inside purple spots and glabrous ..... ***L. fimbrisepatum***

– Leaves elliptic to ovate or obovate, margin serrate to crenate-serrulate. Bract with irregularly dentate margin. Calyx broadly ovate or oblanceolate. Corolla yellowish, inside purplish to brownish spots and puberulent..... ***L. griffithii***

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RESEARCH ARTICLE

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Actinostachys minuta, a new species of grass fern from Mindanao, Philippines

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Abstract

Actinostachys minuta Amoroso & Coritico (Schizaeaceae), from Mindanao, Philippines, is described herein as a new species. This species is distinguished from all other species of *Actinostachys* (grass ferns) by its notably short and narrow fronds, distinct triangular stipe, and bifid apex of the sorophore lamina with profuse white long hairs. This species is distinct from the other known Philippine species of *Actinostachys* by its diminutive epiphytic habit and a habitat restricted to the trunks of the tree fern *Sphaeropteris polypoda* (Baker) R.M.Tryon. A taxonomic key to the species of Philippine Schizaeaceae that incorporates the new species is provided.

Keywords

ferns, lowland tropical rainforest, Mount Hamiguitan Range Wildlife Sanctuary, Schizaeaceae

Introduction

The fern family Schizaeaceae comprises two genera, *Actinostachys* and *Schizaea*, and ca. 30−35 species widely distributed in tropical and south-temperate regions (PPG I 2016; Smith et al. 2006; Chen et al. 2017). In the Philippines, the family is represented by two species of *Schizaea*: *S. dichotoma* (L.) Sm. and *S. malaccana* Bak., and two species of *Actinostachys*: *Actinostachys digitata* (L.) Wall. and *A. inopinata* (Selling) C.F.Reed

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(Barcelona et al. 1996). Of these, *S. dichotoma* and S. *malaccana* are distinctive by having the sorophores attached pinnately to an elongate axis. *Schizaea dichotoma* is easily recognized by the dichotomously branching sterile portions of the frond, whereas *S. malaccana* has an unbranched sterile portion. The two species of *Actinostachys*, *A. digitata* and *A. inopinata*, both have digitately arranged sorophores and are differentiated by the relative width of their lamina and by the number of sporangial rows (4-seriate or biseriate, respectively) (Holttum 1955; Barcelona et al. 1996). Moreover, the different species of *Schizaea* and *Actinostachys* are classified into sub-genera and sections based on the exospore (smooth or striated to pitted) and spore size (Reed 1947).

All four Philippine species of the family Schizaeaceae are reported in Mount Hamiguitan Range Wildlife Sanctuary (MHRWS), a protected UNESCO World Heritage Site (Amoroso et al. 2016; Amoroso et al. 2018). During fieldwork in MHRWS in 2016 and 2018, we encountered unusual individuals of *Actinostachys* growing on the trunks of tree ferns. On careful examination of these plants, available type images from JSTOR Global Plants, and in consultation of the literature, we conclude that they represent a species new to science. Here we describe this new species and provide detailed photographs of it along with a key to the five Philippine species of Schizaeaceae, all of which are found in MHRWS.

Taxonomy

Actinostachys minuta **Amoroso & Coritico, sp. nov.**
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Figures 1, 2

Diagnosis. This new species *Actinostachys minuta* is most similar to *Actinostachys plana* (Fourn.) Reed but differs by its shorter and narrow fronds with a distinct triangular stipe, sorophore lamina longer and narrower with white long hairs and sorophores 1−4 but usually 1. It differs from the other four Philippine species by its restricted epiphytic habit on the trunk of the tree fern *Sphaeropteris polypoda* (Baker) R.M. Tryon.

Type. Philippines • Mindanao Island. Davao Oriental: San Isidro Municipality, Mount Hamiguitan Range Wildlife Sanctuary, 622 m a.s.l., 10 October 2016, *V.B. Amoroso 11213* with F.P. Coritico (***holotype***: PNH; ***isotypes***: BRIT, CMUH).

Description. Epiphytic on trunks of the tree fern *Sphaeropteris polypoda* with rhizome embedded between adventitious roots. ***Rhizome***: short-creeping to erect, black, becoming elongate, attached to the persistent tuberous gametophyte with profuse, long, uniseriate, pale brown hairs. ***Fronds***: crowded, pendulous, grass-like, unbranched, up to 3.0–4.5 cm long; ***stipe*** distinct, black, oblong to triangular in transection, 5–8 mm long, with short scattered glandular hairs, with a few large cortical sclerenchymatous cells, vascular tissues reduced with single flattened xylem strand; ***lamina*** (sterile portion) simple, unbranched, flattened, up to 2.5–3.7 cm × 0.8−1.0 mm wide, margin entire, adaxial surface with distinct costa and scattered

Figure 1. A the tree fern *Sphaeropteris polypoda* with associated vegetation. The trunks of this tree fern species serve as the substrate of *Actinostachys minuta* **B** close-up view of *in-situ* epiphytic habitat of *A. minuta* embedded in the trunk of *S. polypoda* with the moss *Leucobryum* sp.

uniseriate hairs, the basal cells of the hairs persistent and forming scattered warts and disappearing distally; ***stomata*** arranged in one row (uniseriate) on each side of costa; ***sorophores*** 1 to 4 per frond but mostly 1, sessile or attached by a short stalk at apex of lamina, digitately arranged, 4–6 mm long; laminae of sorophores covered with profuse white long hairs adaxially, margin entire, apex bifid; ***sporangia*** in 2 rows, nearly symmetrically arranged, completely covering abaxial surface and protected by reflexed edge of sorophore lamina, sessile, ellipsoidal, with distal annulus, surface striated, glabrous; ***spores*** monolete, smooth.

Distribution and habitat. This species is currently known only within the buffer zone located outside the boundaries of MHRWS in San Isidro Municipality, in shaded habitat in lowland tropical rainforest at 622 m a.s.l. It grows strictly as an epiphyte on trunks of the tree fern *Sphaeropteris polypoda* with rhizomes embedded between adventitious roots in association with the moss genus *Leucobryum* and has not been observed terrestrially. The vegetation surrounding *Sphaeropteris polypoda* with *Actinostachys minuta* consists of trees 20–30 meters tall, including *Canarium asperum* Benth., *Dillenia philippinensis* Rolfe, *Gymnostoma rumphianum* (Miq.) L.A.S.Johnson, *Lithocarpus* spp., *Pittosporum euphlebium* Merr., and *Shorea polysperma* Merr., and tree ferns such as *Alsophila lurida* (Blume) Hook. and *Sphaeropteris elmeri* R.M.Tryon. The ground cover is dominated by other fern and lycophyte species such as *Dicranopteris linearis* (Burm. f.) Underw., *Lindsaea gueriniana* (Gaudich.) Desv., *Nephrolepis biserrata*

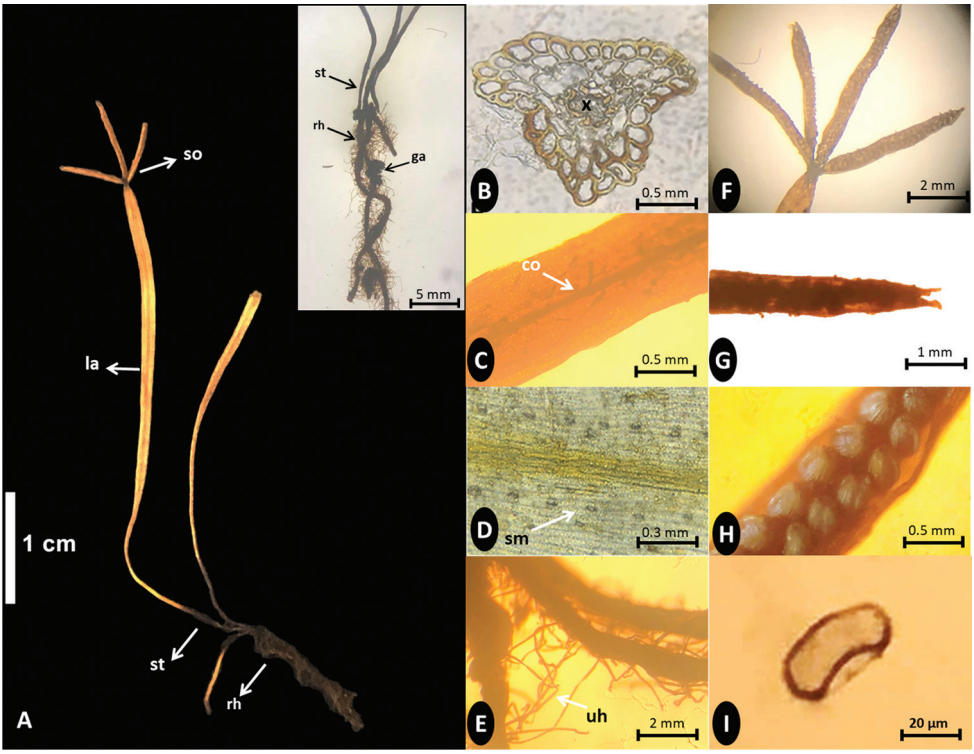

Figure 2. *Actinostachys minuta* **A** habit with distinct stipe (st), unbranched fronds with 3 sorophores (so) attached at the tip of lamina (la), (inset) elongate rhizome (rh), with persistent gametophyte (ga) and uniseriate hairs **B** transection of the stipe showing flattened xylem (x) **C** lamina with distinct costa (co) **D** single row of stomata (sm) on each side of costa **E** elongated rhizome with long uniseriate hairs (uh) **F** digitate sorophores attached at the tip of the sterile lamina **G** bifid apical lamina of sorophore **H** portion of sorophore with reflexed lamina margins and biseriate sporangia, I. Monolete spore.

(Sw.) Schott, *Schizaea dichotoma*, *Selaginella jagori* Warb., *Selliguea taeniata* Parris, and *Taenitis blechnoides* (Willd.) Sw., as well as several species of *Calamus*.

Additional specimens examined. Philippines, Mindanao, Davao Oriental Province, Municipality of San Isidro, Mt. Hamiguitan Range Wildlife Sanctuary, 06°44'15.24"N, 126°08'59.36"E, 622 m a.s.l., 16 June 2018, *V.B. Amoroso 13515* with F.P. Coritico (CMUH).

Etymology. The specific epithet refers to the diminutive size of the fronds relative to the other species in the genus.

Suggested common name. Diminutive grass fern.

Notes. The traditional treatment of Schizaeaceae includes all species with digitately (connate) and pinnately arranged sorophores in *Schizaea* as in Barcelona et al. (1996), Barcelona (2011), Holttum (1955) and Kramer (1990). Here we follow the classification of PPG 1 (2016) segregating them into two genera *Schizaea* (species with pinnately arranged sorophores) and *Actinostachys* (species with digitately arranged sorophores)

and by less easily observed features of their gametophytes (tuberous in *Actinostachys* versus filamentous in *Schizaea*) (Bierhorst 1968, 1971) and based on phylogenetic evidence (Labiak and Karol 2017; Wikstrom et al. 2002). The size of the fronds and sorophores is used in identifying the species of the family Schizaeaceae (Barcelona et al. 1996). However, the length of the sorophore is a much more reliable character than the length of the whole frond because the short sorophore is much less influenced by environmental conditions than the whole frond (Brownsey and Smith-Dodsworth 2000). In this respect, the new species and the closest related species (*A. plana*) differ from all other species of *Actinostachys* in its very short sorophores, about 2.5–6 mm long.

We compare the new species to three other digitate species of *Actinostachys* that are most similar to it in morphology based on the published descriptions of Bierhorst (1968), Holttum (1955), Barcelona et al. (1996), Reed (1947) and Sofiyanti et al. (2019), as well as examinations of JSTOR type images viz., *A. plana*, *A. spirophylla*, and *A. wagneri*. Our new species is closest morphologically to *A. plana*, followed by *A. spirophylla* Troll, and *A. wagneri* Sell. (Table 1). *Actinostachys minuta* shares an epiphytic habitat with *A. plana*, *A. spirophylla* and *A. wagneri*, growing in moss cushions on tree fern trunks, although Holttum (1955) did not explicitly mention tree fern trunks but simply trees.

The sorophores of *A. plana* and *A. spirophylla* come closest in length to those of *A. minuta* (2.8–8 mm long versus 4–6 mm). In addition to the shorter sorophores,

Table 1. Major characters delineating *Actinostachys minuta* from *A. wagneri*, *A. spirophylla* and *A. plana*

Character	***A. wagneri*** **(Holttum 1955; Reed 1947)**	***A. spirophylla*** **(Holttum 1955; Reed 1947)**	***A. plana*** **(Reed 1947)**	***A. minuta***
Habitat	Epiphytic on stumps and bases of trees	Epiphytic in moss-cushions on trees	Epiphytic on tree ferns	Strictly epiphytic on trunks of the tree fern *Sphaeropteris polypoda*
Stipe	Indistinct	Indistinct	Distinct (5.5–7.5 long mm) flat	Distinct (5–8 mm long) triangular in transection
Lamina (sterile portion) length (cm)	6–20	4–8	5.5–10.2	2.5–3.7
Lamina (sterile portion) width (mm)	0.5–0.7	Ca. 1.5	1.4–1.74	0.8–1.0
Number of stomatal rows on each side of costa	1	1	Not described	1
Sorophore length (mm)	7–15	4–8	2.5–4.8	4–6
Sorophore number	2 to 5	1 to 3	3 to 6 but usually 4	1 to 4 but usually 1
Sorophore lamina apex	Not bifid, glabrous	Not described	Bifid or toothed	Bifid with profuse white long hairs
Sorophore lamina width (mm)	Not described	Not described	0.5–0.8	0.5–0.6 wide
Sporangia	Biseriate with brown hairs	Biseriate (sometimes apparently tetraseriate) and glabrous	Biseriate	Biseriate and glabrous
Spore surface	Striate	Striate	Smooth	Smooth
Distribution	Northeastern Australia, Indonesia (Borneo, Moluccas), Malaysia (Peninsular Malaysia), Papua New Guinea, Singapore, Thailand	Indonesia (Moluccas), Malaysia (Peninsular Malaysia), Micronesia (Ponape)	New Caledonia (Sommet du Mont Mi)	Philippines (Mindanao)

however, our new species is distinguished from *A. plana* by several other features, viz., shorter (2.5–3.7 cm long) and narrower (0.8–1.0 mm) lamina (sterile portion) with distinct triangular stipe up to 8 mm long (versus longer and wider (5.5–10.2 cm × 1.4–1.74 mm) and with flattened stipe in *A. plana*) and longer and narrower sorophores (4–6 × 0.5–0.6 mm vs. 2.5–4.8 × 0.5–0.8 mm).

It is interesting to mention that we found a persistent gametophyte in our new species as also reported by Bierhorst (1968) in *Actinostachys oligostachys* Bierh., *A. melanesica* C.F.Reed, *A. intermedia* (Mett.) C.F.Reed, and *A. laevigata* (Mett.) C.F.Reed. The tuberous gametophyte is attached to the well-developed sporophyte (Fig. 2A).

All five species of Philippine Schizaeaceae are found in MHRWS in shaded forest. Except for *A. minuta* which is epiphytic on the trunks of tree ferns, the other four species are terrestrial, inhabiting an ultramafic soil with fallen leaves of *Gymnostoma rumphianum*.

Conservation status. Although MHRWS is a protected area, we only have observed this species from the type locality. The species occurs within the buffer zone of San Isidro, MHRWS with an estimated number of 30 individuals growing strictly on trunks of tree ferns. Its location in the buffer zone and the over-collection of tree fern trunks as a medium to grow other plants and for the making of handicrafts will likely reduce the populations of the species if this threat continues. Thus, we recommend listing the species as Critically Endangered (CR) based on its very small and restricted population with ≤ 50 mature individuals and the extent of occurrence estimated to be < 10 km^2 (IUCN Standards and Petition Committee 2019).

Key to the genera and species of grass ferns (Schizaeaceae) from the Philippines

1a Sorophores attached pinnately arranged or comb-like ..... ***Schizaea***
2a Fronds repeatedly dichotomously branched; lamina ≥ 2 mm wide ..... ***S. dichotoma***
2b Fronds unbranched; lamina < 2 mm wide ..... ***S. malaccana***
1b Sorophores digitate ..... ***Actinostachys***
3a Lamina ≥ 2 mm wide; sorophores 1.0−5.0 cm long **4**
4a Lamina (sterile portion) ≤ 5 mm wide; stomata in one row on each side of costa; sporangia in four rows on the sorophores ..... ***A. digitata***
4b Lamina (sterile portion) ≤ 2.5 mm wide; stomata in two rows on each side of costa; sporangia in two rows on the sorophores ..... ***A. inopinata***
3b Lamina < 2 mm wide; sorophores < 1.0 cm long ..... ***A. minuta***

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RESEARCH ARTICLE

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New species and new records of *Artabotrys* (Annonaceae) from peninsular Thailand

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Abstract

Two new species of *Artabotrys* (Annonaceae) are described from peninsular Thailand. *Artabotrys longipetalus* J.Chen & Eiadthong, **sp. nov.**, is unique among *Artabotrys* species in Thailand in having linear petals, relatively long flower pedicels and sessile monocarps. *Artabotrys insurae* J.Chen & Eiadthong, **sp. nov.**, resembles *Artabotrys uniflorus* (Griff.) Craib, but can be distinguished by its oblique leaf base, flat petal blades, apiculate anther connective apex and the presence of a monocarp stipe. In addition, two new records for the Flora of Thailand are reported, viz. *Artabotrys crassifolius* Hook.f. & Thomson and *Artabotrys pleurocarpus* Maingay ex Hook.f. & Thomson; both species are so far only known from peninsular Thailand. A key to the 20 species of *Artabotrys* in Thailand is provided.

Keywords

Annonaceae, *Artabotrys*, new records, new species, peninsular Thailand

Introduction

Artabotrys R.Br. (Annonaceae) is a palaeotropical genus of woody climbers that inhabits tropical rain forests and seasonally dry forests. The genus comprises over 100 species, with the majority occurring in Asia, ca. 30 species in Africa, and one species in Northern Australia (Chen et al. 2018). The presence of specialised inflorescence hooks that assist climbing distinguishes *Artabotrys* from other Annonaceae climbers. A recent

† Deceased

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molecular phylogenetic study (Chen et al. 2019) revealed that the genus consists of an early-divergent grade (EDG) of two African species, and a main *Artabotrys* clade (MAC) comprising an Asian clade sister to an African clade. *Artabotrys* possess trimerous flowers, with a whorl of sepals and two whorls of petals. The outer and inner petals are generally similar in size whereas the sepals are much smaller than the petals. MAC species are characterised by petals with a distinct upper blade and a basal concave claw, and an elaborate rim between the inner petal blade and claw which enables the inner petals to cohere tightly over the reproductive organs (Chen et al. 2020). Conversely, EDG species lack a projecting rim on the inner petals, with one species (*A. brachypetalus* Benth.) entirely lacking the distinction between petal blade and claw (Chen et al. 2020). The flowers of *Artabotrys* are hermaphroditic, with many stamens and few to many unfused carpels. Each carpel has two ovules on a basal placenta. After fertilisation, these carpels develop into free monocarps that are sessile or borne on short stipes.

Herbarium specimens are easily assigned to *Artabotrys* if the diagnostic inflorescence hooks are present. The inflorescence is sometimes only slightly recurved, however; in rare cases, it does not manifest as a hook (Fig. 1A). The inflorescence hook is peculiar with regard to its morphology and ontogeny, which are discussed in great detail in Posluszny and Fisher (2000). The hook formation involves successive development of two hook leaves (hook leaf 1, HL_1 followed by hook leaf 2, HL_2), flattening and curving of the inflorescence away from the main shoot, and curving of the inflorescence back towards the main shoot. Uneven tissue expansion displaces HL_1 to the distal position and HL_2 to the proximal position (figs 23, 24 in Posluszny and Fisher 2000). The floral bud in the axil of HL_2 is in fact the original apical meristem. The definition of the peduncle, which is usually the distance between the first-formed lower bract and the twig, is contentious in *Artabotrys* because the first-formed bract (HL_1) is not in the lowest (proximal) position. Here, we regard the entire hook (curved axis from HL_1 to twig) as the peduncle but it should be noted that its morphology is highly variable within a species, becoming woody as it clasps onto a twig or not manifest as a hook at all as mentioned earlier. Further higher-order branching of the hook inflorescence may occur, resulting in the formation of lateral branches, which are defined as the axes between the hook and the base of the last pedicel (Fig. 1B). The inflorescence lateral branches may be condensed (Fig. 1A, 2F) or elongate (Fig. 1B). Although the genus is easily recognised, identification at the species level is not as straightforward. Petal morphology is sometimes useful (especially for fresh material), but a suite of more subtle characters are often needed for the identification of herbarium specimens. The characters of taxonomic utility in *Artabotrys* include indumentum on lower leaf surface (erect vs. appressed), leaf base (cuneate vs. decurrent on petiole vs. rounded vs. oblique), pedicel length, sepal size, petal size and shape, anther connective apex (apiculate vs. truncate), number of carpels per flower, number of monocarps per fruit, monocarp apex, monocarp stipe length and monocarp size.

Although Thailand is considered to be well known botanically, there remains an upward trend in the number of plant species described from Thailand (Middleton et al. 2019). This is also the case for Annonaceae, particularly in peninsular Thailand where new Annonaceae species are continuously added to the baseline of 39 species listed in Craib (1925). Over the past five years, for instance, an *Alphonsea* species (Turner and

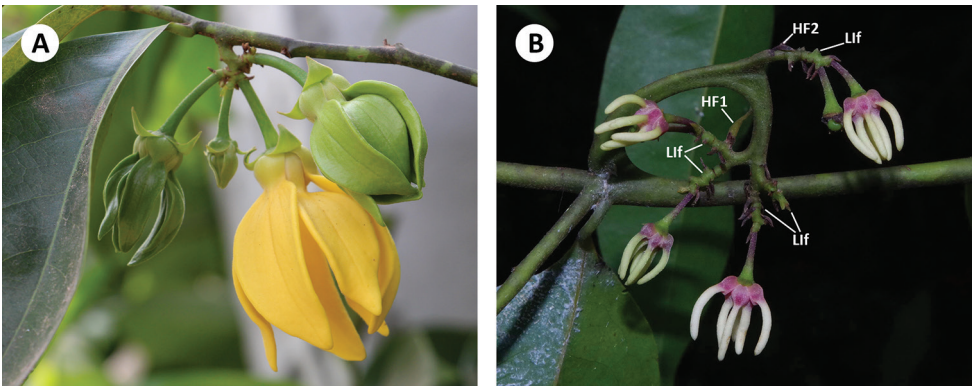

Figure 1. A *Artabotrys hexapetalus*, with condensed lateral inflorescence branches borne on a peduncle that barely resembles a hook **B** *Artabotrys suaveolens*, with elongate lateral inflorescence branches (LIf) borne on a conspicuously hooked peduncle. HF1: Hook leaf 1; HF2: Hook leaf 2 (*H. Sauquet HS164*). Photos: **A** J. Chen **B** T.L.P. Couvreur.

Utteridge 2017), two *Artabotrys* species (Turner and Utteridge 2015; Chen et al. 2018), a *Meiogyne* species (Johnson et al. 2019), two *Mitrephora* species (Damthongdee et al. 2019; Saunders and Chalermglin 2019) and two *Xylopia* species (Johnson and Murray 2019) were recently reported as new to science and narrowly distributed in peninsular Thailand and/or northern Peninsular Malaysia. During the preparation of a revision of *Artabotrys* for the Flora of Thailand, two new species and two new records from peninsular Thailand are discovered and reported here, bringing the total number of species recognised for Thailand to 20 (including the commonly cultivated *A. hexapetalus* (L.f.) Bhandari). A key to the 20 species of *Artabotrys* in Thailand is provided.

Material and methods

The material studied include herbarium specimens of *Artabotrys* from Thailand and neighbouring regions housed in various herbaria (A, BK, BKF, L, PSU, QBG and SING) and digital images of specimens (especially types) from JSTOR Global Plants (https://plants.jstor.org/) and other online herbarium databases viz. AAU (https://www.aubot.dk/search_form.php), BM (https://data.nhm.ac.uk/dataset/collection-specimens), E (https://data.rbge.org.uk/search/herbarium), K (https://apps.kew.org/herbcat/navigator.do), L (https://bioportal.naturalis.nl) and P (https://science.mnhn.fr/institution/mnhn/collection/p/item/search). All specimens cited in this paper have been seen. All measurements were taken from herbarium specimens.

The conservation status of the new species was assessed using the criteria stipulated in the IUCN Red List (IUCN 2012). The extent of occurrence (EOO) and area of occupancy (AOO) of each new species were calculated with the default 2 km^2 grid using GeoCAT (Bachman et al. 2011; http://geocat.kew.org). The abbreviations used in the conservation assessments follow IUCN (2012).

New species descriptions

***Artabotrys longipetalus* J.Chen & Eiadthong, sp. nov.**
urn:lsid:ipni.org:names:77209924-1
Fig. 2A, B

Diagnosis. Distinct from *A. tipuliferus* I.M.Turner & Utteridge (Fig. 2C, D), the only other *Artabotrys* species in Thailand with linear petals, by its relatively long flower pedicels (8–16 mm long vs. 2–4 mm long) and sessile (vs. stipitate) monocarps. Similar to *A. multiflorus* C.E.C.Fisch. (Fig. 2E, F) but distinguished by its chartaceous (vs. coriaceous) leaves, acute (vs. obtuse to acute) petal apex and linear (vs. narrowly lanceolate) petals, specifically its longer and narrower outer petals (35–45 mm long, blade 1–2 mm wide vs. 18–30 mm long, blade 3–5 mm wide) and inner petals (32–40 mm long, blade 1–1.5 mm wide vs. 18–27 mm long, blade 2–4 mm wide).

Type. Peninsular Thailand. Surat Thani Province: Ban Na San District, Tai Rom Yen National Park, Dat Fa Waterfall, 730 m elev., 25 February 2006, *S. Gardner ST2374* (holotype: BKF [SN 198209]; isotypes: BKF [SN 198210], QBG [SN 49402]).

Description. Climbers, to ca. 10 m tall. Twigs drying light brown to brownish black, glabrous, epidermis non-flaky. Leaf laminas 8.5–15 cm long, 2.9–7.7 cm wide, elliptic to oblong-elliptic, chartaceous, glabrous above and below; base cuneate or decurrent on petiole; apex acute to acuminate, acumen up to 5 mm long; midrib raised to flush above, prominent below; secondary veins 7–12 pairs per leaf, raised to flush above and below; tertiary venation reticulate, visible on both surfaces; petiole 2–8 mm long, 1–1.5 mm in diameter, glabrous. Inflorescences 1–15-flowered, peduncles recurved (often laterally compressed and hook-like), glabrous, lateral branches condensed, pedicels 8–16 mm long, ca. 1 mm in diameter, subglabrous. Sepals 3, free, valvate, ca. 1.5 mm long, 1.5–2 mm wide, ovate, glabrous inside, sparsely puberulent outside, apex acute, green in vivo. Petals 6, free, valvate, sparsely appressed-pubescent to glabrous on both surfaces except the glabrous base inside, membranous, greenish yellow in vivo, blade often curly, base concave. Outer petals 3, 35–45 mm long, claw 2–2.5 mm wide, blade 1–2 mm wide, linear, apex acute. Inner petals 3, 32–40 mm long, claw 1.5–2 mm wide, blade 1–1.5 mm wide, linear, apex acute. Stamens 25–35, ca. 1 mm long, ca. 1 mm wide, oblong, anther connective apex truncate. Carpels 8–10, ovary ca. 1 mm long, ca. 0.5 mm wide, stigma ca. 0.5 mm long, cylindrical. Fruit of up to 8 monocarps borne on a glabrous pedicel 19–22 mm long, ca. 4 mm in diameter. Monocarps ca. 26 mm long, 18–20 mm wide, broadly ellipsoid, rough, glabrous, apex weakly beaked (ca. 1 mm long) or rounded, sessile, colour in vivo unknown, drying brownish black, pericarp thickness unknown. Seeds not seen.

Phenology. Flowering specimens collected in February and August; fruiting specimens collected in May.

Distribution and habitat. So far only known from peninsular Thailand (Fig. 6). It occurs in lowland rain forests at elevation 100–730 m, in both undisturbed and partially disturbed sites, sometimes along ridges.

Etymology. The specific epithet reflects the long petals of this species.

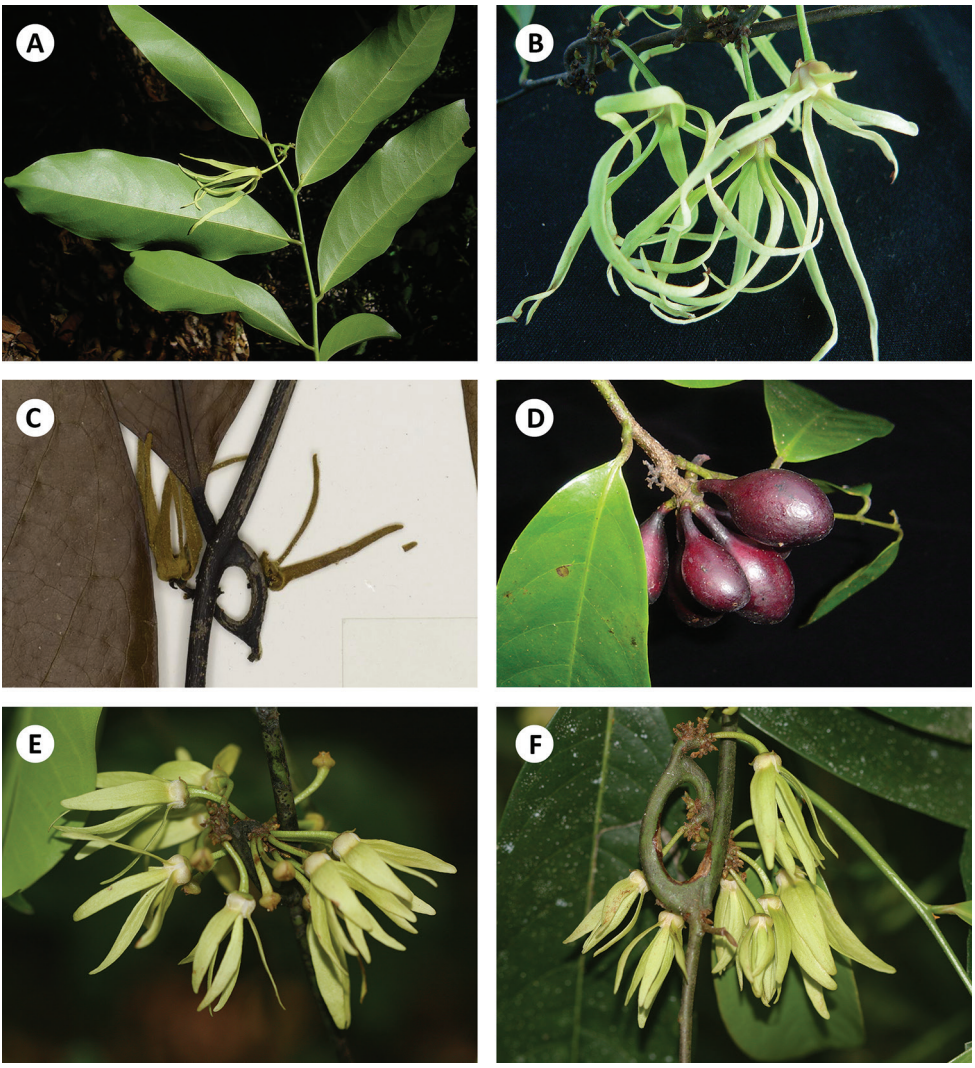

Figure 2. A, B *Artabotrys longipetalus* sp. nov. **A** habit and inflorescence (*T. Insura 57*) **B** flowers, showing linear petals with acute apex (*T. Insura 57*) **C, D** *Artabotrys tipuliferus* **C** flowers, showing short flower pedicel and linear petals (*S. Phusomsaeng 272*) **D** fruit, showing short fruit pedicel and stipitate monocarps (*T. Insura 56*) **E, F** *Artabotrys multiflorus* **E** flowers, showing lanceolate petals with acute to obtuse apex **F** hooked inflorescence with many flowers. Photos: **A, B, D** T. Insura **C** Royal Botanic Garden Edinburgh **E, F** P. Chalermglin.

Preliminary conservation status. *Artabotrys longipetalus* is only known from three localities, with estimated EOO and AOO of 1,165 km^2 and 12 km^2, respectively. All the localities are well within the boundaries of various National Parks in Thailand. Nevertheless, this species may become threatened with future climate change and/or other unpredictable threats owing to its restricted AOO and few known locations. Therefore, we suggest a status of Vulnerable [VU D2].

Additional specimens examined. Peninsular Thailand. Nakhon Si Thammarat Province: Lan Saka District, Khao Luang National Park, Karom Waterfall, 100 m elev., 11 August 2006, *T. Insura 57* (BKF). Surat Thani Province: Vibhavadi District, Kaeng Krung National Park, ridge ca. 2 km east of Ban Cham village, 200 m elev., 13 May 2006, *S. Gardner & P. Sidisunthorn ST2731* (BKF).

Notes. *Artabotrys longipetalus* is similar to *A. multiflorus* from Myanmar (Dawna Range) and Thailand (Kanchanaburi and Tak) in having long, narrow petals and sessile monocarps with rounded to weakly beaked apex. Also comparable to the new species, *A. arachnoides* J.Sinclair from New Guinea shares a similar floral morphology of long, linear, curly petals and long flower pedicels but differs in its highly coriaceous leaves, larger sepals (4–5 mm long) and larger petals (50–60 mm long, 2–3 mm wide). A number of *Artabotrys* species also possess linear petals but have very short flower pedicels (2–4 mm long): *A. speciosus* Kurz from the Andaman Islands, *A. sumatranus* Miq. from Sumatra, Java and Borneo (Kalimantan), and *A. tipuliferus* from peninsular Thailand and Peninsular Malaysia. Significantly, *A. longipetalus* was previously confused with *A. sumatranus* in Insura (2009). "*Artabotrys sumatranus*" in Insura (2009) consists of mixed elements: the description and line drawing of the vegetative parts and flowers match *A. longipetalus* whereas the description and line drawing of the fruit match *A. tipuliferus*. Apart from the short flower pedicels, *A. tipuliferus* can be further distinguished from the new species by its apiculate anther connective apex and the presence of a monocarp stipe (ca. 1 cm long) whereas *A. sumatranus* is distinct from the new species in having shorter petals (up to 15 mm long) and apiculate anther connective apex.

***Artabotrys insurae* J.Chen & Eiadthong, sp. nov.**
urn:lsid:ipni.org:names:77209925-1
Fig. 3, 4A–C

Diagnosis. Distinct from other *Artabotrys* species in Thailand in having oblique leaf base and erect-pubescent lower leaf surface. Similar to *A. uniflorus* Craib (Fig. 4D–F) but with oblique (vs. rounded or rarely cuneate) leaf base, flat (vs. three-angled) petal blades, apiculate (vs. truncate) anther connective apex and short-stipitate (vs. sessile) monocarps that are weakly beaked (beak ca. 1 mm long vs. 2–5 mm long).

Type. Peninsular Thailand. Surat Thani Province: Vibhavadi District, Khlong Yan Wildlife Sanctuary, trail from headquarters, ca. 200 m elev., 31 August 2002, *D.J. Middleton et al. 1487* (holotype: BKF [SN 142020]; isotype: A).

Description. Climbers, to ca. 5 m tall. Twigs drying light brown to greyish black, sparsely to densely erect-pubescent, becoming glabrous, epidermis non-flaky. Leaf laminas 9–19 cm long, 3.7–7.5 cm wide, oblong-elliptic to oblong-obovate, chartaceous, glabrous above except the sparsely erect-pubescent midrib and secondary veins, sparsely to densely erect-pubescent below; base oblique; apex caudate to acuminate, acumen up to 15 mm long; midrib sunken above, prominent below; secondary veins 8–13 per side, sunken to flush above, raised below; tertiary venation reticulate, visible on both

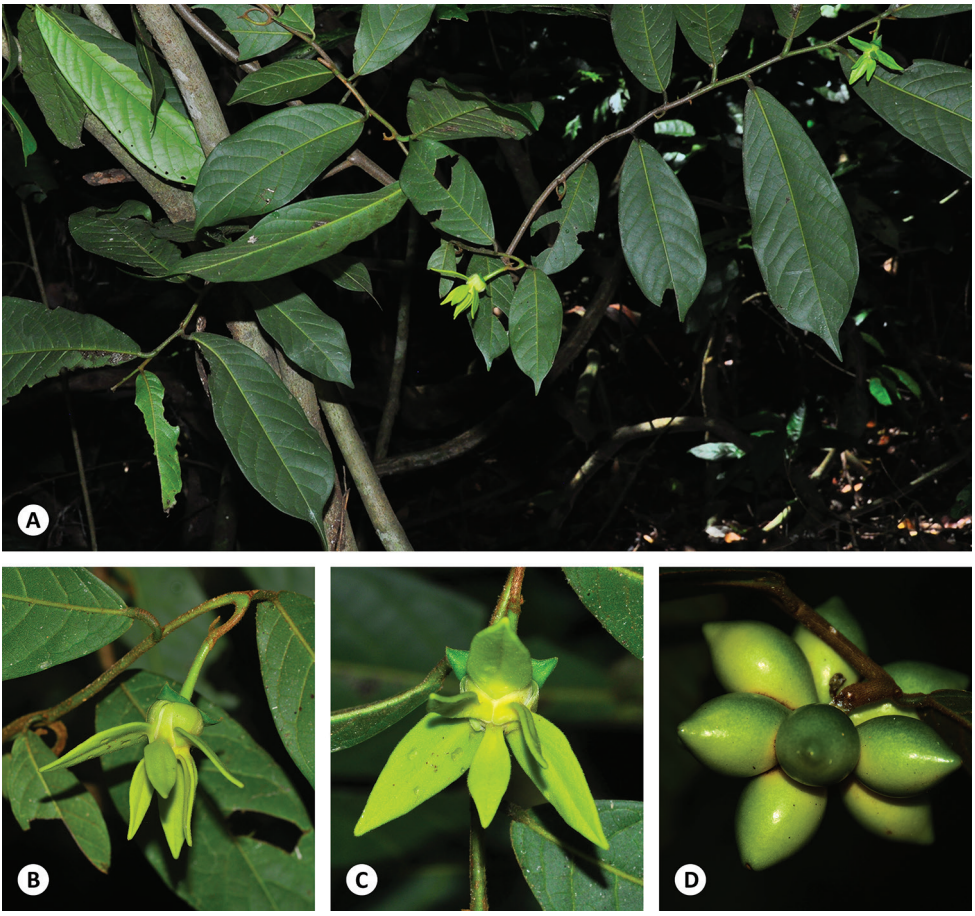

Figure 3. *Artabotrys insurae* sp. nov. **A** habit and leaves, showing caudate to acuminate leaf apex (*C. Leeratiwong 18-1522*) **B** oblique leaf base and inflorescence with hooked peduncle (*C. Leeratiwong 18-1522*) **C** flower, showing oblong-ovate outer petals and oblong-elliptic inner petals (*C. Leeratiwong 18-1522*) **D** fruit (*C. Leeratiwong 17-1116*). Photos: C. Leeratiwong.

surfaces; petiole 3–10 mm long, 1–1.5 mm in diameter, erect-pubescent. Inflorescences 1-flowered (rarely 2-flowered), peduncles recurved (often laterally compressed and hook-like), sparsely erect-pubescent, lateral branches condensed, pedicels 5–15 mm long, ca. 1 mm in diameter, sparsely to densely erect-pubescent. Sepals 3, free, valvate, 6–10 mm long, 5–6 mm wide, ovate, sparsely puberulent inside, densely puberulent outside, apex acute, green in vivo. Petals 6, free, valvate, sparsely to densely puberulent on both surfaces except the glabrous base inside, chartaceous, yellow in vivo, blade flat, base concave. Outer petals 3, 17–29 mm long, claw 6–8 mm wide, blade 6–12 mm wide, oblong-ovate, apex acute. Inner petals 3, 16–28 mm long, claw 4–6 mm wide, blade 3–6 mm wide, oblong-elliptic, apex acute. Stamens 20–30, ca. 2 mm long, ca. 1 mm wide, oblong, anther connective apex apiculate. Carpels 10–14, ovary ca. 3 mm

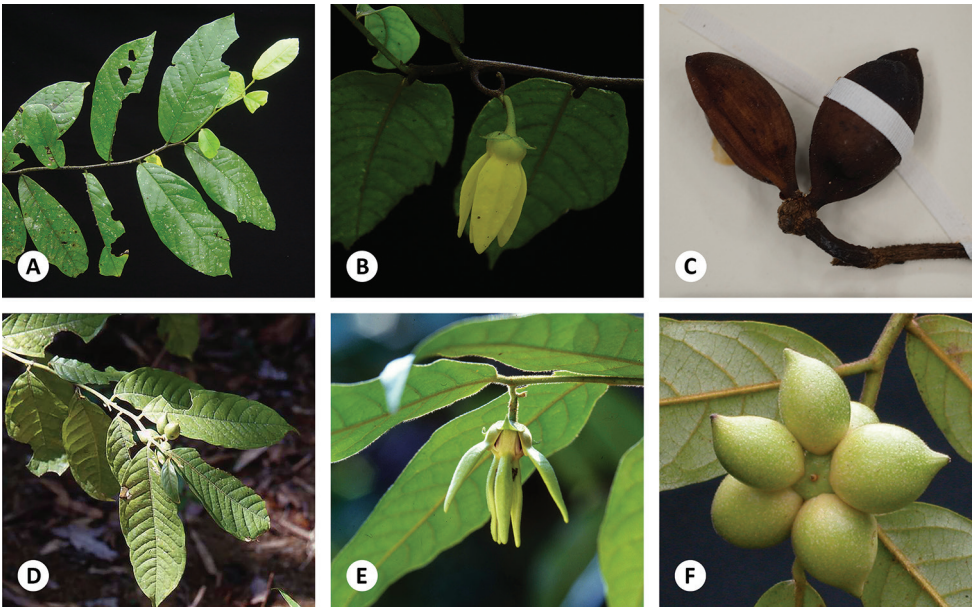

Figure 4. A–C *Artabotrys insurae* sp. nov. **A** habit (*T. Insura 58*) **B** flower, showing flat petal blades (*T. Insura 58*) **C** fruit, showing weakly beaked monocarps with distinct stipes (*D.J. Middleton et al. 1487*) **D–F** *Artabotrys uniflorus* **D** habit **E** flower, showing three-angled petal blades **F** fruit, showing strongly beaked monocarps that are sessile. Photos: **A, B** T. Insura **C** D.M. Johnson **D–F** P. Chalermglin.

long, ca. 0.5 mm wide, stigma ca. 2 mm long, cylindrical. Fruit of up to 10 monocarps borne on a subglabrous pedicel 8.5–20 mm long, 2–2.5 mm in diameter. Monocarps 23–27 mm long, 10–13 mm wide, ellipsoid, smooth, glabrous, apex weakly beaked (ca. 1 mm long), base contracted into a stipe 1.5–4 mm long, green in vivo, drying brownish black, pericarp ca. 2 mm thick. Seeds 15.5–17.8 mm long, 9.4–10.7 mm wide, 4.6–5.2 mm thick, generally smooth with wrinkled area on sides, light yellowish brown.

Phenology. Flowering and fruiting specimens collected in August and September. Fruiting specimens also collected in February and June.

Distribution and habitat. So far only known from peninsular Thailand (Fig. 6). It occurs in lowland moist and dry forests, secondary forests and forest edges at elevation 80–200 m.

Etymology. The specific epithet was given in honour of Mr Tawee Insura, whose prolific collection of *Artabotrys* specimens during his MSc study led to the discovery of several new species and new records for Thailand.

Preliminary conservation status. *Artabotrys insurae* is estimated to have an EOO of 15,994 km^2 and an AOO of 20 km^2. This species largely occurs within various Wildlife Sanctuaries, which constitute Protected Areas in Thailand. A population exists in a remnant forest adjacent to Khao Le Buddhist Temple in Songkhla; such vegetation is regarded as sacrosanct and hence would likely remain undisturbed. We suggest a status of Vulnerable [VU D2] for this species because its restricted AOO makes it susceptible to future threats such as climate change.

Additional specimens examined. Peninsular Thailand. Narathiwat Province: Sukhirin District, Hala-Bala Wildlife Sanctuary, 7 September 2006, *T. Insura 75* (BK, BKF). Songkhla Province: Hat Yai District, Ton Nga Chang Wildlife Sanctuary, *Puangpen et al. N192* (QBG); idem, Ton Nga Chang Waterfall, 150 m elev., 2 February 1997, *C. Leeratiwong s.n.* (PSU); idem, 80 m elev., 12 August 2006, *T. Insura 58* (BK, BKF); Sadao District, Khao Le, 150 m elev., 16 August 2018, *C. Leeratiwong 18-1522* (PSU); Sadao District, Ton Nga Chang Wildlife Sanctuary, Pha Dam Ranger Station, 350 m elev., 2 June 2017, *C. Leeratiwong 17-1116* (PSU).

Notes. This species is most similar to *A. uniflorus* from peninsular Thailand (Chumphon, Ranong, Phang-Nga and Surat Thani) in having erect-pubescent lower leaf surfaces, 1-flowered (rarely 2-flowered) inflorescences, caudate to acuminate leaf apex and relatively narrow monocarps (10–15 mm wide). Its distribution overlaps with *A. uniflorus* in Surat Thani. *Artabotrys siamensis* Miq. from Northern, Northeastern, Eastern and Southwestern Thailand is also similar in having erect-pubescent lower leaf surfaces, but is distinct due to its coriaceous leaves, cuneate leaf base, thicker petals, numerous carpels (25–29 per flower), numerous monocarps (up to 22 per fruit) and broader monocarps (15–20 mm wide).

New records for peninsular Thailand

Artabotrys pleurocarpus Maingay ex Hook.f. & Thomson

Fig. 5

Artabotrys pleurocarpus Maingay ex Hook.f. & Thomson, Fl. Brit. India 1: 54 (1872). Type: Peninsular Malaysia. Malacca, 6 Feb 1868, *A.C. Maingay 3261* [Kew distribution no. 34] (lectotype K [K000381010], designated in Turner (2016) explicitly excluding material in packet; isolectotype BM [BM001014846]).

Distribution and habitat. Peninsular Malaysia and peninsular Thailand (Fig. 6), in lowland rain forests.

Specimens examined. Peninsular Thailand. Songkhla Province: Rattaphum District, Boripat Forest Park, 4 July 1986, *J.F. Maxwell 86-444* (A) [A00571911]; idem, 6 April 2006, *T. Insura 61* (BK, BKF). Satun Province: Thale Ban National Park, Ton Plio Falls, open area by stream, 115 m elev., 3 June 2001, *R. Pooma et al. 2004* (BKF) [SN 134816]. Trang Province: Na Yong District, Ton Pliw Waterfall, 7 April 2006, *T. Insura 62* (BK, BKF); idem, 7 April 2006, *T. Insura 63* (BK, BKF); idem, 7 April 2006, *T. Insura 64* (BK, BKF).

Notes. This species was hitherto known from Malacca, Kedah and Perak in Peninsular Malaysia (Sinclair 1955). Specimens of *A. pleurocarpus* from peninsular Thailand were formerly misidentified as *A. kurzii* Hook.f. & Thomson or identified to genus level; they were only recently re-identified during our preparation of the *Artabotrys* treatment for the Flora of Thailand. The specimens from peninsular Thailand and Peninsular Malaysia closely match one another in leaf and fruit morphology and there can

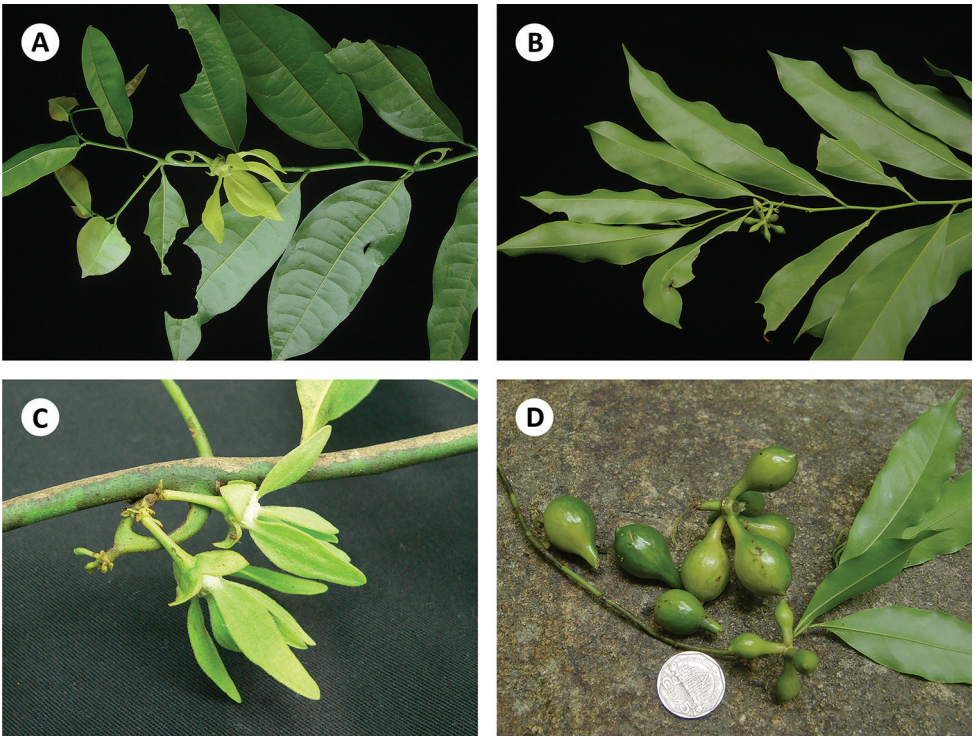

Figure 5. *Artabotrys pleurocarpus* **A** habit and mature flower **B** habit and developing fruit **C** developing flowers on hooked inflorescence **D** fruits, showing monocarps borne on very distinct stipes. Photos: T. Insura.

be no doubt that they are conspecific. Therefore, this represents the first record of *A. pleurocarpus* in Thailand. *Artabotrys pleurocarpus* is distinct among the Thai species on account of its fruit morphology, with relatively few monocarps (up to 9 per fruit) that are prominently beaked (2–3 mm long), quite large (22–30 mm long, 15–20 mm wide) and borne on a long stipe (7–10 mm long). The fruits therefore superficially resemble those of *Polyalthia* species, but specimens can be easily assigned to *Artabotrys* if the inflorescence/infructescence hook is present. Although *A. kurzii* from Myanmar (Pegu) was previously confused with *A. pleurocarpus*, it bears little resemblance to *A. pleurocarpus*, differing in its obovate (vs. oblong-lanceolate to oblong-elliptic) leaves, mucronate (vs. caudate to acuminate) leaf apex and short petioles (1–2 mm long vs. 4–6 mm long).

Artabotrys crassifolius Hook.f. & Thomson

Artabotrys crassifolius Hook.f. & Thomson, Fl. Brit. India 1: 54 (1872). Type: Peninsular Malaysia. Malacca, *Griffith s.n.* [EIC 426] (lectotype: K [K000607645], designated in Sinclair (1955)).

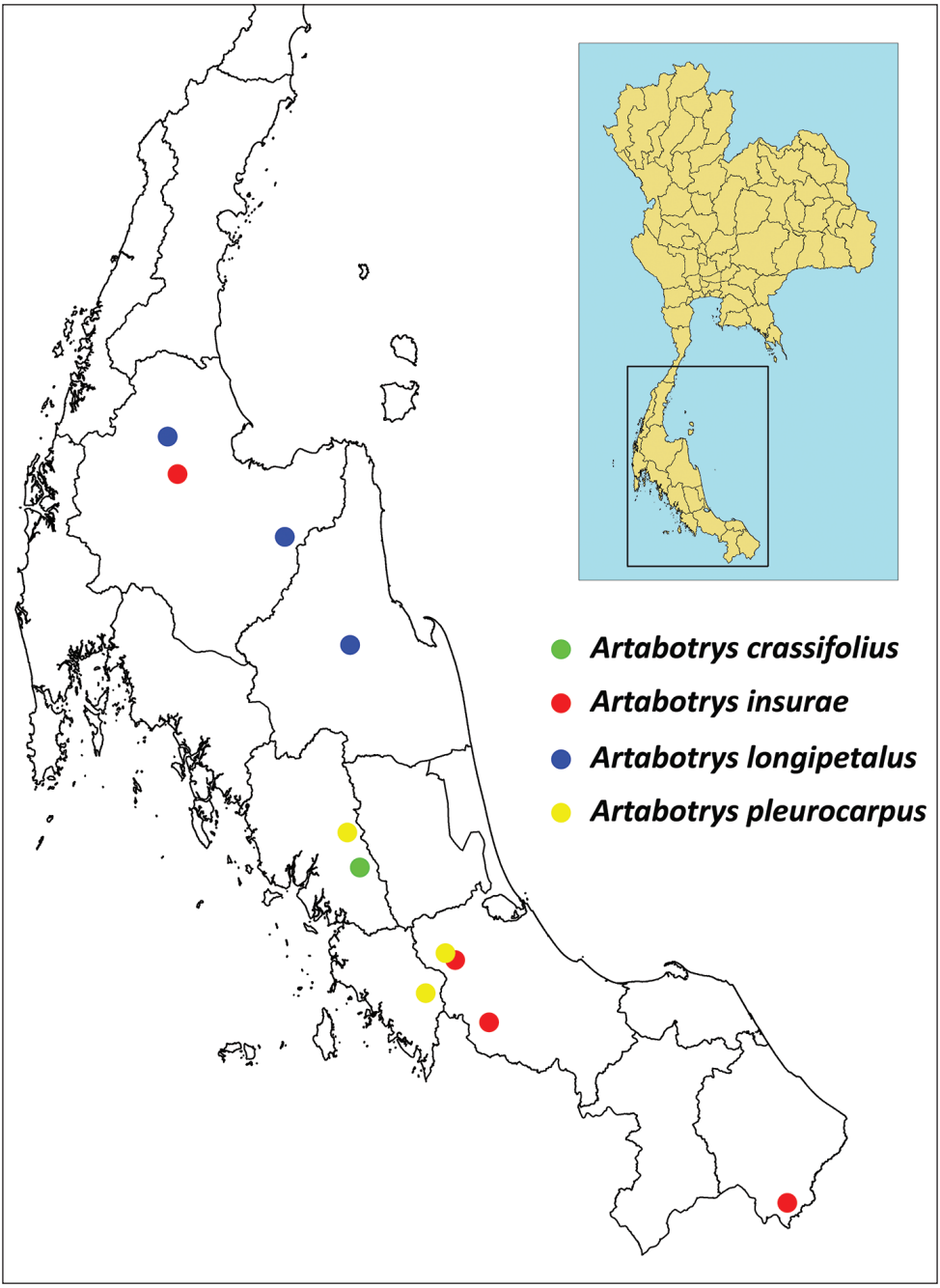

Figure 6. Distributions of *A. crassifolius*, *A. insurae*, *A. longipetalus* and *A. pleurocarpus* in peninsular Thailand. Only the region in peninsular Thailand is shown; adjacent areas in Peninsular Malaysia and Myanmar are removed.

Distribution and habitat. Singapore, Peninsular Malaysia, peninsular Thailand (Fig. 6) and probably Myanmar (see notes), in lowland rain forests.

Specimen examined. Peninsular Thailand. Trang Province: Palian District, Lam Plok Waterfall, ca. 20 m elev., 4 May 2010, *W. Eiadthong 2010-1* (BK, BKF).

Notes. The protologue for *A. crassifolius* cites a specimen from Martaban in Myanmar. In addition, a regional checklist (Kress et al. 2003) and a forest flora (Kurz 1877) indicate the presence of this species in Tenasserim (Taninthayi), Myanmar. However, Turner (2015) was unable to trace the syntype or any other specimen of this species from Myanmar; our attempts to trace those specimens were likewise in vain. The occurrence of *A. crassifolius* in Myanmar therefore requires future verification. *Artabotrys crassifolius* can be distinguished from other species in Thailand as its young twigs, flower pedicels and lower surface of sepals have a dense covering of long appressed hairs that is visible with the naked eye. In Thailand, this species is currently known from a single gathering from Trang, which exhibits the unique indumentum mentioned earlier and has monocarps with shape and size matching *A. crassifolius*. The specimens of this gathering were previously filed as '*Artabotrys* indet' and only recently identified for the Flora of Thailand project. Outside of Thailand, *A. crassifolius* is widespread in Peninsular Malaysia but restricted to the Central Catchment Nature Reserve and Bukit Timah Nature Reserve in Singapore.

Key to *Artabotrys* species in Thailand

1 Axillary shoots often with thorns; leaf apex retuse, truncate, rounded or mucronate (rarely acute); riparian plants ..... ***A. spinosus***

– Axillary shoots without thorns; leaf apex acute, acuminate or caudate (rarely or never retuse, truncate, rounded or mucronate); forest plants **2**

2 Young twigs erect-pubescent; leaves erect-pubescent below **3**

– Young twigs appressed-pubescent, puberulent or glabrous; leaves glabrous or appressed-pubescent below **5**

3 Leaves coriaceous, apex acute to acuminate (never caudate), base cuneate; petals coriaceous; carpels 25–29 per flower; monocarps up to 22 per fruit, 15–20 mm wide ..... ***A. siamensis***

– Leaves chartaceous, apex caudate to acuminate, base rounded or oblique (rarely cuneate); petals chartaceous; carpels 10–18 per flower; monocarps up to 12 per fruit, 10–15 mm wide **4**

4 Leaf base rounded, rarely cuneate; petal blades three-angled; anther connective apex truncate; monocarps sessile, apex strongly beaked (2–5 mm long)... ..... ***A. uniflorus***

– Leaf base oblique; petal blades flat; anther connective apex apiculate; monocarp base contracted into a stipe 1.5–4 mm long, apex weakly beaked (ca. 1 mm long) ..... ***A. insurae***

5 Young twigs, flower pedicels and lower surface of sepals with a dense covering of long appressed hairs (visible with the naked eye) ..... ***A. crassifolius***

– Young twigs, flower pedicels and lower surface of sepals glabrous or with a sparse covering of short appressed hairs (visible with hand lens) **6**

6 Twigs with flaky outer layer; leaf blades 21–33 cm long, tertiary venation subscalariform; inflorescence lateral branches often elongate (up to 6 cm long)... ..... ***A. byrsophyllus***

– Twigs usually with unbroken outer layer; leaf blades 5–20 cm long, tertiary venation reticulate; inflorescence lateral branches condensed or short (up to 2.5 cm long) **7**

7 Petals cream-white in vivo, blades terete; monocarps 1–2(–5) per fruit .... ***A. suaveolens***

– Petals yellow, orange, beige, maroon or brown in vivo, blades not terete; monocarps 4–30 per fruit **8**

8 Petals 7–14 mm long **9**

– Petals 15–45 mm long **11**

9 Leaves lanceolate, base oblique or rounded; flower pedicels 3–6 mm long; outer petals ovate; monocarp base contracted into a stipe ca. 4 mm long .... ***A. oblanceolatus***

– Leaves oblong-elliptic to oblong-obovate, base cuneate or decurrent on petiole; flower pedicels 7–10 mm long; outer petals deltoid; monocarps sessile or with base contracted into a stipe up to 2 mm long..... **10**

10 Leaf apex acuminate to caudate; outer petal blades flat, inner petal blades spathulate; monocarp apex strongly beaked (ca. 2 mm long)... ***A. spathulatus***

– Leaf apex acute; outer petal blades undulate, inner petal blades rhomboid; monocarp apex weakly beaked (less than 1 mm long) ..... ***A. tanaosriensis***

11 Anther connective apex apiculate **12**

– Anther connective apex truncate **16**

12 Sepals ca. 3 mm long, ca. 2.5 mm wide; petal blades 1–2 mm wide..... ..... ***A. tipuliferus***

– Sepals 5–10 mm long, 5–8 mm wide; petal blades 5–18 mm wide **13**

13 Flower pedicels 5–9 mm long **14**

– Flower pedicels 15–32 mm long **15**

14 Leaf apex often caudate (sometimes acuminate); carpels ca. 10 per flower; monocarps up to 9 per fruit, 22–30 mm long, 15–20 mm wide, base contracted into a stipe 7–10 mm long ..... ***A. pleurocarpus***

– Leaf apex acute to acuminate (never caudate); carpels ca. 20 per flower; monocarps up to 17 per fruit, 18–20 mm long, 11–15 mm wide, base contracted into a stipe 3–4 mm long ..... ***A.brevipes***

15 Leaves membranous; monocarp apex beaked (ca. 2 mm long), base contracted into a stipe 4–5 mm long; cultivated only ..... ***A. hexapetalus***

– Leaves coriaceous; monocarp apex rounded (rarely weakly beaked), base contracted into a stipe 5–12 mm long; occurs in the wild..... ***A. harmandii***

16 Outer petal blades 11–14 mm wide, broadly elliptic; monocarps 8–10 mm wide, apex sharply beaked ca. 5 mm long.....***A. oxycarpus***
– Outer petal blades 1–7 mm wide, ovate, lanceolate or linear; monocarps 15–28 mm wide, apex rounded or beaked up to 3 mm long.....**17**
17 Outer petals ovate; monocarp base contracted into a stipe 1–3 mm long...**18**
– Outer petals lanceolate or linear; monocarps sessile.....**19**
18 Leaves chartaceous; inflorescences 10–20-flowered; carpels 15–20 per flower; monocarp apex rounded or weakly beaked; inhabits montane forests at 900–1700 m.....***A. punctulatus***
– Leaves coriaceous; inflorescences 3–5-flowered; carpels ca. 10 per flower; monocarp apex beaked ca. 3 mm long; inhabits lowland forests...***A. venustus***
19 Leaves coriaceous; petals lanceolate, apex obtuse to acute; outer petals 18–30 mm long, blade 3–5 mm wide; inner petals 18–27 mm long, blade 2–4 mm wide ..... ***A. multiflorus***
– Leaves chartaceous; petals linear, apex acute; outer petals 35–45 mm long, blade 1–2 mm wide; inner petals 32–40 mm long, blade 1–1.5 mm wide ....***A. longipetalus***

Acknowledgements

We thank Tawee Insura, Piya Chalermglin, Charan Leeratiwong and David Johnson for use of their photographs. We are also grateful to David Johnson and Charan Leeratiwong for their advice and assistance in taking measurements of *Artabotrys* specimens. The curators of A, BK, BKF, L, PSU, QBG and SING made specimens and specimen images available for study. Financial support was received from the National Parks Board (Singapore). Finally, we thank David Johnson and Timothy Utteridge for their constructive and comprehensive comments on the manuscript.

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RESEARCH ARTICLE

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Capparis kbangensis (Capparaceae), a new species from central Vietnam

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Abstract

Capparis kbangensis Sy & D.V. Hai, a new species from Kbang District, Gia Lai Province, Vietnam, is described and illustrated. The new species is morphologically similar to *Capparis versicolor* but differs by several characters such as emarginate leaf apex, hairy margin of sepals, smaller fruits, and fewer seeds per fruit. Its ecology and conservation status are provided along with a taxonomic key to the closely allied species.

Keywords

Capers, *Capparis versicolor*, Gia Lai Province, taxonomy

Introduction

Capparis Tourn. ex L. is one of the largest genera of the family Capparaceae and is important due to its economic and medicinal value (Rivera et al. 2003; Jiang et al. 2007; Chedraoui et al. 2017). The genus consists of 139 species distributed in tropical and

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subtropical Old World to Mongolia (POWO 2019). It occupies mostly xeric habitats and is characterized by the presence of thorns and saccate outer sepals (Jacobs 1965; Hall et al. 2002, 2004). The genus is represented by the four formal sections namely *Capparis*, *Sodada*, *Monostichocalyx*, and *Busbeckea* (Jacobs 1965) (Jacobs 1965). In Vietnam, they are represented by 37 species, three subspecies and two varieties (Ho 1999; Ban and Dorofeev 2003; Sy et al. 2018). The central highlands of Vietnam possesses a rich floristic diversity and includes five provinces namely Lam Dong, Dak Lak, Dak Nong, Gia Lai and Kon Tum. Our earlier explorations in these areas have resulted in the discovery of two new *Capparis* species, namely *C. daknongensis* and *C. gialaiensis* (Sy et al. 2013, 2015). The present discovery signifies the importance of the highlands of Vietnam and demands more floristic survey and explorations in these areas.

Material and methods

While revising the taxonomy of *Capparis* in Vietnam, a floristic exploration trip was conducted during 2011 to Kbang District of Gia Lai Province. During this trip, an interesting *Capparis* species with young flowers and ripened fruits was encountered. However, only one individual could be located at that time. During our other trips to the same area conducted during 2017–2018, another population with 11 individuals in both flowering and fruiting stage could be traced. After a thorough examination of the type materials housed at HN, K, E, P, CAL and comparison of the morphological features of the collected taxon with all *Capparis* species from South east Asia (Gagnepain 1908, 1943; Jacobs 1960, 1965; Chayamarit 1991; Raghavan 1993; Ho 1999; Ban and Dorofeev 2003; Srisanga and Chayamarit 2004; Hu 2007; Zhang and Tucker 2008; Sy et al. 2013, 2015, 2018; Fici 2016; Fici et al. 2018, 2020; Souvannakhoummane et al. 2018) led us to conclude that our species does not match perfectly with any of the existing *Capparis* and hence we describe it here as a new species.

Taxonomy

***Capparis kbangensis* Sy & D.V. Hai, sp. nov.**
urn:lsid:ipni.org:names:77209926-1
Figures 1–4

Diagnosis. *Capparis kbangensis* is similar to *Capparis versicolor* Griff. in the number of secondary veins of the leaves, color of petals, number of stamens, the length of gynophore, but differs from it by the leaf characters (emarginate vs acute apex), hairy sepal margins (vs. glabrous), smaller fruits and number of seeds per fruit (4–5 per fruit, reniform vs. 15 per fruit, nearly polygonal).

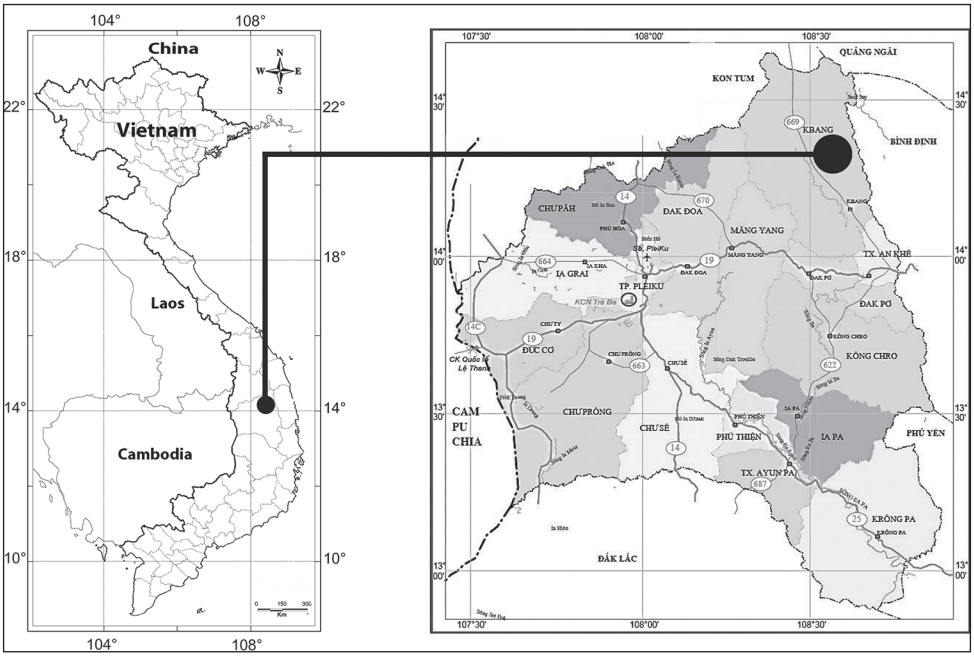

Figure 1. Map of Vietnam indicating type locality of *Capparis kbangensis* Sy & D.V. Hai.

Type. Vietnam. Gia Lai Province: Kbang District, along the road, on hillocks, alt. 626 m, 14°11'44.0"N, 108°35'40.9"E, 07 April 2018, *Sy Danh Thuong, Do Van Hai, Thuong 0704201801* (holotype HN!; isotype, IBSC!).

Description. Scandent shrubs, up to 5 m high. Innovations with densely brown hairs, glabrous when mature. Thorns ca. 3 mm long, reddish brown, recurved. Petiole 6–8 mm long, hairy; blade elliptic to obovate, 4.5–6 × 2.8–3.2 cm, glabrous, young leaves yellowish green, dark green when older; midvein abaxially raised, adaxially flat; secondary veins 6–7 on each side of midvein, abaxially not obvious; base round or cuneate; apex emarginate. Inflorescence corymbs simple, terminal, with the lower flowers axillary, or few flowered in lateral racemes; pedicels 1.5–1.7 cm long, glabrous. Flower buds globose, 5–6 mm. Sepals 0.9–1 × 0.4–0.5 cm long, outer pairs hairy along margins, inner pairs hairy inside and along the margins; sepals of outer whorl boat-shaped and inner whorl obovate. Petals white, later turns to light pink, obovate, lower pairs 1.6–1.7 × 0.7–0.9 cm, upper pairs 1.7–1.8 × 0.9–1 cm, both surfaces pubescent, especially at the base. Stamens 57–60; filaments 3–3.5 cm long, glabrous, white; anthers ca. 2 mm long. Disk nearly parallelogram shaped. Gynophore 3.8–4.2 cm long, glabrous. Ovary elliptic, 0.2 × 0.1 cm, top with beak, yellowish green, glabrous, placentas 4. Fruits globose, 1.8–1.9 cm in diam, black when mature, surface with some knobs, beaked apex. Seeds 4–5 per fruit, reniform, 4–5 × 2–3 mm.

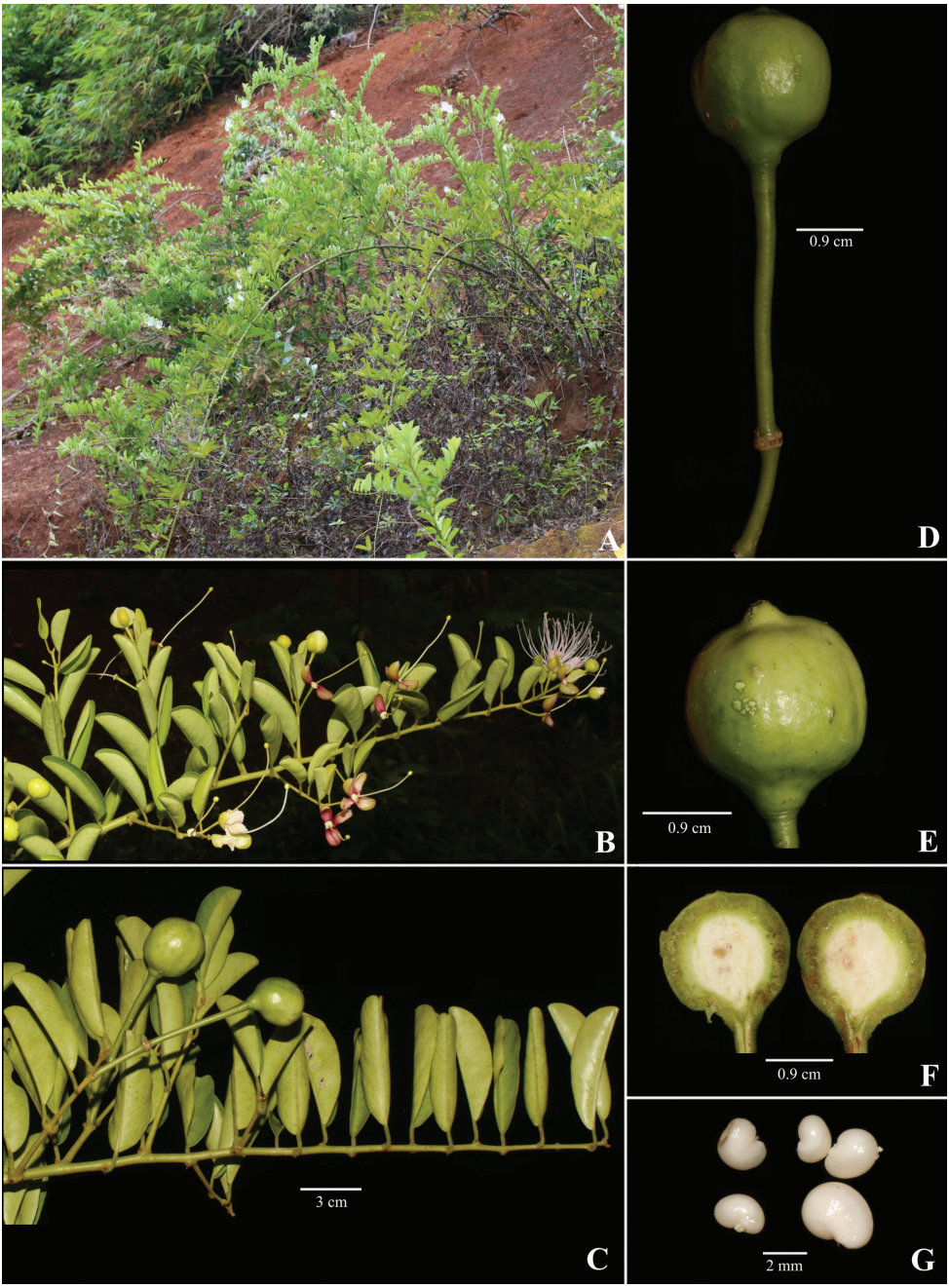

Figure 2. *Capparis kbangensis* Sy & D.V.Hai **A** habit **B** flowering branch **C** fruiting branch **D** fruit **E** fruit showing a distinct beak **F** cross section of the fruit **G** seeds. (Photographs by Sy & D.V. Hai).

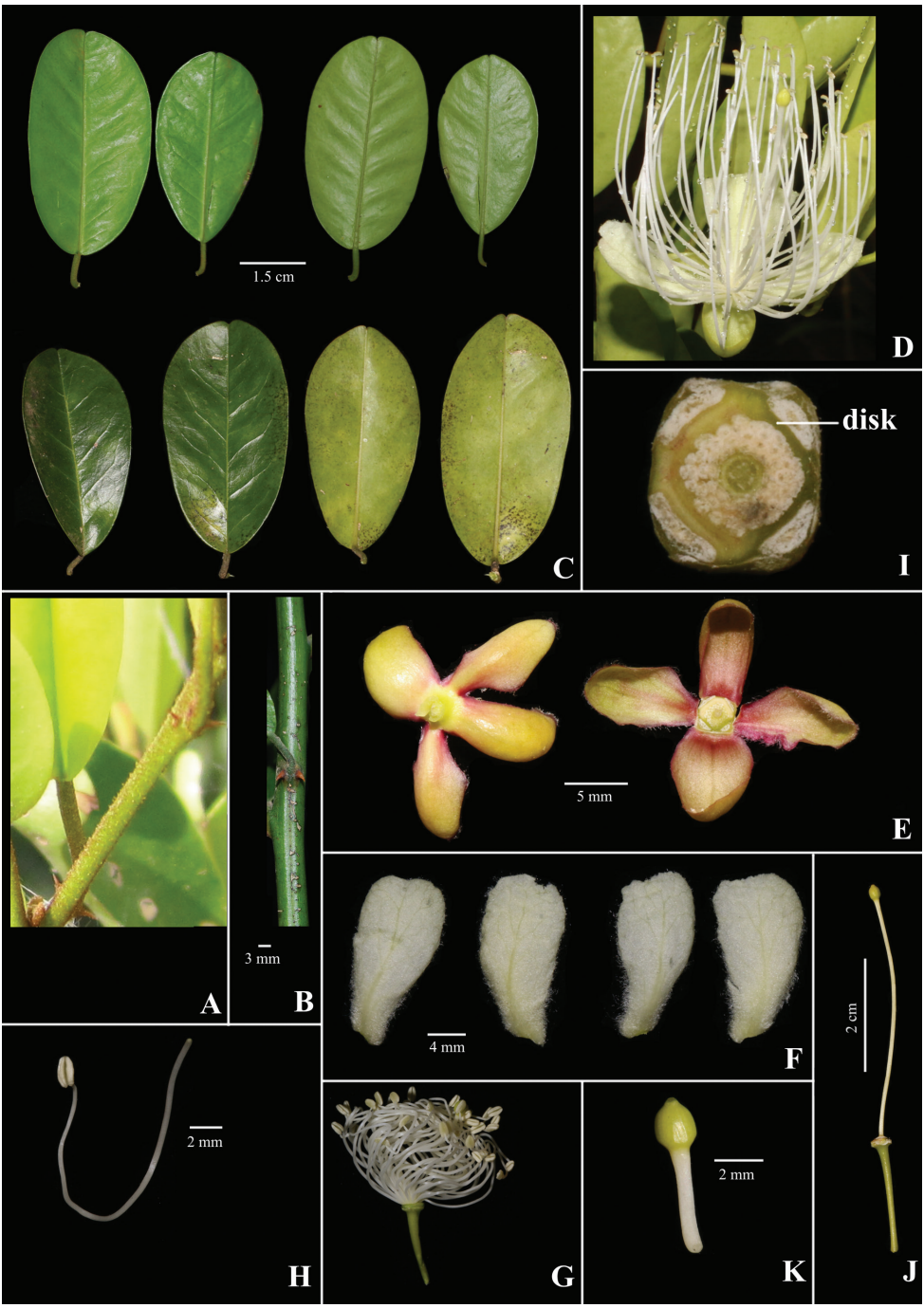

Figure 3. *Capparis kbangensis* Sy & D.V.Hai **A** young stem **B** mature stem showing thorns **C** leaf **D** flower **E** sepals **F** petals **G** stamens **H** stamen with filament and anther **I** disk **J** gynophore and ovary **K** ovary. (Photographs by Sy & D.V. Hai).

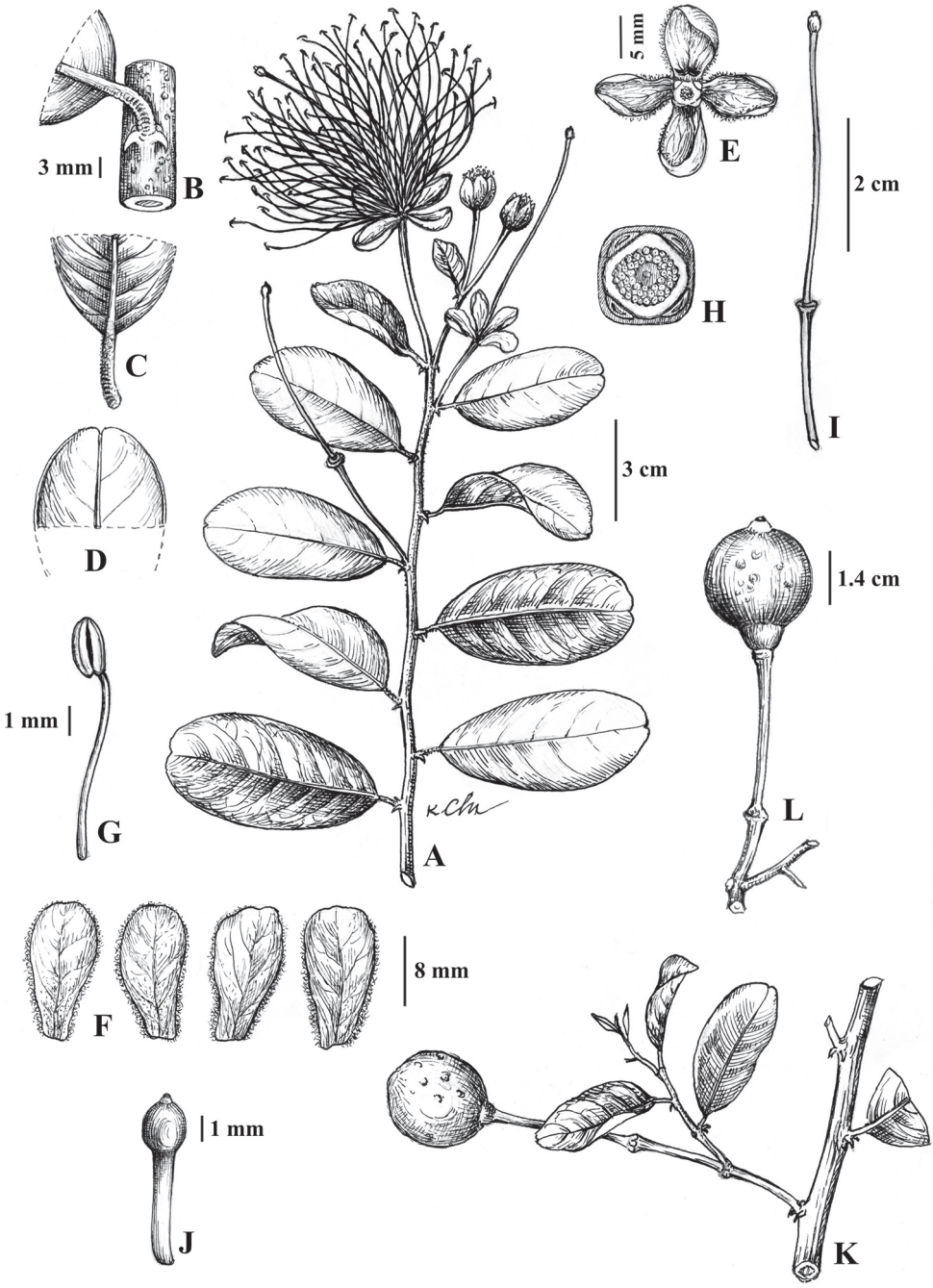

Figure 4. *Capparis kbangensis* Sy & D.V Hai, sp.nov (**A, C–J** drawn from holotype *Thuong*0704201801 **B** drawn from *PTV698*; **K, L** drawn from *Hai28042017*) **A** flowering branch **B** stem with thorns **C** base of leaf **D** apex of leaf **E** sepals **F** petals **G** filament and anther **H** disk **I** gynophore and ovary **J** ovary **K** fruiting branch **L** fruit (Drawn by Mrs. Le Kim Chi).

Other specimens examined. Vietnam. Gia Lai Province, Kbang District, near the edge of forest, alt. 630 m, 14°12'16.0"N, 108°36'18.5"E, 11 March 2011, *T.T. Bach, D.V. Hai, B.H. Quang, H.M. Tam, S.D. Thuong, PTV 698* (HN!). VIETNAM. Gia Lai Province, Kbang District, along the road, on the small hillocks, alt. 626 m, 14°11'44.0"N, 108°35'40.9"E, 28 April 2017, *D.V. Hai, Hai28042017* (HN!).

Phenology. Fls. March to April; Frts: April to August.

Distribution and ecology. *Capparis kbangensis* is currently known from Kbang District, Gia Lai Province. It was found growing on the basaltic soils of hillocks along the roads or near the edge of forests, at an elevation of around 626–630 m. *Capparis micracantha* DC., *Saccharum spontaneum* L., *Chromolaena odorata* (L.) R.M. King & H. Rob., *Erycibe* sp., *Callicarpa albida* Bl., *Bidens pilosa* L. were found associated with the new species.

Etymology. The new species derives its name from the type locality Kbang District of the Gia Lai Province in Vietnam. In Vietnamese, it is known as Cáp kbang.

Conservation status. During the last 10 years of our survey in Vietnam forests, we could observe only 12 individuals of *Capparis kbangensis* growing along the road or near the edge of forests. These habitats are frequently affected by the anthropogenic activities. Locating this species in the nearby areas proved a futile exercise. Therefore, *Capparis kbangensis* is assessed as Critically Endangered (CR) or Data deficient (DD) based on the IUCN Red List Categories (IUCN 2017). Further inventories are needed to find additional populations in Vietnam.

Note. *Capparis kbangensis* is morphologically similar to *Capparis versicolor*. However, it also exhibits some similarities with *C. monantha*, *C. siamensis*, and *C. flavicans.* A comparison of the morphological characters of these species belonging to section Monostichocalyx is summarized in Table 1.

Key to the *Capparis kbangensis* and allied species

1 Stamens 6–12 ..... ***C. flavicans***
– Stamens more than 30 ..... **2**
2 Leaf hairy. Ovary elongate or ovate, hairy **3**
– Leaf glabrous. Ovary elliptic, glabrous **4**
3 Sepal obovate. Petals yellowish-white. Ovary elongated..... ***C. monantha***
– Sepal boat-shaped. Petal greenish-white. Ovary ovate..... ***C. siamensis***
4 Apex of the leaf acute, obtuse, V-shape or acuminate. Inner pairs of sepals elliptic, glabrous. Fruits globose, diam. 3–5 cm. Seeds 15 per fruit, nearly polygonal..... ***C. versicolor***
– Apex of the leaf emarginate. Inner pairs of sepals obovate, hairy. Fruits globose, diam. 1.8–1.9 cm. Seeds 4–5 per fruit, reniform..... ***C. kbangensis***

Table 1. Morphological comparison of *Capparis kbangensis* with others species of section Monostichocalyx.

Characters	*Capparis kbangensis*	*Capparis versicolor*	*Capparis monantha*	*Capparis siamensis*	*Capparis flavicans*
Shape of leaf	elliptic, nearly obovate or obovate	elliptic, oblong	ovate, elliptic,	ovate	obovate, elliptic, rhomboid
Size of leaf (cm)	4.5–6 × 2.8–3.2	3.5–8 × 1.5–3.5	4–7 × 2–4	5–10.5 × 3–4.5	1.2–3 × 1–1.7
Leaf surface	glabrous	glabrous	hairy when young, soon glabrous	hair on the midvein and secondary vein	densely hairy when young, soon glabrous
Leaf base	round or cuneate	cuneate	obtuse, acute	cordate, obtuse, round	obtuse, cuneate, acute
Leaf apex	emarginate	acute, obtuse, V-shape or acuminate	acute-acuminate, mucronate	acute or acuminate	round, obtuse, notched, mucronate
Secondary veins (in pairs)	6–7	6–9	2–4	4–7	3–5
Inflorescence	simple corymb	simple corymb	solitary	solitary	solitary
Length of pedicels of flowers (in cm)	1.5–1.7, glabrous	1.5–5, glabrous	0.5–1.5, glabrous	1–1.3, hairy	1–3, hairy
Shape of sepal	outer pairs boat-shape. inner pairs obovate	outer pairs boat-shape or nearly orbicular. inner pairs elliptic	both outer and inner pairs obovate	both outer and inner pairs elliptic or boat-shaped	outer pairs boat-shape, inner pairs ovate or obovate
Size of sepal (in cm)	0.9–1 × 0.4–0.5	0.9–1.1 × 0.8–1	1.4–1.8 × 0.6–0.8	0.8–1 × 0.3–0.5	0.6–0.8 × 0.4–0.5
Sepal surface	outer pairs only hairy along the margin. inner pairs hairy inside and along the margins	outer pair and inner pair glabrous	outer pair and inner pair only hairy outside	outer pairs hairy. inner pairs hairy outside	inner pair more hairy than outside
Shape of petal	obovate	nearly orbicular, obovate	obovate	obovate, sometimes spathulate	obovate
Size of petal (cm)	inner pairs 1.6–1.7 × 0.7–0.9; outer pairs 1.7–1.8 × 0.9–1; both surface hairy, especially at the base	1.2–1.7 × 0.7–1.4, glabrous or inside hairy near base	2.5–2.8 × 0.8, hairy outside	2–2.5 × 0.5–0.8, hairy outside	0.8–0.9 × 0.4, densely hairy outside
Petal color	white, turns light pink on maturity	white, purple, pink	white with yellow	green, white, upper pairs with a deep yellow blotch, fading red	yellow, upper pairs with golden yellow blotch, fading brown
Stamens	57–60	50–70	more than 46	36–46	6–12
Ovary	elliptic, 0.2 × 0.1 cm, top with knob, glabrous	elliptic, 0.2 cm long, glabrous	elongate, 0.5 × 0.1 cm, long beak, hairy	ovate, 0.3–0.5 × 0.25 cm; beaked, densely yellowish hairy	ovate, obovate, densely hairy
Gynophore	3.8–4.2 cm, glabrous	3–5 cm, glabrous	2.1–2.4 cm, hairy	2–2.5 cm, hairy	1.2–1.7 cm, hairy
Fruits	globose, diam. 1.8–1.9 cm, surface glabrous with some protuberances, beaked	globose, diam. 3–5 cm, surface glabrous or scabrous, sometimes with a few small irregular protuberances, beaked	unknown	nearly globose, elliptic or ovate; 3.5–5.5 × 2.5–3 cm, with 8 longitudinal rows of small protuberances, sometimes glabrous	subglobose, elliptic, 2.5–4 × 2–3.5 cm, surface with densely small protuberances
Seeds	4–5 per fruit, reniform	15 per fruit, nearly polygonal	unknown	0.7–1 × 0.5–0.6 cm	2–8 per fruit, elliptic, reniform
Distribution	Vietnam	China, India, Malaysia, Myanmar, Thailand, Vietnam	Thailand	Cambodia, Vietnam, Thailand	Cambodia, India, Malaysia, Myanmar, Thailand, Vietnam
Habitat	on the basaltic soils of the hillocks along the roads or near the edge of forests	on slightly dry areas, sandy areas, scattered forests or among shrubs	on limestone hills	on mixed deciduous forest, bamboo forest, open dry jungle, edge of evergreen forest	dry scrub, deforested land, evergreen jungle, dry *Dipterocarp* forest on poor sandy or rocky soil
Elevation (m asl)	626–630	100–1000	100	50–1200	40–350
Phenology	Fls: March-April Frts: April-August	Fls: April-July Frts: July-April	Fls: February-August Frts: unknown	Fls: December-April Frts: May-November	Fls: December-April Frts: May-November

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A threatened new species of *Ipomoea* (Convolvulaceae) from the Brazilian Cerrado revealed by morpho-anatomical analysis

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Abstract

A new species of *Ipomoea*, endemic to the Cerrado domain in Maranhão, Brazil, is described. *Ipomoea maranhensis* D.Santos & Buril, **sp. nov.** has been misidentified as *I. burchellii* Meisn. in several herbaria. Even though both species have oblong, pubescent leaves, they can be distinguished by morpho-anatomical characters. We present a diagnosis, complete description, illustration, taxonomic comments, conservation status and distribution map.

Keywords

biodiversity, Brazilian flora, conservation, endangered species, endemic species, morpho-anatomy, South America

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Introduction

Ipomoea (Convolvulaceae) comprises approximately 700 species (Staples 2015) and is widely distributed throughout the world, but is predominantly pantropical and absent in Mediterranean areas and temperate climates (Staples and Brummitt 2007). In Brazil, it is represented by 149 species distributed in all regions and phytogeographic domains (Flora do Brasil 2019). The genus can be distinguished by its echinate pollen (Simão-Bianchini 1998). Recently, knowledge of *Ipomoea* has been increased with the publication of several new species (e.g. Wood et al. 2015; Vasconcelos et al. 2016; Wood et al. 2017a, b; Wood and Scotland 2017a, b), many of which are endemic to Brazil (Wood et al. 2017c; Santos et al. 2019; Santos et al. in press).

Among Brazilian phytogeographic domains, the Cerrado stands out as a center of diversity and endemism for several plant groups (Simon et al. 2009). Despite being one of the 34 global biodiversity hotspots (Mittermeier et al. 2004), this domain has been intensely devastated in recent decades due to the expansion of agriculture and livestock (Cunha et al. 2008). Of the 12,113 Cerrado angiosperm species (BFG 2018), 366 are considered endangered (Martinelli et al. 2014). The genus *Ipomoea* is represented by 92 species in the Cerrado biome, which corresponds to 22% of the family's diversity in the country (Flora do Brasil 2019). Of these, *I. macedoi* Hoehne, *I. maurandioides* Meisn. and *I. sobrevoluta* Choisy are considered endangered and do not occur in protected areas (Martinelli and Moraes 2013), and may become extinct if we do not take any conservation initiative.

While analyzing *Ipomoea* collections from CEN, HST, HUEFS, and SLUI (acronyms follow Thiers 2019), we found a morphotype collected in the municipality of Carolina, Chapada das Mesas National Park in the State of Maranhão, that was dubiously identified as *I. burchellii* Meisn. When we analyzed the protologue and the type collection of *I. burchellii*, we noted significant differences in the morphology and indumentum of sepals between this species and the morphotype. After analyzing several *I. burchellii* specimens, we found that these differences are consistent.

We consulted literature related to climbing and subshrubby species of *Ipomoea* from South America (O'Donell 1948; O'Donell 1959a, b; Simão-Bianchini 1998; Léon 2006; Krapovickas 2009; Wood et al. 2015; Wood et al. 2017a, b, c; Wood and Scotland 2017a, b), type specimens from online database (http://plants.jstor.org), and Brazilian herbaria through *SpeciesLink* network (http://www.splink.org.br) in order to investigate similiar species to this morphotype. However, the combination of morphological features found in the morphotype did not match those of any known species.

To support the morphological delimitation between this morphotype and *I. burchellii*, we performed a comparative anatomical analysis of the leaf, as this has been used to support the morphological delimitation of species in various plant groups (Lersten 1974; Gomes et al. 2005; Rio et al. 2005; Oliveira et al. 2011; Thadeo et al. 2014), as well as in Convolvulaceae (Ketjarun et al. 2016; Traiperm et al. 2017). Thus,

considering the taxonomic alleged consistency of the anatomical characters analyzed in Convolvulaceae (Metcalfe and Chalk 1979), along with the morphological discontinuities found, we describe this morphotype as a new species.

Methods

Morphological analysis

We analyzed specimens from the following herbaria: CEN, HUEFS, SLUI (acronyms follow Thiers 2019), and HST (unindexed herbarium from the Universidade Federal Rural de Pernambuco). Morphological terminology followed Harris and Harris (1994). The specimen collected in the Carolina municipality, Chapada das Mesas National Park, Maranhão state, was preserved according to standard taxonomic techniques (Mori et al. 1989) and deposited in SLUI. The main diagnostic characters of the species were illustrated based on the type specimen.

Comparative anatomical analysis of the leaf

For comparative anatomical analyses, three *I. burchellii* specimens and two vouchers of the new species were included in this study (Table 1). Three leaves from the fourth node and parts of the petiole of each specimen were rehydrated according to Smith and Smith (1942). Then, the samples were placed in 2% potassium hydroxide solution at room temperature for two hours. Subsequently, the material was washed with distilled water three times. The samples were progressively dehydrated from 10% alcohol until their final storage in 70% ethanol (Johansen 1940). The median region of blade and petioles were free-hand sectioned and clarified with 50% sodium hypochlorite and stained with safrablue (safranin and Astra-Blau, Bukatsch 1972). The slides were prepared with glycerin and fixed with enamel (Kraus and Arduin 1997). The slides were deposited into the Plant Anatomy Laboratory (LAVeg) at the Universidade Federal de Pernambuco. The analysis and documentation were performed under a Leica DM500 microscope. The anatomical terminology followed Metcalfe and Chalk (1979).

Conservation status

Distribution records were obtained from herbarium sheets. The conservation status was based on IUCN guidelines and criteria (IUCN 2019) using georeferenced data from cited collections. The area of occupancy (AOO) and extent of occurrence (EOO) were calculated using GeoCAT (Bachman et al. 2011). The distribution map was created using the QGIS version 2.7 software (QGIS Development Team 2015).

Table 1. List of vouchers sampled for comparative anatomical analysis of *Ipomoea maranhensis* and *I. burchellii*.

Species/specimens	Collection point	Voucher	Herbarium
I. maranhensis			
specimen 1	Ibipira, Mirador, Maranhão state	L.P. Felix et al. 8136	HST
specimen 2	Carolina, Maranhão state	R.V.C. Saraiva 107	SLUI
I. burchellii			
specimen 1	Canápolis, Bahia state	Yoshida-Arns, K. 557	HUEFS
specimen 2	São Desidério, Bahia state	A.M. Miranda 3787	HST
specimen 3	Paraiso, Goiás state	Irwin, H.S. 21745	HUEFS

Taxonomic treatment

Ipomoea maranhensis **D. Santos & Buril, sp. nov.**
urn:lsid:ipni.org:names:77209927-1
Figs 1, 2

Type. Brazil. Maranhão: município de Mirador, Ibipira, Parque Estadual do Mirador, 06°22'01"S, 44°22'00"W, 11 April 1998 (fl.), *L.P. Félix et al. 8136* (holotype HUEFS38133, isotype HST8028).

Diagnosis. *Ipomoea maranhensis* differs morphologically from *I. burchellii* Meins. by its twining habit (vs. subshrubs), lanceolate (vs. oblong), long-acuminate (vs. acute) and densely sericeous (vs. hirsute) sepals.

Description. Vine, internodes 1–5 cm long, latex absent; stem pubescent with whitish trichomes. Leaf blade 3.3–7 × 0.9–2.3 cm, oblong, base cuneate, rounded to subcordate, apex obtuse, acute, apiculate, margin entire, pubescent on both surfaces, discolor, whitish on abaxial face, brochidodromous, 6–10 pairs of secondary veins, main vein prominent; petiole 2–3 mm long, canaliculate, pubescent, nectary near the apex of the petiole. Inflorescence of dichasial cymes reduced, bracteolate in the axils of the upper leaves, with 3–7 flowers; peduncle 2–3 mm long, pubescent; bracts 1.7–2 × 0.5–0.8 cm, elliptical, base cuneate, apex obtuse, pubescent, foliaceous, discolor; pedicel 2–4 mm long, pubescent; bracteoles 0.9–1.6 cm long, lanceolate, oblong, base truncate, apex acute, obtuse, margin entire, pubescent. Sepals all equal, 1.7–2.3 × 0.4–0.5 cm, lanceolate, base cuneate, apex long-acuminate, margins non-membranous, densely sericeous on the adaxial surface of the sepals, whitish. Corolla ca. 4 cm long, ca. 4.5 cm diam, infundibuliform, tube ca. 1.6 cm long, rose with whitish tube, midpetaline bands area sericeous externally. Stamens ca. 3 cm long, included, unequal, pilose at the base, anthers ca. 4 mm long, oblong, white. Ovary ca. 4 mm long, conical, glabrous, 4 locule; style ca. 2 cm long, glabrous; stigma bi-globose, papillose. Fruit unknown.

Anatomical description – petiole and leaf blade. Petiole epidermis uniseriate with juxtaposed cells, parenchyma with isodiametric cells, prominent/concave main rib shape, U-shaped vascular bundles. Leaf epidermis uniseriate, mesophyll dorsiventral with crystallized idioblasts (druses), palisade parenchyma with one to two layers of elongated

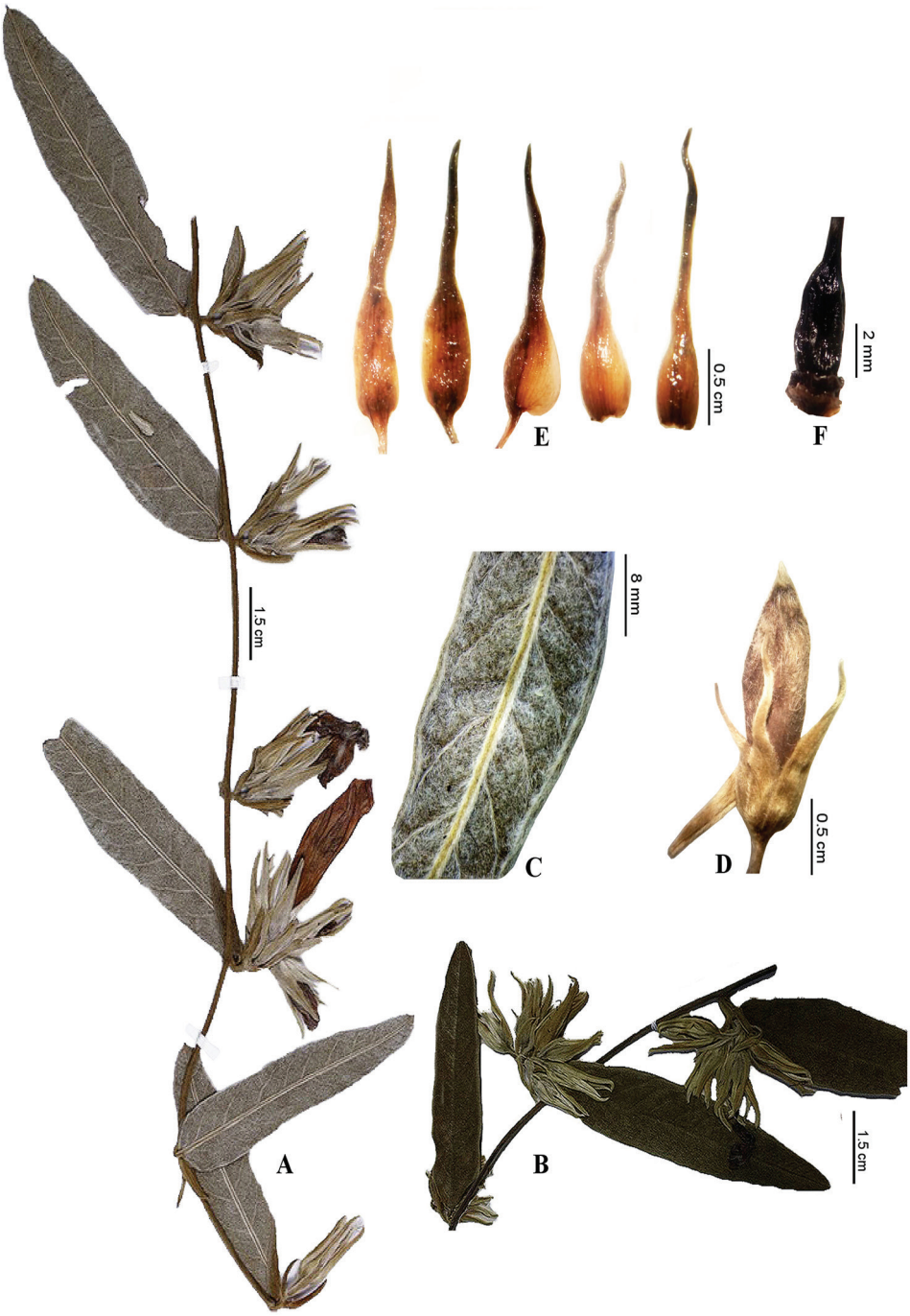

Figure 1. A–F *Ipomoea maranhensis* **A** branch with leaves (abaxial surface) and flowers **B** branch with leaves (adaxial surface) and floral buds **C** leaf in abaxial view presenting sericeous aspect **D** floral bud **E** sepals **F** ovary (Photos by F. Santos and Flora do Brasil 2019).

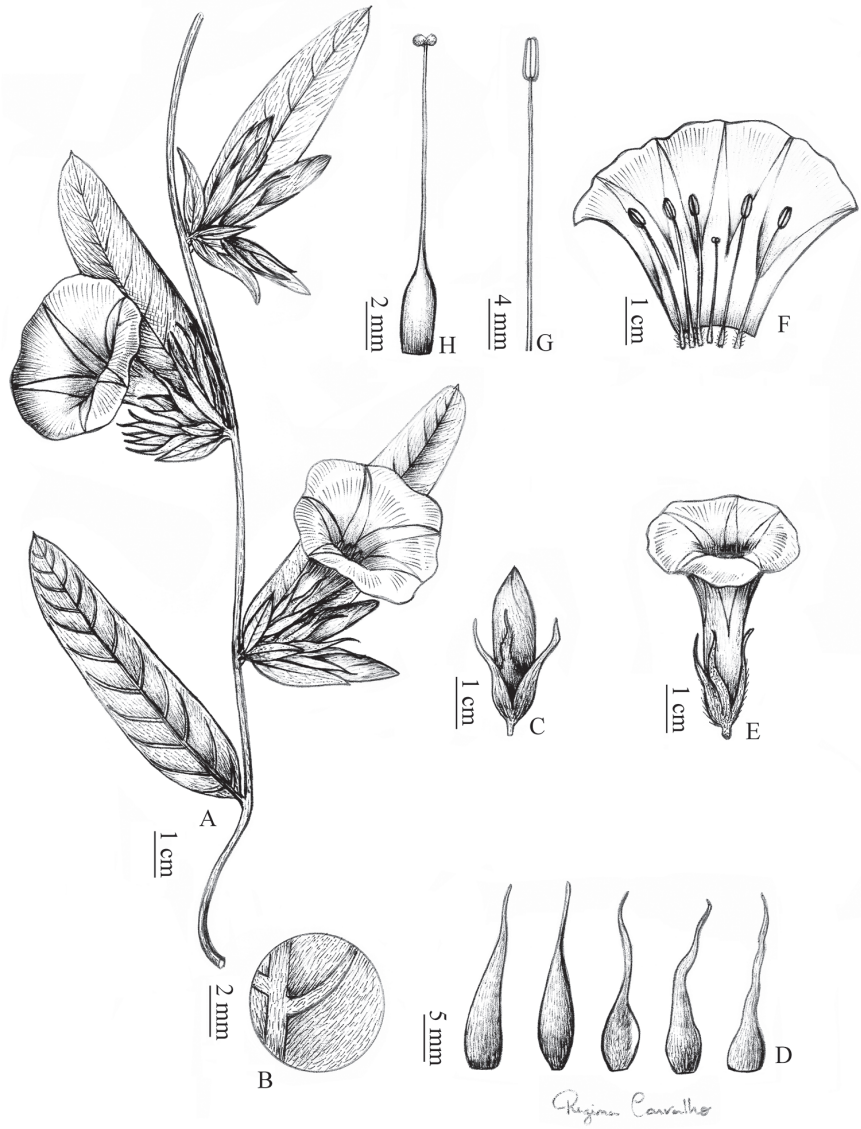

Figure 2. A–H *Ipomoea maranhensis* **A** twining habit **B** primary and secondary veins on the abaxial surface **C** floral bud **D** sepals with apex long acuminate **E** flower **F** open corolla **G** stamen **H** gynoecium. Drawn by Regina Carvalho from *Félix et al. 8136.*

Table 2. Comparison of morpho-anatomical characters of *Ipomoea maranhensis* and *I. burchellii*.

Characters	*I. maranhensis*	*I. burchellii*
Shape of sepals	Lanceolate	Oblong
Apex of sepals	Acuminate	Acute
Indumentum of sepals	Sericeous	Hirsute
Arrangement of vascular bundles	U-shaped	V-shaped
Glandular trichomes on leaf	Both surfaces	Abaxial surface
Type of mesophyll	Dorsiventral	Isobilateral

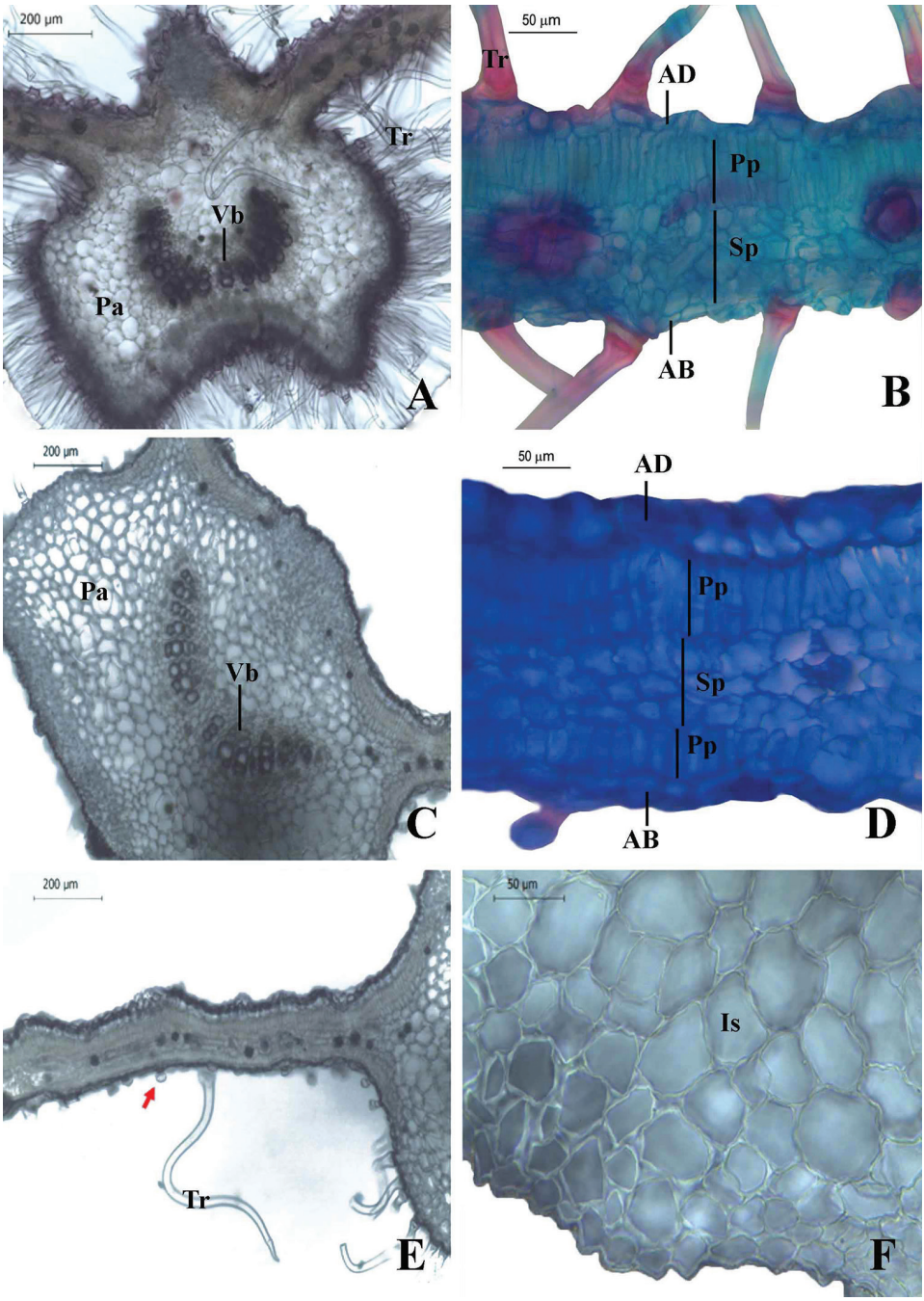

Figure 3. A, B *Ipomoea maranhensis* **A** arrangement of vascular bundles in U; prominent/concave main rib shape **B** dorsiventral mesophyll **C–F** *I. burchellii* **C** arrangement of vascular bundles in V; convex/flat main rib shape **D** mesophyll isobilateral **E** glandular trichomes restricted to the abaxial surface of the leaf (red arrow) **F** parenchymatous tissue with isodiametric cells (Photos by E. Pereira Arruda). AD: adaxial epidermis; AB: abaxial epidermis; Is: isodiametric cells; Pa: Parenchymatous tissue; Pp: palisade parenchyma; Sp: spongy parenchyma; Vb: vascular bundle; Tr: trichome.

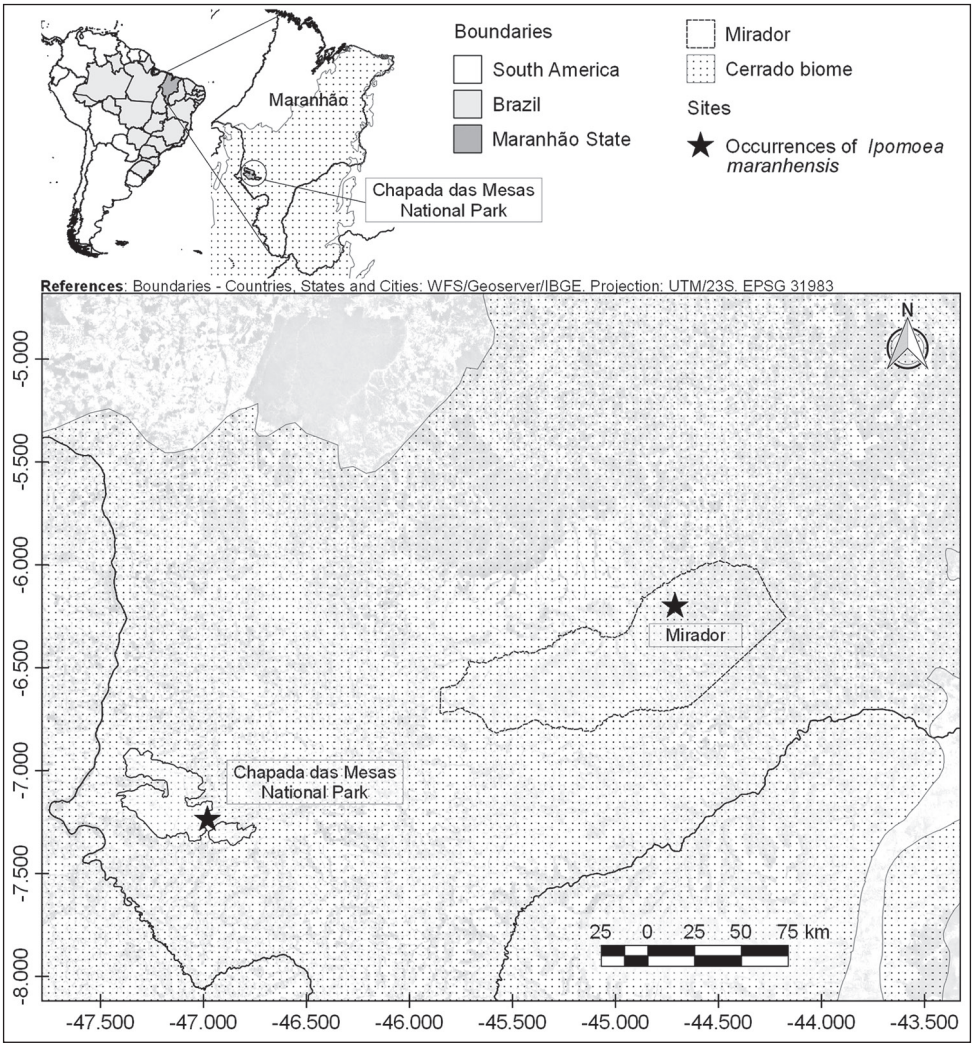

Figure 4. Distribution map of *Ipomoea maranhensis*.

cells more evident on the adaxial surface, spongy parenchyma with three to four layers of round cells with sinuous anticlinal walls; glandular trichomes on both leaf surfaces.

According to the anatomical analysis, we observed that *I. maranhensis* and *I. burchellii* share mesophyll with crystallized idioblasts (druses) and petiole parenchyma with isodiametric cells. However, *I. maranhensis* is distinguished from *I. burchellii* by a prominent/concave main rib shape (vs. convex/flat main rib shape in *I. burchellii*), U-shaped vascular bundles (vs. V-shaped), glandular trichomes spread on both leaf surfaces (vs. only on abaxial one) and dorsiventral mesophyll (vs. isobilateral) (Fig. 3) (Table 2).

Phenology. Collected with flowers in April.

Distribution and habitat. *Ipomoea maranhensis* is known only from two disjunct populations between the municipality of Mirador, in the Mirador State Park (area of

4370 km^2) and the municipality of Carolina, in the National Park Chapada das Mesas (CMNP, area of 1600 km^2) (Fig. 4). In both areas this species grows on quartzite soils associated with Cerrado vegetation at 186–345 m elevation, average temperature of 26 °C and annual precipitation between 1250–1500 mm (Alcântara 2004; IBAMA 2013). The occurrence of this new species in the National Park Chapada das Mesas and in the Mirador State Park emphasizes the importance of these protected areas for the preservation of this taxon in the Cerrado domain.

Etymology. The specific epithet refers to Maranhão state, where the type specimens were collected.

Additional specimens examined. Brazil. Maranhão: Carolina, Parque Nacional da Chapada das Mesas, 345 m elev., 7°14'14"S, 46°58'50"W, 07 April 2017 (fl.), *R.V.C. Saraiva 107* (SLUI 5037); Parque Nacional Chapada das Mesas, accesso no Km 596 da BR – 230, 7 km E em estrada vicinal, 290 m elev., 7°07'33"S, 47°22'13"W, 12 April 2016 (fl.), *M.F. Simon et al. 2921* (CEN 95523).

Conservation status. We categorized this species as Endangered (criteria EN) according to B1 (EOO < 5000 km^2) and B2ab (ii, iii) (AOO < 500 km^2) from IUCN (2019). Although populations of *I. maranhensis* occur in protected areas, this species is threatened due to the reduction of its habitat because of anthropogenic fires lit by small communities who remove vegetation with fire for subsistence agriculture in the Cerrado *sensu stricto* and *Cerradão* formations (Ribeiro and Walter 2008). According to Estivalet (1997), prostrate or climbing plants seem to be more prone to burning than upright species, whose growth points are more protected inside the clump.

Identification key for *Ipomoea* species from the Chapada das Mesas National Park and Mirador State Park

1	Leaf blade oblong, oblanceolate, linear or obovate	**2**
–	Leaf cordate, hastate, lobed	**5**
2	Leaf linear; sepals obovate, elliptic, glabrous	***I. schomburgkii* Meisn.**
–	Leaf oblong, oblanceolate, obovate; sepals oblong, ovate, lanceolate, sericeous, hirsute	**3**
3	Leaf oblanceolate to obovate; sepals ovate	***I. cuneifolia* A. Gray**
–	Leaf oblong; sepals oblong or lanceolate	**4**
4	Sepals oblong, obtuse, hirsute	***I. burchellii* Meisn.**
–	Sepals lanceolate, long-acuminate, sericeous	***I. maranhensis***
5	Sepals with subapical rostrum; corolla hypocrateriform	***I. hederifolia* L.**
–	Sepals lacking subapical rostrum; corolla funnelform	**6**
6	Leaf 5-lobed	***I. mauritiana* Jacq.**
–	Leaf hastate or cordate	**7**
7	Outer sepals unequal in size	***I. maurandioides* Meisn.**
–	Outer sepals equal in size	**8**
8	Sepals convex	***I. goyazensis* Gardner**
–	Sepals flat	***I. squamosa* Choisy**

Discussion

The new species has been confused with *I. burchellii* because they share oblong, discolorous and sericeous leaves, flowers arranged in a dichasium and peduncle 2–3 mm long. However, according to the analysis of the type specimens (*Burchell 8738* deposited in K [K000612855]) and protologue of *I. burchellii*, the new species is morphologically different from *I. burchellii* by its habit, shape, apex, and indumentum of sepals. Misidentifications probably occurred because both species have oblong, discolorous leaves, 2–3 mm long peduncles and inflorescence arranged in dichasium, as well as because they occur in the Cerrado domain. Anatomical analysis revealed that the morphological delimitation of these species is supported by the shape of the vascular bundles, distribution of glandular trichomes in the leaf and type of mesophyll.

These characters are considered consistent (Metcalfe and Chalk 1979) and useful for Convolvulaceae taxonomy (e.g. Ketjarun et al. 2016; Traiperm et al. 2017). *Ipomoea maranhensis* can also be compared to *I. langsdorffii* Choisy, an endemic species from the Southeastern region of Brazil occuring in the Cerrado and Atlantic forest, due to its oblong leaves and flowers in dichasia. However, *I. maranhensis* can be distinguished from this species by its acute leaves (vs. obtuse in *I. langsdorffii*), lanceolate (vs. ovate), long-acuminate (vs. acute), and densely sericeous (vs. hirsute) sepals. These morphological characters present great taxonomic value for *Ipomoea* (Simão-Bianchini 1998; Ferreira and Miotto 2009; Wood et al. 2015).

One of the barriers that can hinder access to knowledge about the diversity of the genus *Ipomoea* is that several of its new species have been described based on the morphology from one or two specimens without the without using a tool to support the morphological delimitation (Wood et al. 2017a, b). Such a limited number of specimens can lead to misinterpretation about the consistency of characters, making it difficult to recognize these species. In these cases, investigating other sources of characters is important for preventing the proliferation of names that cause taxonomic confusion and nomenclatural instability. Anatomical studies have been used to support the morphological delimitation of species in various plant groups (Smith and Smith 1942; Lersten 1974; Gomes et al. 2005; Rio et al. 2005). Among the leaf anatomical characters used to support such delimitation are mesophyll type, main vein shape, and vascular bundle type (Gomes et al. 2005; Gomes et al. 2008; Zini et al. 2016).

In Convolvulaceae, these characters have also been consistent and informative, such as the type of mesophyll that was used to delimit three species of *Evolvulus* (Ketjarun et al. 2016), the shape of the main vein and vascular bundles used to clarify the relationship between morphologically similar *Argyrea* species (Traiperm et al. 2017). Furthermore, anatomical characters strongly supported species identification in an investigation of *Merremia* section *Xanthips* (Pisuttimarn et al. 2013). Such anatomical information has been used in these studies because it has proven to be useful and informative for taxonomic identification of plants (Thadeo et al. 2014).

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Agrostis and *Podagrostis* (Agrostidinae, Poaceae) from páramos of Boyacá, Colombia: synoptic taxonomy including a key to Colombian species

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Abstract

We present taxonomic notes, including updated species descriptions and images, for the nine species of *Agrostis* and one species of *Podagrostis* found in páramos of Departamento Boyacá, Colombia (*A. boyacensis*, *A. breviculmis*, *A. capillaris*, *A. foliata*, *A.* cf. *imberbis*, *A. mertensii*, *A. perennans* s.l., *A. stolonifera*, *A. tolucensis*, *Podagrostis trichodes*). *Agrostis* cf. *imberbis*, previously known from austral South America, is newly recorded for Colombia, *A. capillaris* is a new regional record for Boyacá, and the name *Agrostis stuebelii* is lectotypified. We include keys in English and Spanish to distinguish the 15 species of *Agrostis* and two species of *Podagrostis* that are cited as occurring in Colombia.

Resumen

Se presentan notas taxonómicas, además de descripciones e imágenes actualizadas, para las nueve especies de *Agrostis* y una especie de *Podagrostis* encontradas en los páramos del departamento de Boyacá, Colombia (*A. boyacensis*, *A. breviculmis*, *A. capillaris*, *A. foliata*, *A.* cf. *imberbis*, *A. mertensii*, *A. perennans* s.l., *A. stolonifera*, *A. tolucensis*, *Podagrostis trichodes*). *Agrostis* cf. *imberbis*, previamente conocido de Sudamerica austral, se presenta como un nuevo registro para Colombia y *A. capillaris* se presenta como un nuevo registro regional para Boyacá, con el nombre de *Agrostis stuebelii* también lectotipificado. Se incluyen claves en inglés y español para distinguir las 15 especies de *Agrostis* y dos especies de *Podagrostis* citadas para Colombia.

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Keywords
Andes, Gramineae, grasses, grassland, identification key, Neotropics, South America, taxonomy

Introduction

The grass genera *Agrostis* L. and *Podagrostis* (Griseb.) Scribn. & Merr. belong to tribe Poeae R.Br., subtribe Agrostidinae Fr., with molecular data supporting their close relationship (Saarela et al. 2017). They both share numerous morphological characteristics, including paniculate, single-flowered laterally-compressed spikelets that disarticulate above the glumes, while lacking characteristics such as notably pubescent calluses and prominent rachilla prolongations that define the related genera once placed in *Calamagrostis* Adans. s.l. (Peterson et al. 2019; Sylvester et al. 2019a). Indeed, *Podagrostis* was originally described as a section of *Agrostis* and considered to be limited to just one species in Austral South America and three species from North America (Soreng 2003). Recent taxonomic research in Colombia has, however, discovered two new species of *Podagrostis* for South America, with *P. colombiana* Sylvester & Soreng being found from the páramos of the Sierra Nevada de Santa Marta, Colombia (Sylvester et al. 2019b), and the common High-Andean grass *Agrostis trichodes* (Kunth) Roem. & Schult. being transferred to *Podagrostis* (Sylvester et al. 2020). Aside from these studies, the only other published taxonomic research related to the genus *Agrostis* in Colombia is mostly limited to type protologues and checklists, some with a single voucher cited (Luteyn 1999; Soreng et al. 2003, 2003 and onwards; Giraldo-Cañas 2011, 2013; Giraldo-Cañas et al. 2016), with no taxonomic revisions or keys to the species existing for the genus in Colombia. Palacio et al. (in press) recently described the new species *Agrostis laegaardiana* A.M. Molina & Rúgolo, from Ecuadorian and Colombian páramos, and provided a brief key to distinguish morphologically similar species with condensed spikelike panicles from these habitats. With this, coupled with the new record of *Agrostis* cf. *imberbis* Phil. described herein and not including the new combination *Podagrostis trichodes* (Kunth) Sylvester & Soreng (Sylvester et al. 2020), Colombia is believed to hold 15 species of *Agrostis*, including three possible endemics, and three exotic species (Giraldo-Cañas et al. 2016; Palacio et al. in press).

Neighboring Ecuador and Venezuela also lack comprehensive taxonomic treatments for *Agrostis*: Ecuador has the aforementioned recent paper that describes *A. laegaardiana* and includes a brief key to similar species (Palacio et al. in press), checklists (Jørgensen and Ulloa-Ulloa 1994; Jørgensen and León-Yánez 1999) and Hitchcock's (1927) synoptic treatment available; Venezuela has checklists (Hokche et al. 2008; Bono 2010) plus synoptic treatments for different regional areas (Briceño 2010; Dorr 2014). Thus, researchers have only these plus treatments from Central America (Pohl 1980; Pohl and Davidse 1994; Morales-Quirós 2003) and further south, such as those

from Peru (Tovar 1993), Bolivia (Renvoize 1998) and Argentina (Rúgolo de Agrasar 2012), to help identify *Agrostis* taxa in Colombia.

The majority of *Agrostis* taxa cited for Colombia (Giraldo-Cañas et al. 2016; Palacio et al. in press) are found in high-elevation páramo grasslands. These ecosystems are located above the montane treeline of the humid tropical Andes from northern Peru to Colombia and Venezuela, with isolated regions also found in the mountains of Costa Rica and Panama (Luteyn 1999; Peyre et al. 2018). Páramos are classified as one of the world's 34 biodiversity hotspots (Myers et al. 2000), with their high diversity and endemism probably a result of a unique geological and climatological history (Flantua et al. 2019). Colombia hosts the largest area of páramo of any country, holding 49% of the world's páramo, which is an estimated c. 2 million hectares of national territory with the lower elevational limit ranging between 2850 and 3550 m alt. (Morales et al. 2007). Colombian páramos can be separated into five main high-elevation island-like enclaves within the country, namely the Cordillera Oriental, the Cordillera Central, the Cordillera Occidental, the Sierra Nevada de Santa Marta, and páramos of Nariño-Putumayo (Morales et al. 2007; Peyre et al. 2018). Roughly 60% of Colombia's páramos are found in the Cordillera Oriental, with the political region (termed 'Departamento') Boyacá being especially important and hosting the largest area of páramo of any Departamento in Colombia, calculated at 19% of Colombia's overall páramo (Morales et al. 2007). When conducting fieldwork in the páramos of Boyacá, *Agrostis* was found to be the most locally diverse grass genus (Sylvester pers. observation; unpubl. data), but with a notable dearth of taxonomic information available to help identify specimens. To support ecological and taxonomic research in Colombia's páramos, we present a key to the species of *Agrostis* and *Podagrostis* currently (sometimes tentatively) accepted in Colombia, and short descriptions, images, and notes for the species found in páramos of Departamento Boyacá, Colombia.

Materials and methods

Accepted species follow Soreng et al. (2003 and onwards). Herbarium acronyms follow Thiers (continuously updated). In this treatment, glabrous means without pubescence (in the sense of slender, relatively soft hairs unless otherwise stated). Smooth indicates no prickle-hairs with broad bases and/or hooked or pointed apices (i.e., pubescence can occur on a smooth surface, and a rough or scabrous surface can be glabrous). Taxonomic notes, including updated short descriptions mentioning the most important taxonomically informative characters for delineating species, are found for the eight species encountered during extensive fieldwork in the páramos of Boyacá. *Agrostis subrepens* (Hitchc.) Hitchc., which is mentioned in Giraldo-Cañas et al. (2016) as occurring in Departamento Boyacá, and *A. gigantea* Roth, *A. scabrifolia* Swallen and *A. lehmannii* Swallen, which are cited for Colombia in general (Giraldo-Cañas et al. 2016), are placed in the 'Excluded species' section at the end of the taxonomic treatment as no specimens were verified from Boyacá. *Agrostis meyenii* Trin., not registered for Colombia (Giraldo-Cañas et al. 2016), but which may occur there, is also included

in the key. Notable synonyms of taxa found in Colombia or neighboring countries are included. The descriptions in the taxonomic notes were made based on specimens studied in both Colombia and neighboring countries, as well as information found in type protologues and literature (Pohl 1980; Tovar 1993; Pohl and Davidse 1994; Renvoize 1998; Morales-Quirós 2003; Briceño 2010; Rúgolo de Agrasar 2012; Dorr 2014). Only specimens studied from Departamento Boyacá are cited, or, exceptionally, specimens of interest from other Departamentos within Colombia are also cited. Specimen localities are cited by country (capital letters), political region (also historically called 'departamento'; in bold) and then municipality. The herbaria COL, FMB, K, UPTC, and US were visited during the study. Only herbaria where specimens have been checked and verified by the authors have been cited.

Taxonomic treatment

Identification key to the 15 species of *Agrostis* and two species of *Podagrostis* that are cited in Colombia

(species that have not been confirmed by us to occur in Colombia are placed in brackets; *Agrostis meyenii*, which may occur in Colombia, but has so far not been registered, is also included)

1 Palea absent or reduced, 0–1/3(–½) of the lemma in length **2**

– Palea well-developed, reaching from ½ to almost the full length of the lemma (rarely 2/5 the length of the lemma in *A. capillaris* and *A. stolonifera*) **15**

2(1) Panicle (at flowering) open, lax, usually ellipsoid, ovoid, obovoid, to pyramidal, not (sub-)spikelike, with upper lateral branches long and ascending or spreading but not held close to the central inflorescence axis, without spikelets close to the base (NB. Some species can have contracted panicles when immature or after flowering, but always diffuse at flowering) **3**

– Panicle (at flowering) moderately to densely congested, sub-spikelike or spikelike, with upper lateral branches short and held close to the central inflorescence axis, usually with spikelets present from the base or close to the base.... **8**

3(2) Lemma awned, awn (1.8–)2.5–4 mm long, flexuose to geniculate, twisted, inserted in the lower or middle 1/3 of the lemma **4**

– Lemma unawned or awn to 0.5 mm long and straight, not twisted, inserted in the middle or upper 1/3 of the lemma or subapical **5**

4(3) Culms scabrous, at least below the nodes; sheaths scaberulous; leaf blades rigid, scabrous on the abaxial and adaxial surfaces and margins..... ..... ***A. scabrifolia* Swallen**

– Culms smooth; sheaths smooth; leaf blades lax or less often semi-rigid (when involute), smooth throughout or finely scaberulous on the adaxial surface and/or margins .....***A. mertensii* Trin.**

5(3) Leaf blades convolute, involute, or conduplicate, rigid, 0.5–1 mm wide in diameter as rolled or folded; plants often stooling with notable pseudostolons and appearing long rhizomatous on herbarium sheets; culms slightly creeping or decumbent at their base but erect towards their apex; anthers 1–2 mm long **6**

– Leaf blades filiform, flat or conduplicate, lax, 0.2–6 mm wide, or rarely involute and firm in the basal leaves in *A. perennans* s.l.; plants usually without notable pseudostolons (sometimes apparent in *A. perennans* s.l.); culms usually erect, sometimes decumbent or stooling; anthers 0.7–1.1 mm long..... **7**

6(5) Culms 50–100 cm tall; panicles 5–10 cm wide; leaf blades with veins expressed and scabers pointed out right and left; flag ligules obtuse, 1–2.2 mm long; caryopsis 1–1.2 mm long; anthers 1–1.3 mm long..... ..... [***A. subrepens* (Hitchc.) Hitchc.**]

– Culms (7–)24–60(–65) cm tall; panicles (0.5–)2–6 cm wide; leaf blades with veins not noticeably expressed (in Colombian material), usually smooth along the veins or lightly scaberulous with scabers in single file (in Colombian material); flag ligules acute to acuminate, (2.8–)3–6.7(–10) mm long; caryopsis 1.5–1.6 mm long; anthers 1–1.2(–2) mm long..... ***A.* cf. *imberbis* Phil.**

7(5) Leaf blades filiform, 0.2–1 mm wide, thin and flaccid; leaves mainly basal at maturity; panicles 4–12 cm × 2–6 cm; culms 10–40 cm tall..... ..... [***A. turrialbae* Mez**]

– Leaf blades flat or conduplicate, (1–)1.5–3.5(–6) mm wide, sometimes involute in the basal leaves, usually thickened at the margins and keel, lax to slightly firm; leaves mainly basal early in the flowering season but tending to become mostly cauline with maturity; panicles often larger, (3.5–)10–22 × 2–11 cm; culms (21–)33–64(–100) cm tall ..... ***A. perennans* (Walter) Tuck. s.l.**

8(2) Lemma muticous, mucronate, or exceptionally with a short straight awn to ca. 1.3 mm long, subapical or inserted above the middle of the lemma, weak and falling easily, straight, not or barely exserted from the glumes **9**

– Lemma with a dorsal awn, (1.6–)2–6 mm long, persistant, twisted and bent, exerted from the glumes..... **12**

9(8) Leaf blades convolute, involute or strongly conduplicate (upper culm leaf blades sometimes flat, to 3 mm wide when opened out, in *A. boyacensis*), usually recurved, rigid, 0.25–1(–1.5) mm wide in diameter as folded or rolled; spikelets 1.5–2.5 mm long..... **10**

– Leaf blades filiform, flat, conduplicate or laxly rolled, straight or flexuous, lax and soft (sometimes involute, recurved and/or rigid in *A. tolucensis*), 1–5 mm wide when opened out; spikelets 2–4.1 mm long..... **11**

10(9) Tillers intravaginal, without cataphylls, not stooling and without notable lateral tending or ascending rhizomes; plants 3–12(–15) cm tall; spikelets 1.5–2.1 mm long (–2.5 mm in Bolivia?); all leaf blades similar, convolute or less often strongly conduplicate, recurved, rigid; widespread in páramos of Colombia ..... ***A. breviculmis* Hitchc.**

– Tillers extravaginal with cataphyllous shoots present, often with notable lateral tending or ascending rhizomes or stooling; plants 3–24 cm tall (plants from Sierra Nevada del Cocuy) or to 37 cm long (plants from elsewhere in Departamento Boyacá); spikelets 1.8–2.4(–2.5) mm long; leaf blades sometimes dimorphic, blades of tillers and lower culms convolute, involute, or sometimes strongly conduplicate, usually recurved or sometimes straight, firm to rigid, upper culm leaf blades sometimes flat, straight and firm; in Colombia, known from Departamento Boyacá, Cordillera Oriental ..... ***A. boyacensis* Swallen & García-Barr.**

11(9) Panicle branches, pedicels and central inflorescence axis usually smooth or exceptionally lightly scaberulous; culms 2–15(–30) cm tall, exceptionally taller; panicles 1–10 cm long, uninterrupted; spikelets 2.2–4.1 mm long; glumes subequal, keels usually scabrous in the distal 1/3, lower glume keel sometimes scabrous throughout or in the upper 2/3, upper glume keel sometimes completely smooth, glume surfaces smooth; lemma 1.7–2.6 mm long ..... [***A. meyenii* Trin.**]

– Panicle branches, pedicels, and sometimes the central inflorescence axis moderately to densely scabrous; culms (3–)5.5–51(–80) cm tall, often > 15 cm tall; panicles (1–)2–15 cm long, often > 10 cm long, interrupted; spikelets 2–3(–3.5) mm long; glumes equal or subequal, keels and often surfaces scabrous at least in the distal half; lemma 1.4–2 mm long ..... ***A. tolucensis* Kunth (= syn. *Agrostis glomerata* (J. Presl) Kunth)**

12(8) Lemma with awn c. 6 mm long; ligules 7–8 mm long ..... ***A. lehmannii* Swallen**

– Lemma with awn (1.6–)2–3.5 mm long; ligules 1–8 mm long **13**

13(12) Leaf blades convolute, recurved, rigid, 0.5–2 mm wide when opened out; plants 3–12 cm tall; tillers intravaginal, plants without cataphyllous shoots or notable lateral tending or ascending rhizomes; ligules c. 1 mm long; glumes with coarse shiny hooks along the keel..... ***A. laegaardii* A.M. Molina & Rúgolo**

– Leaf blades flat or folded, filiform or robust, straight, flexuous, or slightly recurved, lax to coriaceous and firm (sometimes convolute, recurved and rigid in *A. tolucensis* but then the culm blades are flat or folded), 1–6 mm wide when opened out; plants (3–)5.5–51(–80) cm tall; tillers extravaginal and intravaginal, plants usually with cataphyllous shoots and distinct lateral tending or short ascending rhizomes; ligules 2–8 mm long; glumes with minute or short hooks along the keel or smooth **14**

14(13) Leaf blades 2–6 mm wide, flat or folded, sometimes somewhat involute towards their apices, surfaces usually scabrous throughout, subcoriaceous to coriaceous; flag ligules 4–8 mm long; panicle 1–1.7(–2.5) cm wide, with primary lateral branches up to 7 cm long; spikelets 3–4.2 mm long; lemma 1.5–2 mm long, usually c. ½ the length of the glumes, rarely slightly longer ..... ***A. foliata* Hook.f.**

– Leaf blades 1–3(–5) mm wide, filiform, flat or folded, sometimes involute or convolute, scabrous in the margin and veins or smooth, lax to firm but not (sub-)coriaceous; flag ligules 2–4(–6.2) mm long; panicle 0.1–1.5 cm wide, with primary lateral branches 0.5–1.5 cm long; spikelets 2–3(–3.6) mm long; lemma 1.4–2 mm long, ½–2/3(–3/4) the length of the glumes ....***A. tolucensis*** **Kunth**

15(1) Leaf blades involute or convolute; panicles < 5 cm long; floret equalling or subequalling the glumes, usually with a short glabrous, smooth or scabrous rachilla emerging from under the palea (some spikelets within the inflorescence may lack the rachilla prolongation, so needs checking carefully); paleas reaching from (2/3) ¾ the length of the lemma to almost the apex of the lemma; lemmas muticous or with a short straight awn 0.2–0.5 mm long, inserted medially or in the upper half of the lemma, not surpassing the glumes..... **16**

– Leaf blades generally flat (*A. capillaris* often with basal blades involute and culm blades flat); panicles generally > 5 cm long (sometimes to 2 cm long in *A. stolonifera* or 3 cm in *A. capillaris*); floret notably shorter than the glumes, usually 1/3–3/4 the length of the glumes, without a rachilla prolongation; paleas reaching from (2/5–)2/3–3/4 the length of the lemma; lemmas muticous or with an awn of varying length, ranging from a short straight awn, 0.2–1 mm long, to a long geniculate and twisted awn to 4 mm long, inserted basally, medially or in the upper half of the lemma, not surpassing or greatly surpassing the glumes..... **17**

16(15) Panicles contracted and slender, c. 0.5 cm wide, spikelets present from near the base; spikelets 2.2–4.2 mm long; upper glume 3-veined; plants forming small tussocks; anthers 1.5–2.2 mm long..... ..... ***Podagrostis colombiana*** **Sylvester & Soreng**

– Panicles lax and open, 1–2(–3) cm wide, spikelets in the distal 1/3, the lower 2/3 naked; spikelets 1–1.5 mm long; upper glume 1-veined; plants forming short tufts; anthers 0.4–1 mm long..... ..... ***Podagrostis trichodes*** **(Kunth) Sylvester & Soreng**

17(15) Ligules of basal leaves and tillers ≤ 1 mm long, distinctly shorter than wide; ligules of culm leaves 0.5–1.5(–2.9) mm long, shorter to sometimes longer than wide.....***A. capillaris*** **L.**

– Ligules of basal leaves and tillers 1–3 mm long, as long as or distinctly longer than wide; ligules of culm leaves 2–8 mm long, as long as or distinctly longer than wide..... **18**

18(17) Plants erect or decumbent, usually without stolons but always with extensively creeping rhizomes; panicle lax and open after flowering, lateral branches extended at maturity, spikelets absent in the proximal half; palea (0.8–)1.2–1.6 mm long.....***A. gigantea*** **Roth**

– Plants generally creeping, usually extensively stoloniferous, rhizomes usually absent; panicle tightly contracted after flowering, lateral branches held close to the central rachis at maturity, spikelets present in the proximal half; palea 0.7–1.3(–1.6) mm long .....***A. stolonifera*** **L.**

Clave de identificación para las 15 especies de *Agrostis* y dos especies de *Podagrostis* citadas para Colombia

(las especies que no han sido confirmadas por nosotros que ocurran en Colombia se indican entre paréntesis; *Agrostis meyenii*, la cual puede ocurrir en Colombia, pero que hasta ahora no ha sido registrada, es también incluida).

1 Pálea ausente o reducida, 0–1/3(–½) de la longitud de la lema **2**

– Pálea bien desarrollada, que alcanza desde ½ a casi toda la longitud de la lema (rara vez 2/5 de la longitud de la lema en *A. capillaris* y *A. stolonifera*)..... **15**

2(1) Panícula (durante la floración) abierta, laxa, generalmente elipsoide, ovoide, obovoide, a piramidal, no (sub-) espiciforme, con ramificaciones laterales superiores largas y ascendentes o extendidas, pero no próximas al eje central de la inflorescencia, sin espiguillas cerca de la base (NB. Algunas especies pueden presentar las panículas contraídas cuando inmaduras y después de la floración, pero siempre abiertas en la floración) **3**

– Panícula (durante la floración) de moderada a densamente congesta, sub-espiciforme a espiciforme, con ramificaciones laterales superiores cortas y próximas al eje central de la inflorescencia, usualmente con espiguillas presentes desde la base o cerca de la base..... **8**

3(2) Lema aristada, arista (1.8–)2.5–4 mm de largo, flexuosa a geniculada, retorcida, insertada 1/3 en la parte inferior o media de la lema..... **4**

– Lema no aristada o con arista 0.5 mm de largo y recta, no retorcida, insertada 1/3 en la parte media o superior de la lema o subapical..... **5**

4(3) Culmos escabrosos, al menos debajo de los nudos; vainas escabriúsculas; láminas foliares rígidas, escabrosas en la superficie abaxial y adaxial y los márgenes. ..... ***A. scabrifolia*** **Swallen**

– Culmos lisos; vainas lisas; láminas foliares laxas, o menos frecuente semirigidas (cuando involutas), lisas o finamente escabriúsculas a lo largo de la superficie adaxial y/o los márgenes .....***A. mertensii*** **Trin.**

5(3) Láminas foliares convolutas, involutas, o conduplicadas, rígidas, 0.5–1 mm de diámetro cuando enrolladas o dobladas; hierbas estoloníferas provistas de notables pseudo-estolones que aparentan largos rizomas en los especímenes de herbario; culmos ligeramente rastreros o decumbentes en su base, pero erectos hacia su ápice; anteras 1–2 mm de largo **6**

– Láminas foliares filiformes, planas o conduplicadas, laxas, 0.2–6 mm de ancho, o raramente involutas y firmes en las hojas basales de *A. perennans* s.l.; plantas usualmente sin pseudoestolones notables (a veces evidentes en *A. perennans* s.l.); culmos generalmente erectos, a veces decumbentes o estoloníferos; anteras 0.7–1.1 mm de largo **7**

6(5) Culmos 50–100 cm de alto; panículas 5–10 cm de ancho; láminas foliares con costillas conspicuas y espínulas señalando a derecha e izquierda; lígulas bandera (i.e., lígula de la última hoja de la caña florífera) obtusas, 1–2.2 mm

de largo; cariopsis 1–1.2 mm de largo; anteras 1–1.3 mm de largo ....[***A. subrepens*** **(Hitchc.) Hitchc.**]

– Culmos (7–) 24–60 (–65) cm de alto; panículas (0.5–) 2–6 cm de ancho; láminas foliares con venas no expresadas notablemente (en material Colombiano), generalmente lisas a lo largo de las venas o ligeramente escabriúsculas con espínulas dispuestas en un sola fila (en material Colombiano); lígulas bandera agudas a acuminadas, (2.8–)3–6.7(–10) mm de largo; cariopsis 1.5–1.6 mm de largo; anteras 1–1.2 (–2) mm de largo .....***A.* cf. *imberbis*** **Phil.**

7(5) Láminas foliares filiformes, 0.2–1 mm de ancho, delgadas y flácidas, hojas basales maduras; panículas 4–12 × 2–6 cm; culmos 10–40 cm de altura .... [***A. turrialbae*** **Mez**]

– Láminas foliares planas o conduplicadas, (1–)1.5–3.5(–6) mm de ancho, a veces involutas en las hojas basales, generalmente engrosadas en los márgenes y en la quilla, laxas a ligeramente firmes; hojas en su mayoría basales a principios de la floración y que tienden a convertirse en caulinares en la madurez; panículas a menudo más grandes, (3.5–)10–22 × 2–11 cm; culmos hasta (21–)33–64(–100) cm de alto.....***A. perennans*** **(Walter) Tuck. s.l.**

8(2) Lema mútica, mucronada, o excepcionalmente con una arista corta y recta hasta 1.3 mm de largo, subapical o inserta por encima de la mitad de la lema, débil y fácilmente desarticulable, recta, no o escasamente exerta de las glumas.....**9**

– Lema con arista dorsal, (1.6–)2–6 mm de largo, persistente, retorcida y doblada, exerta de las glumas **12**

9(8) Láminas foliares convolutas, involutas, o fuertemente conduplicadas (láminas foliares del culmo superior a veces planas, de 3 mm de ancho cuando abiertas, en *A. boyacensis*), usualmente recurvadas, rígidas, 0.25–1(–1.5) mm de diámetro tanto plegadas como enrolladas; espiguillas 1.5–2.5 mm de largo **10**

– Láminas foliares filiformes, planas, conduplicadas o laxamente enrolladas, rectas o flexibles, laxas y blandas (a veces involutas, recurvadas y/o rígidas en *A. tolucensis*), 1–5 mm de ancho cuando extendidas; espiguillas 2–4.1 mm de largo **11**

10(9) Innovaciones intravaginales, sin catáfilos, no reptante y sin notables rizomas tendidos lateralmente o ascendentes; hierbas 3–12(–15) cm de alto; espiguillas 1.5–2.1 mm de largo (–2.5 mm en especímenes originarios de Bolivia?); todas las láminas foliares son similares, convolutas o con menos frecuencia fuertemente conduplicadas, recurvadas, rígidas; ampliamente distribuidas en los páramos de Colombia.....***A. breviculmis*** **Hitchc.**

– Innovaciones extravaginales, catáfilos con vástagos axilares presentes, a menudo con rizomas laterales inclinados o ascendentes notables, o reptantes; hierbas 3–24 cm de alto (plantas de la Sierra Nevada del Cocuy) o de 37 cm de largo (plantas de otras partes del Departamento de Boyacá); espiguillas 1.8–2.4(–2.5) mm de largo; láminas foliares a veces dimórficos, láminas de las innovaciones y hojas caulinares inferiores convolutas, involutas o a veces fuertemente conduplicadas, generalmente recurvadas o algunas veces rectas, firmes a rígidas; láminas de las hojas caulinares superiores algunas veces planas, rectas

y firmes; nativas en Colombia, presencia confirmada en el Departamento de Boyacá, Cordillera Oriental..... ***A. boyacensis*** **Swallen & García-Barr.**

11(9) Panículas con ramas, pedicelos y eje central de la inflorescencia generalmente lisos o por excepción ligeramente escabriúsculos; culmos 2–15 (–30) cm de alto, excepcionalmente más altos; panículas 1–10 cm de largo, ininterrumpidas; espiguillas 2.2–4.1 mm de largo; glumas subiguales, quillas usualmente escabrosas en el 1/3 distal, a lo largo de la quilla de la gluma inferior generalmente escabrosa o 2/3 de la parte superior, quilla de la gluma superior a veces completamente lisa, superficies de las glumas lisas; lema 1.7–2.6 mm de largo..... **[*A. meyenii* Trin.]**

– Panículas con ramas, pedicelos y, a veces, el eje central de la inflorescencia de moderado a densamente escabroso; culmos (3–)5.5–51(–80) cm de alto, a menudo > 15 cm de alto; panículas (1–)2–15 cm de largo, a menudo > 10 cm de largo, interrumpidas; espiguillas 2–3(–3.5) mm de largo; glumas iguales o subiguales, quillas y a menudo la superficie escabrosas al menos en la mitad distal; lema 1.4–2 mm de largo..... .....***A. tolucensis*** **Kunth (= syn. *Agrostis glomerata* (J. Presl) Kunth)**

12(8) Lema con arista c. 6 mm de largo; lígulas 7–8 mm largo..... .....***A. lehmannii*** **Swallen**

– Lema con arista (1.6–)2–3.5 mm de largo; lígulas 1–8 mm largo..... **13**

13(12) Láminas foliares convolutas, recurvadas, rígidas, de 0.5–2 mm de ancho cuando están abiertas; hierbas 3–12 cm de alto; innovaciones intravaginales, plantas sin catáfilos ni vástagos axilares ni notables rizomas laterales ni ascendentes; lígulas c.1 mm de largo; glumas con espinas gruesas y brillantes a lo largo de la quilla .....***A. laegaardii*** **A.M. Molina & Rúgolo**

– Láminas foliares planas o dobladas, filiformes o robustas, rectas, flexuosas o ligeramente recurvadas, laxas a coriáceas y firmes (generalmente convolutas, recurvadas y rígidas en *A. tolucensis* pero luego las láminas del culmo son planas o plegadas), 1–6 mm de ancho al extenderse; hierbas (3–)5.5–51(–80) cm de alto; innovaciones extravaginales e intravaginales, usualmente catáfilos con vástagos axilares y evidentes rizomas laterales o corto ascendentes; lígulas 2–8 mm de largo; glumas con espinas diminutas o cortas a lo largo de la quilla o lisas **14**

14(13) Láminas foliares 2–6 mm de ancho, planas o a veces algo involutas hacia el ápice, superficies usualmente escabrosas en todo su largo, subcoriáceas a coriáceas; lígulas bandera 4–8 mm de largo; panícula 1–1.7(–2.5) cm de ancho, con ramas primarias laterales de hasta 7 cm de largo; espiguillas 3–4.2 mm de largo; lema 1.5–2 mm de largo, usualmente c. ½ la longitud de las glumas, rara vez un poco más larga .....***A. foliata*** **Hook.f.**

– Láminas foliares 1–3 (–5) mm de ancho, planas o dobladas, a veces involutas o convolutas, escabrosas en el margen y en las venas o lisas, laxas a firmes, pero no (sub-) coriáceas; lígulas bandera 2–4(–6.2) mm de largo; panícula 0.1–1.5 cm de ancho, con ramas primarias laterales 0.5–1.5 cm de largo; espiguillas

2–3(–3.6) mm de largo; lema 1.4–2 mm de largo, c. ½–2/3(–3/4) la longitud de las glumas.....***A. tolucensis*** **Kunth**

15(1) Láminas foliares involutas o convolutas; panículas < 5 cm de largo; antecio que iguala o sub-iguala a las glumas, usualmente con una raquilla corta, glabra, lisa o escabrosa que emerge por debajo de la pálea (algunas espiguillas dentro de la inflorescencia pueden carecer de la prolongación de la raquilla, por ello se necesita revisar cuidadosamente); paleas que alcanzan desde (2/3) ¾ la longitud de la lema a casi el ápice de la lema; lemas múticas o con una arista corta y recta 0.2–0.5 mm de largo, insertada medialmente o en la mitad superior de la lema, sin sobrepasar las glumas **16**

– Láminas foliares generalmente planas (*A. capillaris* a menudo con láminas basales involutas y las láminas caulinares planas); panículas generalmente > 5 cm de largo (algunas veces hasta 2 cm de largo en *A. stolonifera* o 3 cm en *A. capillaris*); antecio notablemente más corto que las glumas, usualmente 1/3–3/4 de la longitud de las glumas, sin una prolongación de la raquilla; paleas que alcanzan desde (2/5–)2/3–3/4 la longitud de la lema; lemas múticas o con una arista de longitud variable, que van desde una arista corta y recta de 0.2–1 mm de largo, a una arista larga, geniculada y retorcida de 4 mm de largo, insertada basalmente, hacia la mitad o en la mitad superior de la lema, sin sobrepasar o superar en gran medida las glumas **17**

16(15) Panículas contraídas y delgadas, c. 0.5 cm de ancho, con espiguillas desde cerca de la base; espiguillas 2.2–4.2 mm de largo; gluma superior 3-nervada; plantas que forman pequeños macollos; anteras 1.5–2.2 mm de largo ....***Podagrostis colombiana*** **Sylvester & Soreng**

– Panículas laxas y abiertas 1–2(–3) cm en ancho, espiculadas en el 1/3 distal, los 2/3 inferiores desnudas; espiguillas 1–1.5 mm de largo; gluma superior 1-nervada; plantas que forman pequeños mechones; anteras 0.4–1 mm de largo ..... ***Podagrostis trichodes*** **(Kunth) Sylvester & Soreng**

17(15) Lígulas de las hojas basales e innovaciones ≤ 1 mm de largo, claramente más cortas que anchas; lígulas de las hojas caulinares 0.5–1.5(–2.9) mm de largo, más cortas hasta a veces más largas que anchas.....***A. capillaris*** **L.**

– Lígulas de las hojas basales e innovaciones 1–3 mm de largo, tan largas o claramente más largas que anchas; lígulas de las hojas caulinares 2–8 mm de largo, tan largas o claramente más largas que anchas **18**

18(17) Plantas erectas o decumbentes, usualmente sin estolones, pero siempre con rizomas extensivamente rastreros; panícula laxa y abierta después de la floración, ramas laterales extendidas en la madurez, espiguillas ausentes en la mitad proximal; pálea (0.8–)1.2–1.6 mm de largo.....***A. gigantea*** **Roth**

– Plantas generalmente rastreras, usualmente extensivamente estoloníferas, rizomas usualmente ausentes; panícula estrechamente contraída después de la floración, ramas laterales próximas al raquis central en la madurez, espiguillas presentes en la mitad proximal; pálea 0.7–1.3(–1.6) mm de largo .....***A. stolonifera*** **L.**

Taxonomic notes for the species of Agrostis and Podagrostis found in páramos of Departamento Boyacá, Colombia

Agrostis L. Sp. Pl. 1: 61. 1753

= *Vilfa* Adans., Fam. Pl. 2: 495. 1763. Type: *Vilfa stolonifera* (L.) P. Beauv. (lectotype, designated by Hitchcock 1920: 127).
= *Trichodium* Michx., Fl. Bor.-Amer. (Michaux) 1: 41. 1803. Type: *Trichodium laxiflorum* Michx. (lectotype, designated by Hitchcock 1920: 127).
Many other heterotypic synonyms.

Type. *Agrostis stolonifera* L. (lectotype, designated by Hitchcock 1920: 125)

Description. Annuals or perennials. Leaves basal or cauline**; ligules** membranous to scarious. **Inflorescence** a panicle, lax and open to contracted and spikelike. **Spikelets** 1-flowered, disarticulating above the glumes, laterally compressed; **glumes** as long as the spikelet, equal or subequal, persisting on the plant after the florets have fallen, usually 1-veined, rarely 3-veined; **floret** usually notably shorter than the glumes or reaching to ¾ the length of the glumes, exceptionally longer; **lemmas** membranaceous or hyaline, generally thinner than the glumes, dorsally rounded, 3- or 5-veined, veins not or distinctly evident; **paleas** often absent or noticeably shorter than the lemma, sometimes reaching to ¾ the length of the lemma, hyaline and slightly to notably thinner than the lemmas, keels usually obscure, rarely distinct, glabrous, usually smooth, rarely scaberulous; **calluses** rounded, glabrous or pubescent and usually with 2 lateral tufts of short hairs; **rachilla** prolongation absent. **Flowers** perfect; **anthers** 3 in number, 0.3–1.8 mm long. **Caryopses** hard (in species from Colombia) or sometimes with liquid endosperm.

Notes. In Colombian páramos, taxa of *Agrostis* can be most easily confused with those of *Calamagrostis* s.l. (i.e., *Cinnagrostis* Griseb., *Deschampsia* P. Beauv., *Paramochloa* P.M. Peterson, Soreng, Romasch. & Barberá, *Peyritschia* E. Fourn.; Peterson et al. 2019; Sylvester et al. 2019a), *Podagrostis*, *Polypogon* Desf., and *Sporobolus* R. Br. The genera previously circumscribed as *Calamagrostis* s.l. (Peterson et al. 2019; Sylvester et al. 2019a) can usually be differentiated by a combination of a prolonged hairy rachilla emerging from the base of the floret, a well-developed palea, a hairy callus, an awn present and inserted dorsally on the lemma, and an upper glume with well-developed lateral veins, although certain species are missing some of these characteristics (see Sylvester et al. 2019a). *Polypogon* is principally differentiated by spikelets that disarticulate below the glumes, with the grain, lemma, palea, glumes and part of the pedicel falling together. The glumes are also often awned in *Polypogon. Sporobolus* is principally differentiated by its ligule in the form of a line of hairs, its well-developed paleas with the same consistency as the lemma, and the lemmas being 1(–3) veined.

Agrostis boyacensis **Swallen & García-Barr., Caldasia 2 (8): 303, fig. A. 1943**
Figs 1, 2

Type. Colombia. Boyacá: Nevado del Cocuy, alto valle de Las Lagunillas, [6.3906N, 72.3542W], 4000–4300 m alt., 12 Sep. 1938, J. Cuatrecasas & H. García-Barriga 1459 (holotype: US (US00131729 [image!]); isotype: COL (COL000006092!), SI (SI000494 [image!] fragm. ex US)).

Description. Perennial herbs, densely tufted, often stooling with perenniating many-branched culms, often with short lateral tending to ascending rhizomes. **Tillers** extravaginal, with cataphyllous shoots present. **Culms** 3–24 cm tall (to 37 cm tall in specimens from Boyacán páramos outside the Sierra Nevada del Cocuy), erect to arched, firm, with 0(–2) nodes exerted at flowering, densely scabrous throughout or scabrous just below the nodes, or rarely smooth (specimens from Boyacán páramos outside the Sierra Nevada del Cocuy). **Leaves** basal and cauline, often mainly basal, glabrous, usually densely scabrous throughout, less often smooth or scaberulous (specimens from Boyacán páramos outside the Sierra Nevada del Cocuy); **ligules** 0.9–2 mm long, membranous or slightly scarious, truncate to triangular and obtuse, moderately to strongly decurrent with the sheath, abaxial surface smooth or scaberulous; **blades** (2–)3–6(–12) cm long, 0.5–1.2(–1.5) mm in diameter as folded or rolled, convolute, involute, or strongly conduplicate, usually recurved or sometimes straight, firm to rigid, those of upper culm sometimes flat, firm, 2–3 mm wide, abaxial surface usually densely scabrous throughout, less often smooth to scaberulous (specimens from Boyacán páramos outside the Sierra Nevada del Cocuy), adaxial surface and margins moderately to densely scabrous, apices blunt or slightly naviculate-acute. **Panicles** (2–)3–6(–8) cm long, c. 0.3–0.7(–0.9) cm wide, moderately to densely congested, sub-spikelike to spikelike, generally not interrupted, subincluded in the basal foliage to greatly exerted, lateral branches with spikelets usually present almost to the base, upper lateral branches short and held close to the central inflorescence axis, central axis and panicle branches moderately to densely scabrous, rarely smooth or scaberulous (specimens from Boyacán páramos outside the Sierra Nevada del Cocuy); **pedicels** 0.8–2.5 mm long, usually shorter than their spikelets, not obviously dilated at their apex, moderately to densely scabrous, sometimes smooth or scaberulous (specimens from Boyacán páramos outside the Sierra Nevada del Cocuy). **Spikelets** 1.8–2.4(–2.5) mm long; **glumes** usually unequal, sometimes subequal, the lower longer than the upper by up to 0.3 mm and usually wider than the upper, 1-veined, lower glume keel scabrous throughout to only in distal 1/3, upper glume scabrous only in the distal 1/3 or sometimes smooth throughout, apices acute; **floret** 3/5–2/3(–3/4) the length of the glumes; **calluses** glabrous or with 2 sparse tufts of very short hairs on the lateral sides; **lemmas** 1–1.5 mm long, glabrous, smooth, 5-veined, apex obtuse to slightly truncate, erose, muticous or exceptionally with a short straight awn inserted in the upper ½ of the lemma, to 0.5 mm long, not sur-

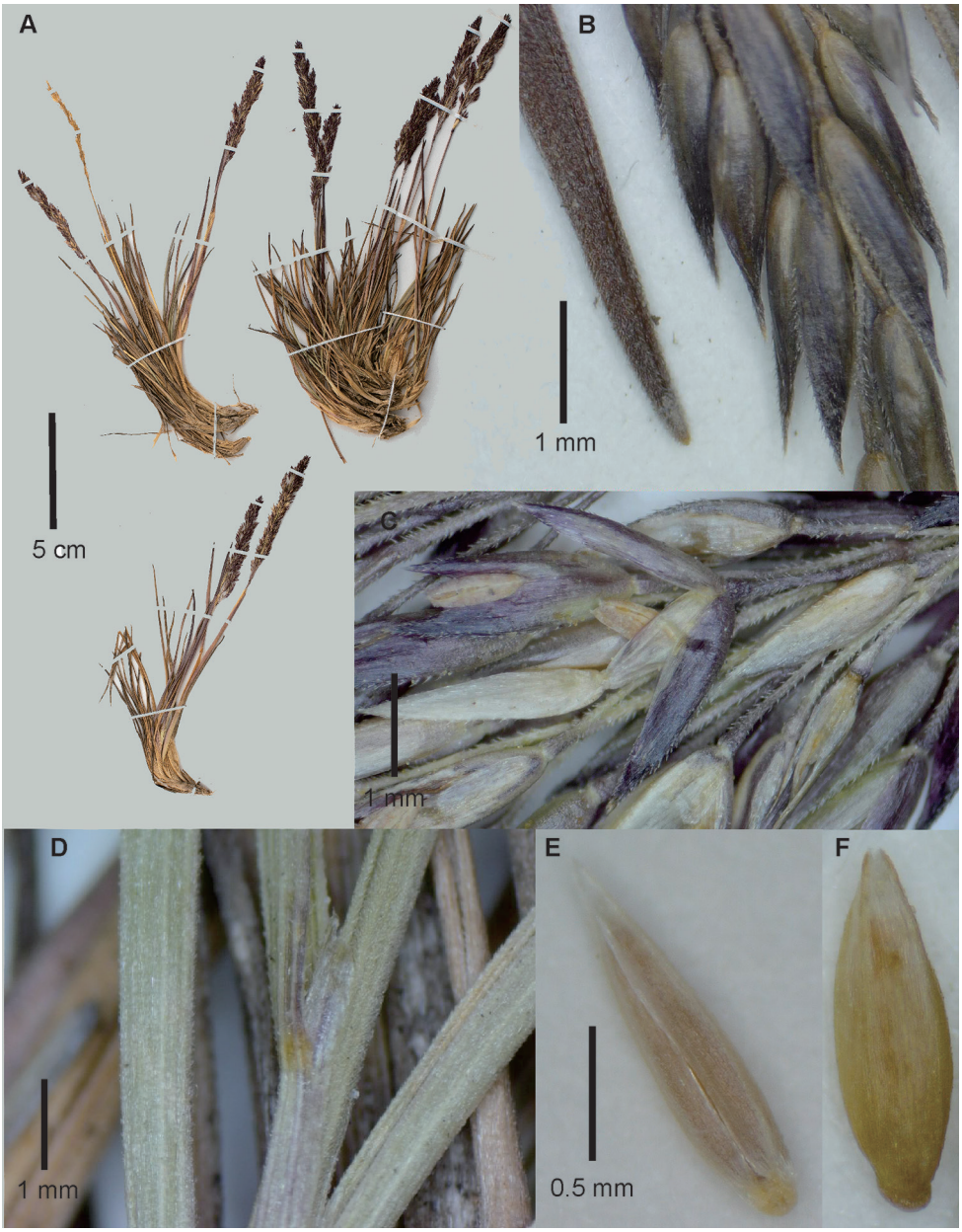

Figure 1. *Agrostis boyacensis*, examples of specimens from páramo or superpáramo of the Sierra Nevada del Cocuy **A** whole plant **B** close-up of inflorescence **C** spikelet at anthesis, lateral view **D** upper culm blades and ligular area **E** floret, ventral view **F** floret, dorsal view. Images **A, C, D, F**: Cleef 8504 (US01247250) courtesy of United States National Herbarium (US); **B, E**: Cleef 5665 (US2785695). Scale bar of **E** also for **F**.

passing the glume apex, weak and falling easily (i.e. Sylvester 3071); **paleas** absent or to 0.3 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** 0.5–0.8(–1) mm long.

Distribution and ecology. Colombia, Ecuador?. Páramos and superpáramos, found in both zonal grass páramo and azonal high elevation moraine, 2850–4500 m alt. Within Colombia, the species seems to be found only in the Cordillera Oriental, with specimens only seen from Departamento Boyacá. Luteyn (1999) mentions the species to be found in Ecuador and the species is also mentioned in the key to some Ecuadorian taxa (Palacio et al. in press), but no specimens have been verified at US.

Other specimens examined. Colombia. Boyacá: Munic. Chiscas, Páramo de Chacaritas, found on a rock escarpment 4 m tall, 6.62227N, 72.39040W, 4192 m alt., 4 Mar. 2018, S.P. Sylvester 3117 (K, UPTC, US); Munic. Chiscas, Páramo de Chacaritas, close to the foot of the talus scree slope, 6.61779N, 72.38899W, 4354 m alt., 4 Mar. 2018, S.P. Sylvester 3129 (COL, FMB, K, US); Sierra Nevada del Cocuy, Laguna Grande, in open gravelly slopes, morranes and similar places at high altitude, [6.5556N, 72.3253W], 4300–4500 m alt., 28 Dec. 1985, J.R.I. Wood 5247 (US3481052); Munic. Duitama, Páramo de la Rusia, Sector del Páramo de Agueros, en la vía que conduce a la vereda Avendaños, páramo dominado por *Chusquea*, evidencia de pastoreo intenso, en alguna perturbación humano / animal, 5.94611N, 73.08481W, 3768 m alt., 3 Oct. 2017, S.P. Sylvester 3017a (COL, K, SI, US); Munic. Arcabuco, Vereda el Carmen, Páramo del Valle, páramo muy húmedo dominado por el grupo *Chusquea*, pastoreo natural, 5.75425N, 73.38303W, 3430 m alt., 15 Nov. 2017, S.P. Sylvester 3071 (K, US, SI). Munic. Chiscas, Páramo de Chacaritas, rocas expuestas en vegetación de páramo, 6.61931N, 72.38898W, 4287 m alt., 4 Mar. 2018, S.P. Sylvester 3124 (K, US, SI). Munic. Mongua, Páramo de Ocetá, valle de Laguna Negra, vegetación de frailejonal pajonal, con presencia de arbustos pequeños, Se observan rastros de pastoreo, 5.69525N, 72.79133W, 3694 m alt., 29 Nov. 2017, L.E. Cuta-Alarcón 353c (US); Planos del Toldadero, [6.3669N, 72.3342W], 3950 m alt., 13 Sep. 1938, J. Cuatrecasas 1554 (US17730370); Sierra Nevada del Cocuy, alrededores de Salto de Correlitos, [6.4444N, 72.3175W], 4400 m alt., 14 Apr. 1959, H.G. Barclay 7394 (US2434358); Sierra Nevada del Cocuy, Alto Ritacuva, [6.5139N, 72.3531W], 4450 m alt., between wet slopes which have dense *Espeletia*, 24 Apr. 1959, H.G. Barclay 7453 (US2434361); Sierra Nevada del Cocuy, alrededores de Salto de Correlitos, rocky, southwest-facing slope, better vegetated between rocky ridges, east of Laguna San Paulino, [6.4444N, 72.3175W], 4300 m alt., 14 Apr. 1959, H.G. Barclay 7381 (US2434355); Sierra Nevada del Cocuy, alto valle de Las Lagunillas, [6.3469N, 72.3261W], 4000–4300 m alt., 12 Sep. 1938, J. Cuatrecasas 1465 (US1772998); Sierra Nevada del Cocuy, Alto Valle Lagunillas, morrena seca pedregosa 100 m al SE de la Laguna Cuadrada, [6.3619N, 72.3344W], 4080 m alt., con *Calamagrostis effusa* [(Kunth) Steud. = *Paramochloa effusa* (Kunth) P.M. Peterson, Soreng, Romasch. & Barberá] y Gymnomitriaceae predominantes, asociadas con *Luzula*, *Espeletia colombiana* [Cuatrec.] y musgos, 26 Nov. 1972, A.M. Cleef 5535 (US2785729); Sierra Nevada del Cocuy, Alto Valle Lagunillas, [6.3906N, 72.3542W], 3995 m alt., con *Espeletia colombiana* predominante, asociada con *Aciachne pulvinata* [Benth.], *Agrostis breviculmis*, *Agrostis trichodes* [*Podagrostis trichodes*] y *Acaena cylindristachya* [Ruiz & Pav.], gramínea común, 25 Sep. 1972, A.M. Cleef 5504 (US2785744); Sierra Nevada del Cocuy, Boqueron de Cusiri, límite superpáramo y

páramo propiamente dicho, vertiente seco muy pedregoso, [6.3431N, 72.3128W], 4320 m alt., con *Calamagrostis effusa* [=*Paramochloa effusa*] y *Espeletia cleefii* [Cuatrec.], gramínea común, 5 Mar. 1973, A.M. Cleef 8796 (US2785680); Sierra Nevada del Cocuy, Laguna Grande de la Sierra, [6.5556N, 72.3253W], 4300–4500 m alt., 28 Dec. 1985, J.R.I. Wood 5247 (US3481052); Sierra Nevada del Cocuy, Páramo Cóncavo, Cuchilla Puentepiedra casi 2km al NE de la Laguna Pintada, vertiente pedregoso seco, [6.3723N, 72.3175W], 4510 m alt., con *Calamagrostis effusa* [=*Paramochloa effusa*], *Poa* sp., asociadas con *Espeletia lopezii* fma. [Cuatrec.], y musgos, 30 Sep. 1972, A.M. Cleef 5665 (US2785695); Sierra Nevada del Cocuy, Páramo Cóncavo, morrena seca en el límite páramo propiamente dicho y superpáramo, 3.5 km al NNW del Morro Pulpito del Diablo, [6.3995N, 72.3123W], 4325m alt., matorral de *Senecio vaccinioides* [Cuatrec.] con *Alchemilla* sp., 1 Mar. 1973, A.M. Cleef 8680 (US2785780); Sierra Nevada del Cocuy, Páramo Cóncavo, superpáramo, morrena seca 3 km aprox. al Norte del morro Pulpito del Diablo. [6.3995N, 72.3123W], 4375m alt., rastrojo de *Senecio guicanensis* [Cuatrec.], gramínea común, 28 Feb. 1973, A.M. Cleef 8627 (US2785676); Sierra Nevada del Cocuy, Páramo Cóncavo, superpáramo 3.5 km aprox. al NNW del morro Pulpito del Diablo, morrena seca muy pedegrosa, [6.3995N, 72.3122W], 4315 m alt., con *Luzula* y *Pernettya prostrata* var. *prostrata* [(Cav.) DC.], gramínea común, 26 Feb. 1973, A.M. Cleef 8504 (US01247250); Sierra Nevada del Cocuy, Páramo Cóncavo, superpáramo abrigo rocoso denominado Cueva de los Hombres, 3 km aprox. al N del morro Pulpito del Diablo, [6.3995N, 72.3122W], 4350 m alt., 28 Feb. 1973, A.M. Cleef 8608 (US2785679); Sierra Nevada del Cocuy, Quebrada Bocatoma, vertiente N del valle, 800 m al ENE [East North-East] de la Laguna Pintada, [6.4795N, 72.3167W], 4060 m alt., *Stephaniella* sp. predominante asociada con *Calamagrostis effusa* [=*Paramochloa effusa*], *Alchemilla polylepis* [Wedd.], *Achyrocline lehmanii* [Hieron.] y *Polytrichum* sp., 29 Sep. 1972, A.M. Cleef 5648 (US2785702).

Notes. Specimens encountered from páramos not belonging to the Sierra Nevada del Cocuy, but within Departamento Boyacá, bear notable differences from those from the type locality and further study is needed to elucidate whether these are a distinct species or subspecies of *A. boyacensis*. These differences include leaf sheaths and blades, panicle branches, and pedicels being usually smooth or very lightly scaberulous, and plants being larger, usually > 20 cm tall and up to 37 cm tall, and with the panicles largely exerted from the basal foliage (Fig. 2). These characteristics place it close to *A. meyenii*, which is not known from Colombia (Giraldo-Cañas et al. 2016) or páramos in general (Luteyn 1999), although it is mentioned in the recently-published abbreviated key to some Ecuadorian species (Palacio et al. in press) (see below for how to differentiate these species).

The habit of type specimens and some of the other specimens examined (e.g. Sylvester 3117 and 3129), with perenniating, many-branched culms, appears to be related to the habitat, with the Sylvester 3117 and 3129 specimens being found growing amongst moss. The leaf blades of these were also slightly laxer, albeit still involute or strongly conduplicate. In harsher conditions, such as open gravelly slopes, the tufts are

Figure 2. *Agrostis boyacensis*, example of a specimen encountered in páramos of Boyacá outside of the Sierra Nevada del Cocuy **A** whole plant **B** spikelet, glumes lateral view and floret ventral view showing anthers **C** spikelet, glumes lateral view with floret detached and raised above the glumes showing ventral surface. Images of Sylvester 3017a (FMB).

more compact and leaf blades are rigid and strongly rolled and resemble a very large, densely-tufted *A. breviculmis* with slightly laxer panicles.

Similar species. *Agrostis breviculmis* and *A. meyenii* both have congested spikelike panicles and florets that lack prominent awns and well-developed paleas. *Agrostis breviculmis* bears close similarity in its convolute, often recurved, rigid to firm leaf blades that usually measure < 1 mm wide in diameter, and small spikelets with fairly well developed coarse scabers on the glume keels. *Agrostis boyacensis* can be distinguished from *A. breviculmis* principally by the habit, with many extravaginally branched culms that form large dense tufts to 37 cm tall (vs. intravaginal innovations forming short tufts to

12(–15) cm tall in *A. breviculmis*), laxer panicles, 3–9 mm wide (vs. c. 0.5–2 mm wide in *A. breviculmis*), and slightly larger spikelets, 1.8–2.4(–2.5) mm long (vs. usually 1.5–2.1 mm long in *A. breviculmis*, noted to reach 2.5 mm long in Bolivia [Renvoize 1998]).

Agrostis boyacensis can be distinguished from *A. meyenii* principally by its robust convolute, involute or strongly conduplicate, usually recurved and rigid leaf blades (vs. laxer, weaker, flat or folded, usually filiform leaf blades in *A. meyenii*). All specimens encountered from the Sierra Nevada del Cocuy can be easily differentiated by their panicle branches, pedicels, and leaf sheaths and blades that are moderately to densely scabrous (vs. panicle branches and pedicels smooth to lightly scaberulous, leaf sheaths smooth, blades smooth or scabrous in *A. meyenii*). Specimens collected in other páramos from Departamento Boyacá, outside of the Sierra Nevada del Cocuy, bear further similarities with *A. meyenii*, such as their culms and inflorescences being longer and greatly exerted from the basal foliage, and panicle branches, pedicels, and leaf blades that are usually smooth to lightly scaberulous (Fig. 2). Nevertheless, these can be differentiated from *A. meyenii* by a) their robust convolute, involute or strongly conduplicate, rigid and usually recurved leaf blades; b) the glumes usually being unequal, with the lower glume longer and usually wider than the upper; and c) the lower glume keel scabrous throughout to only in distal 1/3, the upper glume keel scabrous only in the distal 1/3 or sometimes smooth throughout.

Agrostis tolucensis has a congested spikelike panicle and florets with a minute palea and a lemma that can sometimes lack awns (see notes under *A. tolucensis*). This species usually has leaf blades filiform, flat, or folded, lax to firm, but can sometimes have basal leaf blades involute or convolute and firm to rigid. All specimens examined at US with involute or convolute and rigid leaf blades had lemmas with a well-developed dorsally inserted awn. Further distinction from *A. boyacensis* can be found in how the leaf blades are smooth or scabrous only on the margin and sometimes veins in *A. tolucensis*, while scabrous throughout (margin, veins, and in-between veins) in *A. boyacensis* from the Sierra Nevada del Cocuy, although *A. boyacensis* specimens from other Boyacan páramos have blades smooth to scaberulous.

The sometimes strongly conduplicate leaf blades of this species can also give it a resemblance to *A. foliata*, which has subcoriaceous to coriaceous leaf blades that can sometimes be folded, although these are usually > 1.5 mm wide when opened out, and lemmas with well-developed awns inserted in the lower 1/2 of the lemma.

Agrostis breviculmis **Hitchc., U.S.D.A. Bur. Pl. Industr. Bull. 68: 36, pl. 18. 1905**
Fig. 3

Trichodium nanum J. Presl, Reliq. Haenk. 1 (4–5): 243. 1830.
Agrostis nana (J. Presl) Kunth, Enum. Pl. [Kunth] 1 (1): 226. 1833.

Type. Peru. Hab. in Peruvia, T. Haenke s.n. [#192 in W0014114 isotype] (holotype: PR; isotypes: BR (BR0000006864774 [image!]), MO (MO2104691 [image!];

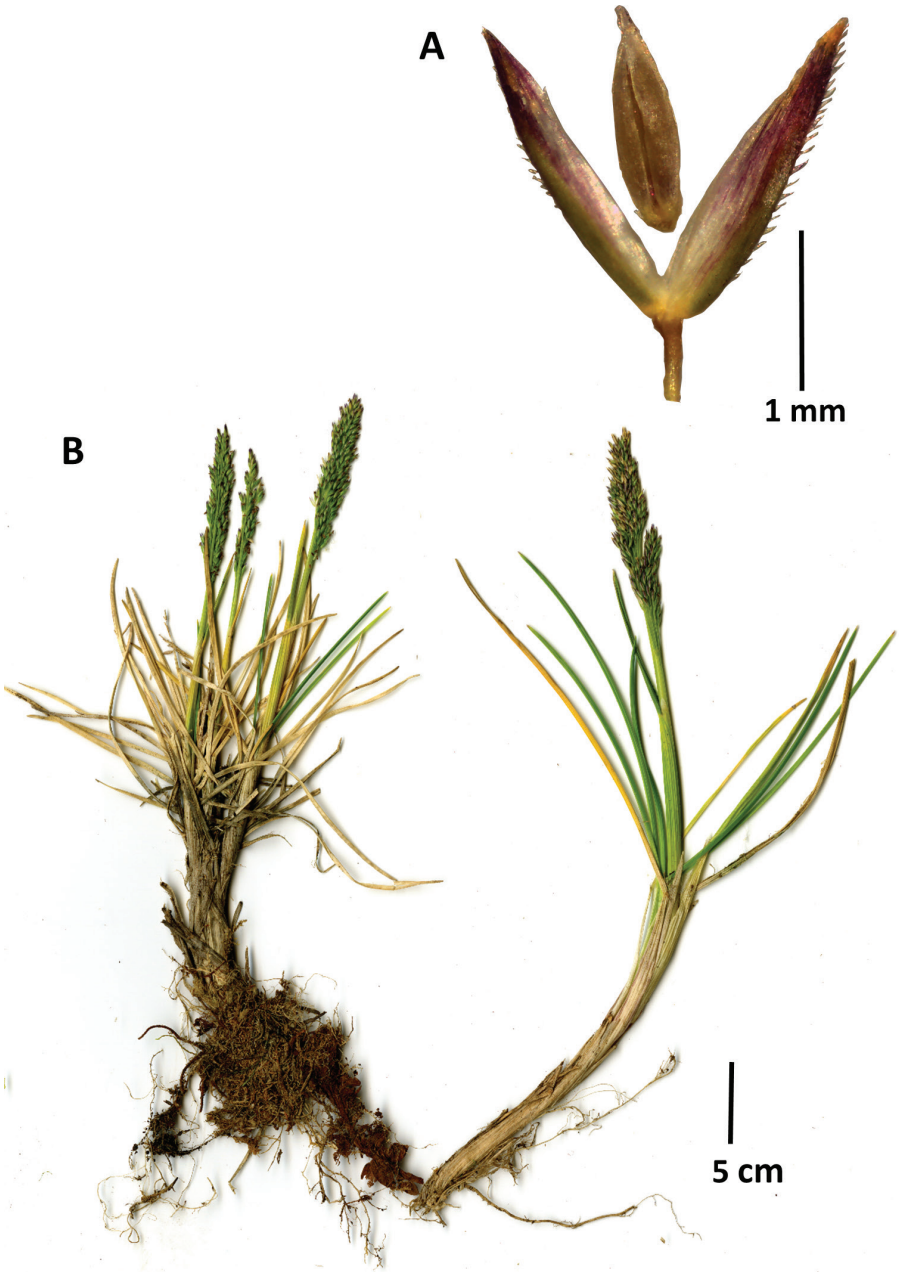

Figure 3. *Agrostis breviculmis* **A** spikelet, glumes in lateral view, floret in ventral view, detached and raised above the glumes **B** whole plant. Images of Cuta-Alarcon 364 (FMB).

MO2104692 [illustration]; MO2114552 [image!]), LE-TRIN (LE-TRIN1627.01 fragm. & fig.), W (W0014113 [image!]; W0014114 [image!])).

Description. Perennial herbs, densely tufted, not stooling and without notable lateral tending or ascending rhizomes. **Tillers** intravaginal, without cataphylls. **Culms**

3–12(–15) cm tall, erect to arched, firm, usually with 0 nodes exerted at flowering. **Leaves** basal, glabrous, smooth or scaberulous; **ligules** c. 1 mm long, membranous or slightly scarious, triangular and obtuse, moderately to strongly decurrent with the sheath, abaxial surface smooth or scaberulous; **blades** 1–4(–6) cm long, 0.25–1 mm wide in diameter as folded or rolled, usually convolute, less often strongly conduplicate, recurved, rigid, abaxial surface usually smooth throughout, rarely scaberulous towards the apex, adaxial surface and margins generally scaberulous, sometimes moderately scabrous, apices blunt to slightly broadly naviculate-acute. **Panicles** 1–2.6(–3) cm long, c. 0.05–0.2(–0.6) cm wide, densely congested, spikelike, generally uninterrupted, subincluded in the basal foliage to slightly or moderately exerted, lateral branches with spikelets almost to the base, upper lateral branches short and held close to the central inflorescence axis, central axis and panicle branches scabrous or smooth; **pedicels** 0.9–2 mm long, usually shorter than their spikelets, not obviously dilated at their apex, smooth or scaberulous. **Spikelets** 1.5–2.1 mm long (–2.5 mm long in Bolivia?; Renvoize 1998); **glumes** equal or subequal, lower glume sometimes longer than upper by up to 0.2 mm and slightly to notably wider, 1-veined, lower glume keel scabrous at least in the distal half, prickle hairs coarse and shiny, upper glume keel like that of lower glume or with fewer scabers to sometimes smooth throughout, apices acute; **floret** 2/3–3/4 the length of the glumes; **calluses** pilose, usually with 2 lateral tufts of short hairs; **lemmas** 1.2–1.4 mm long, glabrous, smooth, 5-veined, apex truncate, erose and 4-mucronate, muticous or with a short straight awn to 0.9 mm long, inserted above the middle, not or only briefly surpassing the glume apex, weak and falling easily; **paleas** absent or to 0.3 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** 0.5–0.9 mm long.

Distribution and ecology. Amply distributed in the high Andes, from Colombia and Venezuela to Chile and Argentina. Predominantly found in open, grazed páramo and puna vegetation, 3200–4500 m alt.

Other specimens examined. Colombia. Boyacá: Munic. Chiscas, Vereda Rechiniga, Páramo de la Mesa, páramo perturbado, dominado por *Espeletia* y gramíneas exóticas, con presencia de ganadera caprina, 6.59291N, 72.44541W, 3694 m alt., 3 Mar. 2018, S.P. Sylvester 3096 (FMB, US); Munic. Duitama, Páramo de la Rusia, vía que conduce a vereda de Avendanos, 5.9324667N, 73.0798W, 3726 m alt., 4 Oct. 2017, S.P. Sylvester 3024 (FMB, K, UPTC, US); Munic. Duitama, Páramo La Rusia, Guanenta Alto Río Fonce National Park, top of the ridge Peña Negra just below military base, ridge along the top of a steep rocky landscape, open páramo with *Espeletia cachaluensis* [Rodríguez-Cabeza], edges of the road, 5.58389N, 73.053263W, 3970 m alt., 21 Nov. 2017, M. Vorontsova 2217 (FMB, K, US); Munic. Mongua, Páramo de Ocetá, Valle de Laguna Negra, pajonal frailejonal, terreno inclinado en medio de valle, 5.7066389N, 72.8036111W, 3699 m alt., 29 Nov. 2017; L.E. Cuta-Alarcón 364 (FMB, K, US).

Similar species. *Agrostis boyacensis* and *A. meyenii* also have congested spikelike panicles and florets with a small palea and which lack awns. See notes under *A. boyacensis* for how to differentiate these taxa. *Agrostis meyenii* can be principally differentiated by its larger spikelets, 2.2–4.1 mm long, and softer, lax, filiform to flat or folded leaf

blades. *Agrostis laegaardii* A.M. Molina & Rúgolo, a recently described species found in Ecuador and the Páramo del Ruiz of the Cordillera Central of Colombia (Palacio et al. in press), also bears very close resemblance. These similarities include: a) plants 3–12 cm tall; b) tillers intravaginal, without notable lateral tending or ascending rhizomes; c) leaf blades convolute, recurved, rigid, 0.5–2 mm wide when opened out, apices blunt or slightly naviculate-acute; d) ligules c. 1 mm long; and e) glumes with coarse shiny prickle hairs along the keel. *Agrostis breviculmis* can be differentiated from *A. laegaardii* by a) often larger spikelets, (1.7–)2–3.3 mm long (vs. 1.5–2.1(–2.5) mm long in *A. breviculmis*); b) pedicels slightly widened towards the apex and cupuliform (vs. pedicel apex not dilated, truncate, in *A. breviculmis*); c) glumes membranous, standard V-shaped in cross section (vs. chartaceous, narrow V-shaped in cross section in *A. breviculmis*); d) lower glume narrowly ellipsoid (vs. navicular in *A. breviculmis*); e) upper glume scabrous in upper 2/3–3/4 (vs. scabrous in upper ½ in *A. breviculmis*); f) distance between upper glume and floret (0.5–)0.7–1 mm (vs. 0.3–0.5 mm in *A. breviculmis*); g) lemma (1.6–)1.7–2 mm long, lateral veins terminating in 4 aristulas (vs. 1.2–1.4 mm long, lateral veins terminating in 4 mucrons in *A. breviculmis*); h) lemmas with well-developed geniculate awns (1.6–)2.3–3 mm long, inserted in the middle or upper third of the lemma, exerted from the glumes, persistant (vs. awnless or with a short straight awn to 0.9 mm long, inserted above the middle, not or only briefly surpassing the lemma apex, weak and falling easily, in *A. breviculmis*); and i) palea 0.4–0.5 mm long (vs. 0.2–0.3 mm long in *A. breviculmis*).

***Agrostis capillaris* L., Sp. Pl. 1: 62. 1753**
Fig. 4

Agrostis polymorpha var. *capillaris* (L.) Huds., Fl. Angl. 1: 31. 1778.
Trichodium capillaris (L.) Roth, Nov. Pl. Sp. 41. 1821.
= *Agrostis tenuis* Sibth., Fl. Oxon. 36. 1794. *Agrostis capillaris* Huds., Fl. Angl.: 27. 1762, hom. illeg., non L., 1753. Type: England (not located).
Many other heterotypic synonyms.

Type. [Habitat in Europae pratis], Herb. A. van Royen s.n. (lectotype, designated by Widén 1971: 65: L (L0052645 left-hand specimen [image!]); isolectotype: L).

Description. Perennial herbs, loosely to densely tufted with short to extensive rhizomes and sometimes with well-developed stolons. **Tillers** extravaginal, with cataphylls present. **Culms** 10–80 cm tall, erect or decumbent at their base, delicate, usually with 2–5 nodes exerted at flowering, smooth or scaberulous. **Leaves** basal and cauline, glabrous, smooth or scaberulous; **ligules** 0.2–1.5(–2.9) mm long, of basal leaves and tillers ≤ 1 mm long, distinctly shorter than wide, of culm leaves 0.5–1.5(–2.9) mm long, membranous, rounded to truncate, not or only slightly decurrent with the sheath, abaxial surface scaberulous to sometimes smooth; **blades** 1–17 cm long, (0.6–)1–5 mm wide as opened out, basal blades and those of tillers often involute and

Figure 4. *Agrostis capillaris* **A** spikelet, lateral view, with floret detached and raised above the glumes **B** Whole plant. Images of Sylvester 3021 (FMB).

0.3–0.8 mm wide as rolled, sometimes flat, culm blades generally flat or becoming convolute upon drying, less often involute, usually soft and lax, rarely firm, abaxial and adaxial surfaces and margins smooth or scaberulous. **Panicles** 3–20 cm long, 2.5–8 cm wide, usually open, sometimes partially closed after flowering, lax, usually ovoid to

pyramidal, subincluded in the basal foliage to greatly exerted, lateral branches without spikelets in the lower ½, long, ascending or spreading but not held close to the central inflorescence axis, central axis and panicle branches scabrous or smooth; **pedicels** 1–2 mm long, usually shorter than their spikelets, dilated or not at their apex, smooth or scaberulous. **Spikelets** (not including awn, if present) (1.8–)2–2.5(–2.7) mm long; **glumes** subequal, the lower slightly longer than the upper, 1-veined, lower glume keel usually scabrous in the distal half, sometimes scabrous throughout, upper glume keel often smooth throughout, infrequently scabrous in the distal half, apices acute; **floret** 2/3–3/4 the length of the glumes; **calluses** glabrous or with 2 sparse lateral tufts of short hairs; **lemmas** 1.4–2.2 mm long, 3- or 5-veined, glabrous or sometimes pubescent at the base when 5-veined, smooth, apex obtuse or truncate, erose, muticous or with an awn 0.5–3 mm long, inserted above the middle of the dorsal keel, exerted from the glumes or not, straight, flexuose or geniculate, twisted or not, weak and easily falling, usually found only on the 5-veined lemmas; **paleas** 0.6–1.3 mm long, (2/5–)½–¾ the length of the lemma; **rachilla** absent; **anthers** 0.8–1.4 mm long.

Distribution and ecology. Eurasian, introduced to the north of South America. Predominantly found in grazed páramo and puna vegetation. *Agrostis capillaris* is here recorded as a new regional record for the Depto. Boyacá of Colombia. Giraldo-Cañas et al. (2016) mention it as an introduced and cultivated herb based on the record of *A. tenuis* by Hafliger and Scholz (1981). It is likely to be an under-recorded element in many Colombian regions with páramo habitat.

Other specimen examined. Colombia. Boyacá: Munic. Duitama, Páramo de la Rusia, vía que conduce a vereda de Avendaños, 5.9324667N, 73.0798W, 3726 m alt., 4 Oct. 2017, S.P. Sylvester 3021 (COL, FMB, K, SI, UPTC, US).

Notes. A highly variable species comprising a set of ecologically and genetically distinct populations that are difficult to pull apart taxonomically. The species can hybridize with *A. gigantea* (*A.* × *bjoerkmannii* Widen), *A. stolonifera* (*A.* × *murbeckii* Fouill. ex P.Fourn.), *A. vinealis* Schreb. (*A.* × *sanionis* Asch. & Graebn.), etc., with hybrids exhibiting intermediate characteristics and all being sterile (Cope and Gray 2009). *Agrostis capillaris* is often planted in the Neotropics as part of a lawn mix with other species, or for livestock feed.

Similar species. *Agrostis castellana* Boiss. & Reut., which has not been recorded for Colombia but is found introduced and naturalized further south in Argentina and Chile (Rúgolo de Agrasar 2012). The only certain characters for distinguishing *A. castellana* from *A. capillaris* are that, in *A. castellana*, the terminal spikelets of the inflorescence branches have a distinctly pubescent upper dorsal surface of the lemma, at least towards the margins, while they are usually glabrous or pubescent only at the base in *A. capillaris*. The panicles are also contracted, lanceolate to narrowly oblong after flowering in *A. castellana*, while being open with spreading branches after flowering in *A. capillaris*. Other characters, such as awn presence, are too variable to be useful in separating these species. Furthermore, these species can also hybridize to produce *A.* × *foilladei* P. Fourn., which has been reported from seed mixtures for amenity grassland in the UK (Cope and Gray 2009). *Agrostis gigantea*, another closely related species which can usually be readily distinguished by its greater size and relatively longer ligules, does

have some smaller variants with thinner leaves that superficially resemble *A. capillaris*, but the ligule will always settle the identity.

Agrostis foliata Hook. f., Bot. Antarct. Voy. I. (Fl. Antarct.). 1: 95. 1845
Fig. 5

= *Agrostis nigritella* Pilg., Bot. Jahrb. Syst. 25 (5): 713–714. 1898. Type: Ecuador. Chimborazo: in páramos montis Antisana ad Cerro de la Media Luna, 4400 m alt., no date, M.A. Stuebel 231 (holotype: [not found]; isotype: US (US75324 fragm.)).

= *Agrostis stuebelii* Pilg., Bot. Jahrb. Syst. 25 (5): 714. 1898. Type: Colombia. Tolima: in monte ignivomo Tolima fere ad nivis limitem adscendens, no date, Stuebel 198 (lectotype, designated here: US ex B (US00902474!); isolectotype: US ex B (US00902473!)). Syntype: Colombia. In monte ignivomo Purace copiose, ubi usque adcineris conum reperiteur, no date, Stuebel 298 (SI ex US (SI000509 [image!], US ex B (US75325)).

Type. Colombia [Ecuador]. Crescit in cacumine monte Pichincha [On Pichincha at the limits of perpetual snow], 15676 ft [4778 m alt. based on protologue; 15000 ft written on isotypes], no date [21 Jan. 1856 on GH isotype], W. Jameson 229 (holotype: K; isotypes: GH (GH00221375 [image!]), P (P00740550 [image!]), US (US843246 fragm. ex K)).

Description. Perennial herbs, tussock-forming or laxly to densely tufted, usually with short ascending rhizomes. **Tillers** extravaginal and intravaginal, with cataphylls usually present. **Culms** 15–30 cm tall, erect, rigid and thickened, with 0 nodes exerted at flowering, smooth or scaberulous. **Leaves** usually more-or-less evenly spread along the culm, sometimes congested basally, glabrous, usually densely scabrous; **ligules** 3–8 mm long, of upper culm 4–8 mm long, usually scarious (at least in part), triangular and obtuse to acute, moderately to strongly decurrent with the sheath, abaxial surface scaberulous to scabrous; **blades** 3–12 cm long, 2–6 mm wide when opened out, flat or folded, sometimes somewhat involute towards their apices, straight or slightly recurved, subcoriaceous to coriaceous, surfaces and margins usually densely scabrous throughout, apices naviculate-acute. **Panicles** 5–12.7 cm long × 1–1.7(–2.5) cm wide, densely congested, spikelike, sometimes interrupted towards the base, usually exerted from the basal foliage or sometimes subincluded, lateral branches with spikelets usually present almost to the base, upper lateral branches short and held close to the central inflorescence axis, central axis and panicle branches moderately to densely scabrous; **pedicels** 0.7–4 mm long, usually shorter than their spikelets, not obviously dilated at their apex, scabrous. **Spikelets** (not including awn) 3–4.2 mm long; **glumes** equal or subequal, 1-veined, keels smooth or lightly scabrous, surfaces smooth, apices acuminate; **floret** usually c. ½ the length of the glumes, rarely slightly longer; **calluses** pilose with 2 sparse tufts of short hairs on the lateral sides; **lemmas** 1.5–2 mm long, glabrous, smooth, 5-veined, apex truncate, denticulate, awned, awn 2–2.8 mm long, inserted in the lower ½ of the dorsal keel, exerted from the glumes, geniculate, twisted, persistant;

Figure 5. *Agrostis foliata* **A** whole plant **B** flag ligule and portion of inflorescence. Image **A** Sylvester 3151 (FMB) **B** Grubb 306 (US2304908).

paleas absent or 0.1–0.2 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** (0.5–)0.6–0.8(–1) mm long.

Distribution and ecology. Colombia, Venezuela, Ecuador, Peru. High-elevation superpáramo and subnival vegetation in the puna grasslands of Peru. In Boyacá, found in superpáramos, > 4300 m alt.

Other specimens examined. Colombia. **Boyacá**: Munic. Chiscas, Páramo de Chacaritas, arribando a la morrena, 6.61779N, 72.38899W, 4354 m alt., 4 Mar. 2018, S.P. Sylvester 3130 (FMB, K, US); Munic. Chiscas, Páramo el Penon, Chiscas,

6.63012N, 72.40073W, 4172 m alt., vegetación de pajonal frailejonal, páramo húmedo, 3 Mar. 2018, S.P. Sylvester 3151 (FMB, K, US); Sierra Nevada del Cocuy, 4600 m alt., tufted grass in loose soil, 6 Aug. 1957, P.J. Grubb 306 (US2304908; US2433280); Sierra Nevada del Cocuy, alto valle de Las Lagunillas, [6.3469N, 72.33W], 4000–4300 m alt., 12 Sept. 1938, J. Cuatrecasas 1466 (US2780332); 1467 (US1772999); 1474 (US1773004; US2855551); Sierra Nevada del Cocuy, Páramo Cóncavo, Superpáramo, abrigo rocoso, denominado Cueva de los Hombres, 3 km aprox. al N del morro Pulpito del Diablo, [6.3995N, 72.3122W], 4350 m alt., gramínea cerca del abrigo, asociada con *Senecio guicanensis*, 28 Feb. 1973, A.M. Cleef 8609 (US2785677); Sierra Nevada del Cocuy, Quebrada Bocatoma, superpáramo 2 km al E de la Laguna Pintada, [6.4795N, 72.3167W], 4280 m alt., playa arenosa húmeda con gramíneas, *Ditrichum* sp. y algas terrestres, gramínea muy común, 5 Oct. 1972, A.M. Cleef 5862 (US3207543); Sierra Nevada del Cocuy, Quebrada Bocatoma, superpáramo, [6.4795N, 72.3167W], 4310 m alt., playa arenosa húmeda con gramíneas y cianófitos terrestres de la lagunita central, gramínea común, 04 Oct. 1972, A.M. Cleef 5792 (US2797551); **Caldas**: Nevado del Ruiz, superpáramo, vallecitos poco húmedos, Arenales 1 km al SW del Refugio cerca del empalme de la carretera, [4.8956N, 75.3508W], 4680 m alt., 18 Mar. 1972, A.M. Cleef 2398 (US2785739).

Notes. Two syntypes of *A. stuebelii* were noted in Pilger's protologue of *Agrostis stuebelii*. We lectotypify the name on the best material at US that includes one flowering and one non-flowering plant, with the bases of the plants well preserved. We were unable to locate the two duplicates of the lectotype at B, from which the US material was taken.

Similar species. See notes under *A. boyacensis*. *Agrostis tolucensis* can sometimes have leaf blades wider than usual (up to 5 mm wide when opened out), but can usually be differentiated by a) the flag ligules being shorter, 2–4(–6.2) mm long (vs. 4–8 mm long in *A. foliata*); b) the spikelets often being shorter, 2–3(–3.6) mm long (vs. 3–4.2 mm long in *A. foliata*); c) florets usually over half the length of the glumes (vs. usually c. ½ the length of the glumes, rarely slightly longer in *A. foliata*); and d) primary panicle branches often shorter, 0.5–1.5 cm long, (vs. up to 7 cm long in *A. foliata*), among other characteristics.

Agrostis cf. *imberbis* Phil. Anales Univ. Chile 94: 11. 1896

Fig. 6

= *Agrostis stenophylla* Phil., Anales Univ. Chile 94: 10. 1896. Type: Chile. Bío-Bío: Baños de Chillán, Jan. 1878, Philippi s.n. ["146" in Herb. R. A. Phillippi s.d.; "No. 18 (II)" on SGO000000043 isotype] (holotype: SGO-PHIL (SGO-PHIL146); isotypes: BAA (BAA00000030 [image!]), BM (BM000938541 [image!]), SGO (SGO000000043 [image!], SGO000000061 [image!], SGO000000062 [image!]), US (US00156498! fragm. ex SGO-PHIL146), W (W19160040646 [image!])).

= *Agrostis scotantha* Phil., Anales Univ. Chile 94: 16. 1896. Type: Chile. Araucanía: La Cueva, Jan. 1887, C. Rahmer s.n. ["183" in Herb. R. A. Phillippi s.d.] (holotype: SGO-PHIL (SGO-PHIL183); isotypes: BAA (BAA00000728 [image!] fragm. ex SGO-PHIL183, BAA00000729 [image!] fragm. ex B), SGO (SGO000000055 [image!], SGO000000056 [image!]), US (US00156493! fragm. ex SGO-PHIL183), W (W19160040640 [image!])).

= *Agrostis moyanoi* Speg. var. *plicatifolia* Speg., Anales Mus. Nac. Buenos Aires 7: 189. 1902. Type: Argentina. Chubut: Corcovado, Oct. 1901, N. Illin 2550 (holotype: LP (LP001364 [image!]; isotypes: BAA (BAA00000023 [image!])).

Type. Chile. Ñuble: Valle de las Nieblas, Chillán, Jan. 1877, sin col. s.n. ["185" in Herb. R. A. Phillippi s.d.] (holotype: SGO-PHIL (SGO-PHIL185); isotypes: BAA (BAA00001345 [image!]), BM (BM000938537 [image!]), SGO (SGO000000042 [image!], SGO000000044 [image!], US (US00156439! fragm. ex SGO-PHIL-185), W (W19160040633 [image!])).

Description. Perennial herbs, laxly to densely tufted, sometimes stooling, with laterally tending or ascending pseudostolons, or rhizomatous with rhizomes ascending or vertical. **Tillers** intravaginal and extravaginal, with cataphylls usually present. **Culms** (7–)24–60(–65) cm tall, usually decumbent at their base or slightly creeping and rooting from the nodes, rarely completely erect, firm, with (0–)1–2 nodes exerted at flowering, smooth or scaberulous. **Leaves** usually mostly basal in first seasons growth, becoming mostly cauline as plant ages, glabrous, usually scaberulous with undeveloped scabers throughout, sometimes notably scabrous throughout; **ligules** 2.5–6.7(–10) mm long, of upper culm (2.8–)3–6.7(–10) mm long, usually scarious (at least in part), acute to acuminate, sometimes fimbriate, strongly decurrent with the sheath, abaxial surface scabrous; **blades** 2.8–9(–11) cm long, 0.5–1 mm wide in diameter as rolled or folded, convolute, involute, or conduplicate, rigid, abaxial surface smooth to scaberulous, adaxial surface lightly scabrous on the veins, apices usually naviculate-acute. **Panicles** (3–)6–12.5(–20) cm long, (0.5–)2–6 cm wide, open to slightly contracted when young, usually ovoid, slightly to greatly exerted from the basal foliage, lateral branches without spikelets near their base and for a long distance, long and ascending or spreading to becoming divaricate at maturity but not held close to the central inflorescence axis, central axis and panicle branches scaberulous; **pedicels** (0.9–)1.5–3.5 mm long, often slightly longer than their spikelets or sometimes shorter, dilated or not at their apex, scaberulous. **Spikelets** (2.3–)2.5–2.7(–3.5) mm long; **glumes** equal or subequal, similar or lower glume slightly wider and longer than the upper, 1-veined, keels usually scabrous in the distal ½–¾, upper glume sometimes completely smooth, apices acute to acuminate; **floret** usually 3/4 the length of the glumes or slightly longer; **calluses** glabrescent, with very sparse short hairs; **lemmas** 1.6–1.8(–2.5) mm long, glabrous, lightly scaberulous throughout or just in distal 1/2, sometimes with just undeveloped scabers as pustulate bases, 5-veined, apex obtuse or truncate, denticulate, muticous, mucronate, or sometimes with a short straight awn to 0.5 mm long, inserted in the middle or upper 1/3 of the lemma and not surpassing the glumes, weak and falling

Figure 6. *Agrostis* cf. *imberbis* **A** whole plant **B** flag ligule and portion of inflorescence **C** floret, lateral view **D** portion of inflorescence with close-up of spikelets. Images of Cleef 6821 (US2785719), courtesy of United States National Herbarium (US).

easily; **paleas** usually c. 0.2 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** 1–1.2(–2) mm long.

Distribution and ecology. *Agrostis* cf. *imberbis* is a new record for Colombia and páramo vegetation in general, and is not found in the most recent checklist for Colombia (Giraldo-Cañas et al. 2016), the páramo checklist (Luteyn 1999) or checklists for Ecuador (Jørgensen and Ulloa-Ulloa 1994; Jørgensen and León-Yánez 1999), Venezuela (Hokche et al. 2008; Bono 2010), or Costa Rica (Morales-Quirós 2003) which host páramo vegetation. The species was previously considered to be restricted to Ar-

gentina and Chile (Rúgolo de Agrasar 2012), but has also been recorded for Bolivia (Jørgensen et al. 2014) and Peru (Davidse et al. 1993; Soreng et al. 2003 and onwards; W3TROPICOS-Peru Checklist 2020; Óscar Tovar unpubl. data).

Additional specimens examined. Colombia. Boyacá: Munic. Belén, Páramo de La Rusia, near Páramo El Consuelo, unprotected private land, somewhat disturbed páramo grazed by horses and rodents, dominated by *Espeletia boyacensis* [Cuatrec.], 6.02146N, 72.5718W, 3832 m alt., 22 Nov. 2017, M. Vorontsova 2228 (US); Munic. Chiscas, Páramo el Penon, Chiscas, borde de bosque de *Polylepis*, 6.59582N, 72.44284W, 3771 m alt., 5 Mar. 2018, S.P. Sylvester 3159 (K, SI, US); Munic. Chiscas, Páramo de Chacaritas, pajonal frailejonal, cercano al cerro de Chacaritas, con fuerte grado de inclinacion, 6.63108N, 72.39815W, 4082 m alt., 5 Mar. 2018, S.P. Sylvester 3144 (FMB, K, SI, UPTC, US); Munic. Duitama, Páramo de La Rusia, NW-N de Duitama, [5.9281N, 73.0936W], 3600 m alt., aislada, vertiente seca con *Calamagrostis effusa* [*Paramochloa effusa*] predominante, asociada con *Espeletia boyacensis* y *Acaena cylindristachya*, gramínea muy abundante, 7 Dec. 1972, A.M. Cleef 6821 (US2785719); Munic. Duitama, Páramo de La Rusia, vía que conduce a vereda de Avendanos, páramo semi-perturbado, pastado por cabras y quemado regularmente hasta hace 1 año, 5.95011N, 73.09097W, 3795 m alt., 1 Oct. 2017, S.P. Sylvester 3014 (COL, FMB, K, SI, US); 5.9324667N, 73.0798W, 3726 m alt., 4 Oct. 2017, S.P. Sylvester 3029 (FMB, US); S.P. Sylvester 3031 (K, US); [Munic. El Cocuy and Soatá,] between Soatá and Cocuy, Páramo del Alto del Escobal, [6.3514N, 72.5483W], 3750 m alt., 8 Oct 1938, J. Cuatrecasas 1232 (US1772922).

Notes. Specimens studied from Boyacá match most characteristics of *A. imberbis* apart from sometimes the leaf blade abaxial surfaces being scaberulous, albeit with silica 'pustules' present throughout that sometimes developed into short hooks, and spikelets sometimes being shorter, to 2.3 mm long. Rúgolo de Agrasar (2012) mentions leaf blades can be smooth in *A. imberbis* under exceptional circumstances. Characters that are diagnostic for the species, such as narrow, rolled (convolute or involute) or conduplicate, rigid blades, long acuminate scarious ligules, usually large spikelets > 2.5 mm long, and glabrescent calluses, were all present on the specimens studied from Boyacá. Given its disjunct distribution and slight differences in morphology, coupled with knowledge that other widespread species such as *A. perennans* are actually numerous evolutionarily distinct taxa (Konstantin Romaschenko pers. communication), we refer to this species with 'cf.' to highlight that it needs to be checked in a molecular framework.

The species has a variable level of panicle congestion depending on the stage of maturity.

Similar species. *Agrostis subrepens*, a species described from Mexico and whose presence in Colombia is uncertain (see notes on *A. subrepens* under 'Excluded species' at the end of the taxonomic treatment), and *A.* cf. *imberbis* share similar morphologies. This includes the habit being decumbent and stooling, appearing rhizomatous or pseudostoloniferous, blades being convolute and rigid, and panicles usually large and open with spikelets that have a similar shape and size with lemmas lacking notable awns, ligules being strongly decurrent with the sheath and usually scarious (at least in part), and

anthers > 1 mm long. While culm and panicle size are generally larger and anthers are often shorter in *A. subrepens*, some overlap occurs with *A. imberbis*, with ligule shape and size seeming to be the only solid character to differentiate them. *Agrostis subrepens* has shorter (< 2.2 mm long), obtuse upper culm ligules while *A.* cf. *imberbis* has acute to acuminate upper culm ligules (2.8–)3–6.7(–10) mm long.

Agrostis perennans s.l. can sometimes have involute and rigid basal blades, but the upper culm blades are flat and lax, unlike those of *A.* cf. *imberbis*, which are rigid and convolute, involute, or strongly conduplicate throughout. The ligules in *A. perennans* s.l. are also usually shorter, with ligules of basal leaves and tillers 0.5–2.5 mm long, while those of *A.* cf. *imberbis* are > 2.5 mm long. Ligule apices of *A. perennans* s.l. are also truncate or obtuse-triangular, unlike the acute or long acuminate ligules of *A.* cf. *imberbis*.

Agrostis vinealis Schreb., a species not recorded for Colombia, but found introduced and naturalized in Argentina and Chile (Soreng and Peterson 2003; Rúgolo de Agrasar 2012), bears similarities in terms of overall habit, being notably rhizomatous and having mainly basal leaves and an exerted open panicle that becomes congested after flowering, as well as other similarities such as the palea being reduced and awns sometimes absent (but usually with a persistent, geniculate and twisted, awn to 4 mm long, inserted near the base of the lemma). *Agrostis vinealis* usually has leaf blades that are flat towards the base, although sometimes these are involute and setaceous, and scabrous throughout or at least on the adaxial surface. It can also be differentiated by the ligules being often shorter, of the tillers 1–2.5 mm long, of the upper culms 1–4(–5) mm long, with apices rounded or bluntly pointed (vs. of the tillers > 2.5 mm long, of the upper culms (2.8–)3–6.7(–10) mm long, with apices acute to acuminate in *A.* cf. *imberbis*).

Agrostis mertensii **Trin., Linnaea 10 (3): 302. 1836**
Fig. 7

Agrostis laxiflora var. *mertensii* (Trin.) Griseb., Fl. Ross. 4 (13): 442. 1852.
Agrostis canina var. *mertensii* (Trin.) Kuntze, Revis. Gen. Pl. 3[3]: 338. 1898.
= *Agrostis boliviana* Mez, Repert. Spec. Nov. Regni Veg. 18 (1–3): 1. 1922. Type: Bolivia. Pinos bei Tarija, 3000 m alt., 22 Jan. 1904, K.A.G. Fiebrig 2821 (lectotype, designated by Rúgolo de Agrasar (2012: 115): BAA (BAA00000014 [image!]); isolectotypes: BAA (BAA00000211 [image!] fragm. ex K), G (G00099216 [image!]), K (K000308377 [image!]), L (L0819974 [image!]; L0819973 [image!]); syntypes: Bolivia. Calderillo, 3000 m alt., Mar. 1904, K.A.G. Fiebrig 2905, BAA (BAA00000013 [image!]; BAA00000210 [image!]), E (E00373832 [image!]), G (G00099217 [image!]), GH (GH00221373 [image!]; GH00221374 [image!]), K (K000308376 [image!]), S (S05-10054 [image!])).
= *Agrostis gelida* Trin., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt. Sci. Nat. 6 (2, Bot.): 343. 1841. Type: Peru. Andibus de Pasco, [ad nives aeternas], E.F. Poeppig s.n. (holotype: LE-TRIN (LE-TRIN1613.01); isotype: US (US75321 fragm.)).
Many other heterotypic synonyms.

Type. USA. Alaska, 1829, D. Mertens s.n. (lectotype, designated by Widen (1971: 52): LE-TRIN (LE-TRIN1622.01, plant 1); isolectotypes: BAA (BAA00001355 [image!] fragm. ex LE-TRIN), S (S-G-263 [image!] fragm. ex LE-TRIN)).

Description. Perennial herbs, tufted, sometimes with short lateral tending rhizomes present or stooling with pseudostolons present. **Tillers** extravaginal, with cataphylls present. **Culms** 20–65 cm tall, erect, ascendant, or geniculate at the base, delicate and slender, with 0–2(–3) nodes exerted at flowering, smooth. **Leaves** mostly cauline but with basal leaves present, glabrous, smooth throughout or finely scaberulous on the blade adaxial surface and margins; **ligules** (0.6–)2–6 mm long, membranous or scarious, obtuse to acuminate, not or slightly to moderately decurrent with the sheath, abaxial surface smooth or scaberulous; **blades** 10–13 cm long, 1–3 mm wide when opened out, usually flat, soft and lax, less often involute and semi-rigid, tiller blades tending to be more involute and thin, semi-rigid, smooth throughout or finely scaberulous on the adaxial surface and/or margins, apices acute to acuminate. **Panicles** 5–15 cm long, c. 4–16 cm wide, open when flowering and mature, congested when immature, lax, ovoid to pyramidal, slightly to usually greatly exerted from the basal foliage, lateral branches without spikelets in the lower ½, long, ascending, spreading, to somewhat divergent and not held close to the central inflorescence axis at flowering or maturity, adpressed when young, central axis and panicle branches scabrous or smooth; **pedicels** 1–6(–15) mm long, sometimes shorter to usually much longer than their spikelets, not or slightly dilated at their apex, smooth or scaberulous. **Spikelets** (not including awn) (2.2–)2.5–3(–4) mm long; **glumes** unequal, the lower slightly longer than the upper by up to c. 0.5 mm, 1-veined, keels smooth to scabrous throughout or more commonly scabrous in the upper half, apices acute; **floret** usually 2/3–3/4 the length of the glumes; **calluses** lightly pilose with 2 sparse lateral tufts of short hairs; **lemmas** 1.7–2 mm long, glabrous, smooth, 5-veined, apex obtuse to acute, 2-dentate, 2–4 mucronate, awned, awn (1.8–)2.5–4.5 mm long, inserted dorsally in the middle or lower third, exerted from the glumes, flexuose to geniculate, twisted, persistant; **paleas** absent or 0.2–0.5 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** 0.5–1 mm long.

Distribution and ecology. Exhibits a disjunct distribution, being found in very cold Arctic and sub-Arctic areas of the Northern Hemisphere (i.e. North America, Europe and Asia), and also in the high Andes of Venezuela, Colombia, Peru, Bolivia, Argentina and Chile (Soreng et al. 2003 and onwards; Rúgolo de Agrasar 2012). It has most likely been introduced and naturalized in South America.

Other specimens examined. Colombia. Boyacá: Munic. Arcabuco, Páramo El Valle, Vereda el Carmen, páramo muy húmedo dominado por *Chusquea*, pastoreo natural, 5.75425N, 73.3830278W, 3430 m alt., 15 Nov. 2017, S.P. Sylvester 3067b (COL, FMB, K, US); Munic. Duitama, Páramo de Agueros, vía que conduce a vereda de Avendanos, 5.91464N, 73.07114W, 3445 m alt., 28 Oct. 2017, S.P. Sylvester 3047 (FMB, K, US); Munic. Duitama, Páramo de Agueros, semi disturbed páramo in Agueros reserve above ridge- along path running through reserve, 5.91653N, 73.07164W, 3445 m alt., 29 Oct. 2017, S.P. Sylvester 3052 (FMB, K, UPTC, US); Munic. Duitama, Páramo de La Rusia, Guanenta Alto Río Fonce National Park, top of the ridge Peña Negra just below military base, ridge along the top of a steep rocky landscape,

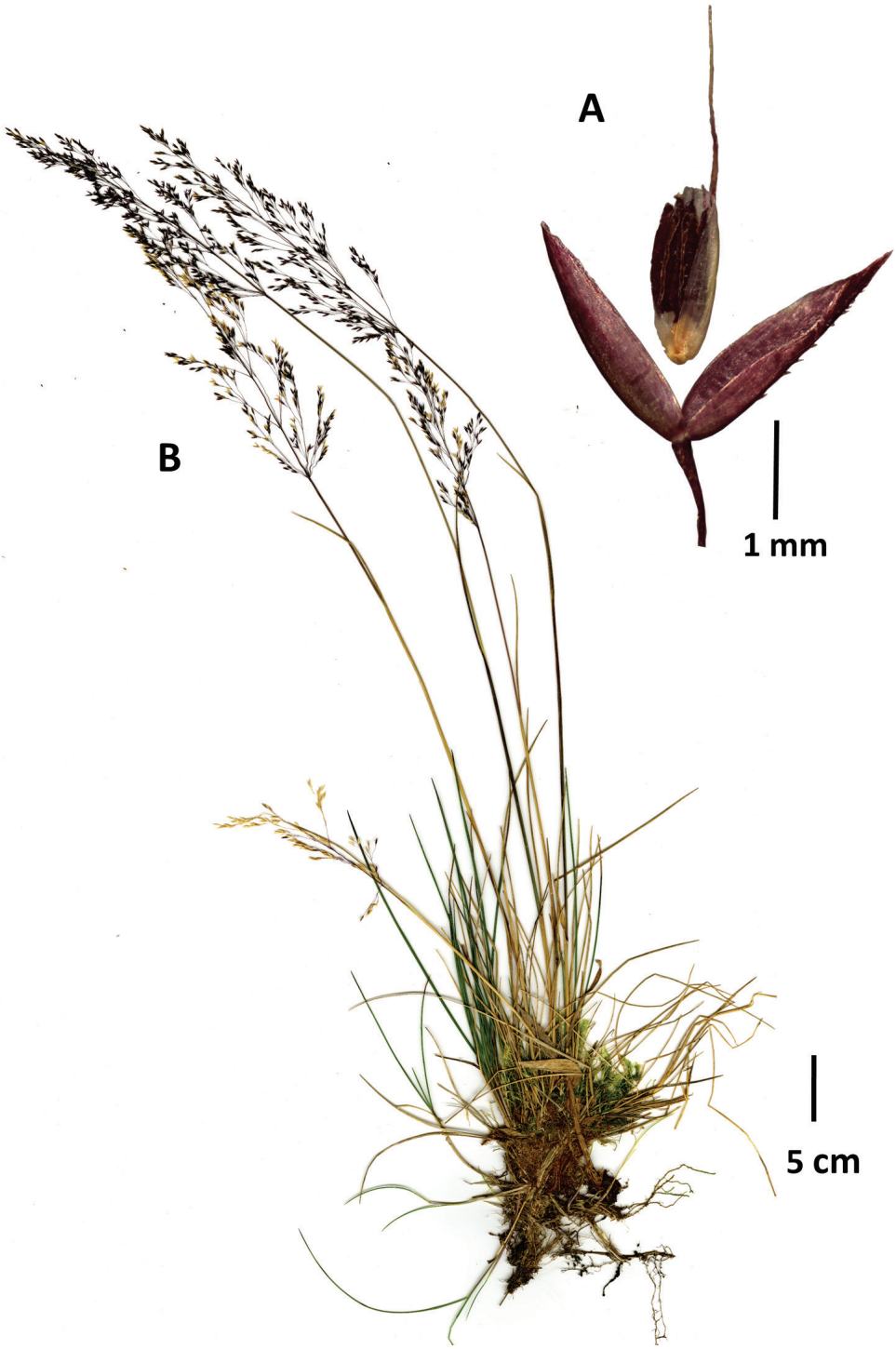

Figure 7. *Agrostis mertensii* **A** spikelet, lateral view, with floret detached and raised above the glumes **B** whole plant. Images of Cuta-Alarcon 365 (FMB).

open páramo with *Espeletia cachaluensis*, no signs of grazing, 5.58389N, 73.053263W, 3970 m alt., 21 Nov. 2017, M. Vorontsova 2198 (FMB, K, US); Munic. Duitama, Páramo de La Rusia, Fina Betania, vereda El Carmen on other side of river, 5.95333N, 73.10864W, 3445 m alt., 30 Oct. 2017, S.P. Sylvester 3060 (FMB, K, US); Munic. Duitama, Páramo de La Rusia, vía que conduce a Vereda de Avendanos, páramo semiperturbado, pastado por cabras y quemado regularmente hasta hace 1 año, 5.95011N, 73.09097W, 3795 m alt., 1 Oct. 2017, S.P. Sylvester 3004 (COL, FMB, K, US); Munic. Duitama, valley between Guantiva and La Rusia, between Susacon and Onsaga, 2 km towards Onzaga, 6.10091N, 72.48263W, 3292 m alt., 24 Nov. 2017, M. Vorontsova 2304a (FMB, K, US); Munic. Mongua, Páramo de Ocetá, Valle de Laguna Negra, pajonal frailejonal, terreno inclinado en medio del valle, 5.70664N, 72.80361W, 3699 m alt., 29 Nov. 2017, L.E. Cuta-Alarcón 365 (FMB, K, UPTC, US); Munic. Mongui, Páramo de Ocetá, Sector La Pedrisca, Vereda Vallado, potrero con 20 años de abandono dominado por *Senecio* y *Espeletia boyacensis*, y gramíneas exóticas, 5.69969N, 72.80892W, 3751 m alt., 30 Nov. 2017, L.E. Cuta-Alarcón 377 (FMB, K, SI, US); Munic. Sotaquira, protected area of Páramo El Valle, day 2 East ridge walk, somewhat disturbed patch of open páramo between patches of *Chusquea tessellata* [Munro], dominated by *Espeletia boyacensis*, limited natural grazing, 5.44436N, 73.22089W, 3717 m alt., 16 Nov. 2017, M. Vorontsova 2155 (FMB, K, US).

Notes. This species is highly variable in terms of its habit, the form of its leaf blades (flat or involute) and ligule (short and obtuse to long and acuminate), and the form of the panicle (panicle branches adpressed and congested when young while open when mature). The combination of open panicle (when mature), lemma with a dorsally inserted awn, and a minute or absent palea are diagnostic for this species.

Similar species. *Agrostis perennans* s.l., which can be principally differentiated by the absence of an awn, or if awn present, this being inserted in the upper half of the dorsal surface of the lemma or subapically and to 0.5 mm long. *Agrostis pittieri* Hack., considered endemic to Costa Rica by Pohl (1980) and Morales-Quirós (2003), also bears close similarity to *A. mertensii* and may be placed as a synonym of the latter in future research. Hokche et al. (2008) and Dorr (2014) record *A. pittieri* for Venezuela, with Dorr (2014) stating *A. pittieri* can be tentatively differentiated by having linear and narrow panicles with green spikelets and lemmas 1.9–2 mm long, while *A. mertensii* has broadly ovate to lanceolate panicles with purple spikelets and lemmas 2–2.5 mm long. However, these characters' overlap in specimens studied from throughout the range of *A. mertensii*.

***Agrostis perennans* (Walter) Tuck. s.l., Amer. J. Sci. Arts 45: 44. 1843**
Fig. 8

Cornucopiae perennans Walter, Fl. Carol. [Walter] 74. 1788.
Agrostis cornucopiae Sm., Gentleman's Mag. 59 (2): 873. 1789, nom. illeg. superfl., also Smith in Frasier, Short Hist. 2,pl. Nov. 25. 1789.

Agrostis cornucopiae Lam., Tabl. Encycl. 161. 1791, nom. illeg. superfl.
Agrostis elegans (Walter) Salisb., Prodr. Stirp. Chap. Allerton 25. 1796, nom. illeg. superfl.
Agrostis anomala Willd., Sp. Pl. 1: 370. 1797, nom. illeg. superfl.
Trichodium decumbens (Walter) Michx., Fl. Bor.-Amer. (Michaux) 1: 42. 1803, nom. illeg. superfl.
Trichodium perennans (Walter) Elliott, Sketch Bot. S. Carolina [Elliott] 1: 99. 1816.
Agrostis scabra var. *perennans* (Walter) Alph. Wood, Class-book Bot. (ed. 1861) 774. 1861.
= *Agrostis fasciculata* (Kunth) Roem. & Schult., Syst. Veg., ed. 15 bis [Roemer & Schultes] 2: 362. 1817. *Vilfa fasciculata* Kunth, Nov. Gen. Sp. [H.B.K.] 1: 139. 1816. Type: Ecuador. Pichincha, May, F.W.H.A. von Humboldt & A.J.A. Bonpland s.n. (holotype: P (P00669402 [image!]; isotypes: HAL (HAL0106915 [image!]), LE-TRIN (LE-TRIN1610.01 fragm. ex P), P (P00740549 [image!]; P00740548 [image!]), US (US556249 fragm. ex P)).
= *Agrostis humboldtiana* Steud., Nomencl. Bot. [Steudel], ed. 2. i. 40. 1840. *Agrostis pulchella* Kunth, Enum. Pl. 1: 223. 1833, hom. illeg., non Roth, 1817, nom. superfl. *Agrostis elegans* (Kunth) Roem. & Schult., Syst. Veg., ed. 15 bis [Roemer & Schultes] 2: 362. 1817, hom. illeg., non. Salisb. 1796. *Vilfa elegans* Kunth, Nov. Gen. Sp. [H.B.K.] 1: 139. 1816. Type: Ecuador. [Crescit in planitie Cochapamba, in regione temperata regni Quitensis, alt. 1340 hexap. Floret Majo] Herbier de Amerique equatoriale, A.J.A. Bonpland & F.W.H.A. von Humboldt 3010 (holotype: P (P00669401 [image!]); isotypes: BAA (BAA-Col. typus 4256), BM (BM000938529 [image!]; BM000938530 [image!]), LE-TRIN (LE-TRIN1644.01 ex hrbr. Humb.), P (P00740586 [image!]; P00740588 [image!]; P00740587 [image!])).
= *Agrostis weberbaueri* Mez, Repert. Spec. Nov. Regni Veg. 18 (1–3): 1. 1922. Type: PERU. Huacapistana and Monson, Weberbauer s.n. (holotype: [not found]; isotypes: [not found]).
Many other heterotypic synonyms.

Type. USA. South Carolina: Richmond County, Fort Jackson Military Reservation, found at the intersection of Cut Off Rd. and Fire Break 49, 11 July 1995, K.B. Kelly, Jr. & J.B. Nelson 254 (neotype, designated by Ward (2007: 1099): GH (GH00247994 [image!])).

Description. Perennial herbs, laxly to densely tufted, sometimes stooling or with short ascending pseudostolons that have the appearance of rhizomes on herbarium sheets. **Tillers** extravaginal, with cataphylls present. **Culms** (21–)33–64(–100) cm tall, erect or decumbent to subgeniculate at their base, delicate to fairly firm, with 0–2(–3) nodes exerted at flowering, smooth to rarely scaberulous. **Leaves** mainly basal early in the flowering season but tending to become mostly cauline with maturity, glabrous, smooth or scaberulous; **ligules** 0.5–5(–7) mm long, of basal leaves and tillers 0.5–2.5 mm long, of upper culm 3–5(–7) mm long, truncate to obtuse-triangular, slightly to strongly decurrent with the sheath, abaxial surface scabrous to scaberulous, rarely

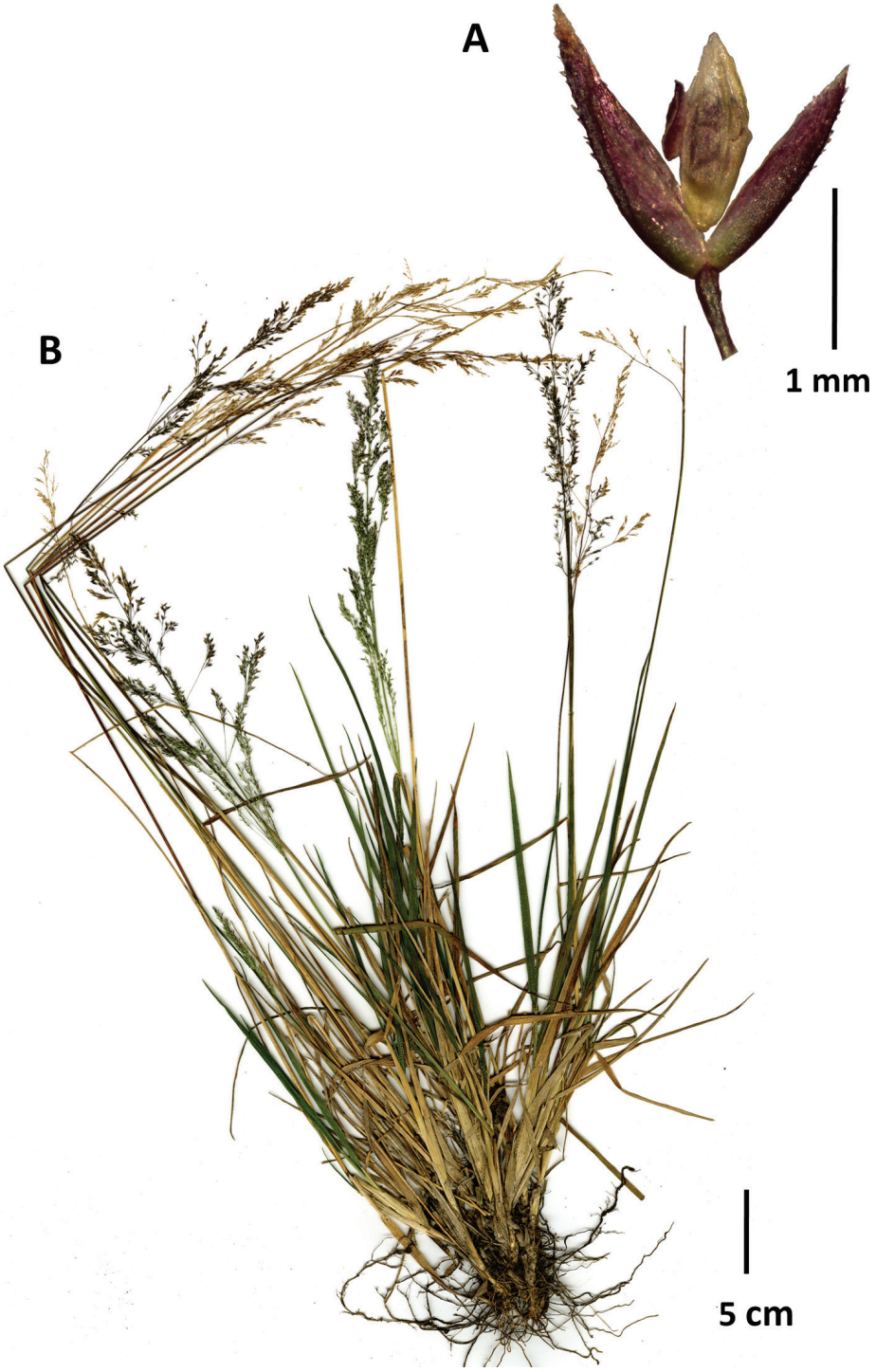

Figure 8. *Agrostis perennans* s.l. **A** spikelet, glumes in lateral view, with floret in dorsal view, detached and raised slightly above the glumes **B** whole plant. Images of Vorontsova 2247 (FMB).

smooth; **blades** (3–)6–15 cm long, (1–)1.5–3.5(–5) mm wide, usually flat or conduplicate and lax to slightly firm, sometimes involute and rigid in the basal leaves, smooth throughout or scaberulous on margins and sometimes surfaces, apices acute. **Panicles** (3.5–)10–22 cm long, 2–11 cm wide, open, lax, ovoid to pyramidal, slightly to usually greatly exerted from the basal foliage, lateral branches without spikelets near their base and for a large distance, long, ascending, spreading, to somewhat divergent and not held close to the central inflorescence axis, central axis and panicle branches smooth or lightly scaberulous; **pedicels** 1–4.5 mm long, usually longer than their spikelets, not or slightly dilated at their apex, smooth or lightly scaberulous. **Spikelets** (not including awn, if present) (1.5–)1.8–2.5(–3.2) mm long; **glumes** subequal, 1-veined, keels scabrous in the distal ½–1/3, apices acute; **floret** usually 1/2–2/3 the length of the glumes, rarely longer; **calluses** lightly pilose with 2 sparse lateral tufts of short hairs; **lemmas** 1.5–2 mm long, glabrous, smooth, 5-veined, apex acute to more-or-less truncate, denticulate, muticous, mucronate or exceptionally with a short awn to 0.5 mm long (to 1.4–1.9 mm long in Argentina; Rúgolo de Agrasar 2012), inserted in the upper (½) 1/3 of the dorsal keel, usually not or rarely only slightly surpassing the glumes, straight, not twisted, weak and falling easily; **paleas** absent or to 0.5 mm long, usually < ¼ the length of the lemma; **rachilla** absent; **anthers** 0.7–1 mm long.

Distribution and ecology. Stretching from Alaska, Canada and USA, through Central America and the Caribbean, to Argentina and Chile of South America. The species has an exceptionally large ecological amplitude, being found in maritime dunes, wetlands, and grasslands from sea level to > 4000 m alt.

Other specimens examined. Colombia. **Boyacá**: Munic. Belén, Páramo de La Rusia, near Páramo El Consuelo, unprotected private land, somewhat disturbed páramo grazed by horses and rodents, with *Espeletia boyacensis* and *E. discoides*, near path, 6.02415N, 72.57289W, 3831, 22 Nov. 2017, M. Vorontsova 2247 (FMB, K, SI, UPTC, US); Munic. Duitama, Páramo de Agueros. junto a la casa, muy perturbado, pastizales junto a la plantación de pinos, 8.91069N, 73.07219W, 3377 m alt., 28 Oct. 2017, S.P. Sylvester 3039 (FMB, K, SI, UPTC, US); Munic. Duitama, Páramo de La Rusia, Guanenta Alto Río Fonce National Park, top of the ridge Peña Negra just below military base, ridge along the top of a steep rocky landscape, 5.58389N, 73.053263W, 3970 m alt., open Páramo with *Espeletia cachaluensis*, no signs of grazing, 21 Nov. 2017, M. Vorontsova 2203 (US); Munic. Duitama, Páramo de la Rusia, Vereda El Carmen, 5.95333N, 73.11019W, 3445 m alt., 30 Oct. 2017, S.P. Sylvester 3064 (FMB, K, SI, US); Munic. Duitama, Páramo de la Rusia, vía que conduce a vereda de Avendaños, 5.95011N, 73.09097W, 3795 m alt., 1 Oct. 2017, S.P. Sylvester 3002 (COL, FMB, K, SI, US); 5.93246N, 73.0798W, 3726 m alt., 4 Oct. 2017, S.P. Sylvester 3036 (COL, K, SI, UPTC, US); Munic. Sotaquira, protected area of Páramo El Valle, páramo just above riverine forest, 5.4605N, 73.21507W, 3220 m alt., 17 Nov. 2017, M. Vorontsova 2161 (K, SI, US); Sierra Nevada del Cocuy, Alto Valle Lagunillas, páramo pantanoso al sur de la Laguna Cuadrada, [6.3619N, 72.3345W], 4060 m alt., 26 Sep. 1972, A.M. Cleef 5579 (US2785750). **Nariño**: Páramo del Tábano, alto

de la Cordillera, entre Pasto y El Escano, vertiente occidental, [1.1756N, 77.1867W], 3200 m alt., 11 Jan. 1941, J. Cuatrecasas 11908-A (US1798782).

Notes. *Agrostis perennans* appears to be a 'grab-bag' of many different taxa that come out in many different places amongst other taxa of *Agrostis* in molecular phylogenies (Konstantin Romaschenko pers. communication), with the species complex needing urgent revision. Specimens found in Boyacán páramos correspond in almost all characteristics with *Agrostis perennans* s.s. apart from sometimes being found with shorter spikelets (c. 1.5–2 mm long) and, what appear to be, short ascending rhizomes/pseudostolons, with these characteristics also found on type material of *A. fasciculata*, which is here considered a synonym of *A. perennans* until comprehensive systematic research is undertaken on the species complex. Cataphyllous extravaginal shoots are found on the neotype of *A. perennans* as well as other type material of species considered synonyms of *A. perennans*, e.g. *A. decumbens* E. Fourn., with it plausible that these 'rhizomes' are short pseudostolons that arise from growing through moss or between rocks.

Type specimens and specimens from North America, Central America, and northwest South America have lemmas without awns or with awns under-developed, to 0.5 mm long, straight and easily falling. Specimens noted by Rúgolo de Agrasar (2012: 119) to have awns to 1.4 mm long, or exceptionally to 1.9 mm long, may be a distinct taxon, but further research is needed to ascertain this.

Similar species. *Agrostis mertensii*, which is principally differentiated in having a well-developed, flexuose to geniculate, twisted awn (1.8–)2.5–4.5 mm long, inserted in the middle or lower third of the lemma, and which is greatly exerted from the glumes (vs. unawned or exceptionally with a short straight awn to 0.5 mm long, inserted in the upper (½) third of the dorsal keel, usually not or rarely only slightly surpassing the glumes in *A. perennans* s.l. specimens from northwest South America, Central America and North America).

Agrostis subrepens, here considered to be excluded from Departamento Boyacá and possibly Colombia (see notes under 'Excluded species' *A. subrepens*), sometimes bears certain similar, but not equal, characteristics such as a) plants often stooling with notable pseudostolons and appearing long rhizomatous on herbarium sheets; b) culms 50–100 cm tall, slightly creeping or decumbent at their base but erect towards their apex; c) panicles open, lax, 5–10 cm wide; d) lemma unawned or awn to 0.5 mm long and straight, not twisted, inserted in the middle or upper 1/3 of the lemma or subapical; e) palea absent or < ¼ the length of the lemma. *Agrostis subrepens* can be differentiated from *A. perennans* s.l. by a) upper culm ligules 1–2.2 mm long, obtuse (vs. 3–5(–7) mm long, truncate to obtuse-triangular in *A. perennans* s.l.) b) leaf blades 0.5–1 mm wide in diameter as rolled or folded, convolute, involute, or conduplicate, rigid, surfaces scabrous (vs. leaf blades (1–)1.5–3.5(–5) mm wide, usually flat or conduplicate and lax to slightly firm, sometimes involute and rigid in the basal leaves, smooth throughout or scaberulous on margins and sometimes surfaces in *A. perennans* s.l.); anthers 1–1.3 mm long (vs. 0.7–1 mm long in *A. perennans* s.l.)

Agrostis turrialbae, here considered to be excluded from Departamento Boyacá and possibly Colombia, bears similarities and may possibly be part of the *A. perennans* s.l. species complex (see notes under 'Excluded species' *A. turrialbae*).

Agrostis vinealis, of Eurasian origin which is not recorded for Colombia, but found introduced and naturalized in Argentina and Chile (Soreng and Peterson 2003; Rúgolo de Agrasar 2012), bears certain similarities (see also comments regarding this species under *A.* cf. *imberbis*). It can be differentiated by having a) lemmas usually with a persistent, geniculate and twisted awn to 4 mm long, inserted near the base (sometimes absent); b) rhizomes conspicuous, long, lateral tending, and usually covered in bracts; c) panicles contracted and rather dense before and after flowering.

Agrostis stolonifera L., Sp. Pl. 1: 62. 1753

Fig. 9

Type. [Habitat in Europa], Herb. A. van Royen s.n. (lectotype, designated by Widén 1971: 77: L (L0059234 [image!])).

Many heterotypic synonyms.

Description. Perennial herbs, generally creeping, usually extensively stoloniferous with long stolons to 200 cm long, less often with short stolons, rhizomes usually absent. **Tillers** extravaginal, with cataphylls present. **Culms** 15–100 cm tall, erect or decumbent at their base, delicate to fairly firm, nodes usually held within sheaths with 0(–3) exerted at flowering, usually smooth to rarely scaberulous. **Leaves** mainly cauline, glabrous, scaberulous; **ligules** 1–6.5(–8) mm long, of basal leaves and tillers 1–3 mm long, of upper culm 2–6.5(–8) mm long, rounded to truncate, not or slightly to moderately decurrent with the sheath, abaxial surface scaberulous; **blades** 2–26 cm long, 1–8 mm wide, flat or sometimes folded, soft and lax, surfaces and margins scaberulous to scabrous, apices acute. **Panicles** 2–20(–32) cm long, 1–16 cm wide, open and lax or contracted after flowering, ovoid to pyramidal, slightly to usually greatly exerted from the basal foliage, lateral branches naked in the lower 1/3–1/4 or with spikelets present to the base, long, ascending, spreading, to somewhat divergent and not held close to the central inflorescence axis at or before flowering, held close to the central rachis at maturity, central axis and panicle branches scabrous or very rarely smooth; **pedicels** 0.5–2.5 mm long, usually shorter than their spikelets, dilated or not at their apex, scabrous. **Spikelets** (not including awn, if present) 1.8–3 mm long; **glumes** subequal or unequal, the lower slightly longer than the upper by up to c. 0.5 mm, 1-veined, lower glume keel usually scabrous in the distal half, upper glume often smooth throughout, apices acute; **floret** usually 2/3–3/4 the length of the glumes; **calluses** with 2 sparse lateral tufts of short hairs; **lemmas** 1.2–2.2(–2.5) mm long, (3-) 5-veined, glabrous or rarely pubescent at the base with hairs 0.1–0.2 mm long, smooth, apex obtuse or truncate, erose, muticous or rarely with an awn 0.5–3 mm long, usually inserted above the middle of the dorsal keel, exerted or not from the glumes, straight, flexuose or geniculate, twisted or not, weak and falling easily;

Figure 9. *Agrostis stolonifera* **A** whole plant **B** inflorescence, close-up **C** spikelet, close-up, lateral view. Image **A** Cuatrecasas 452 (US1772826) **B** García-Barriga 6 (US2115003).

paleas 0.7–1.3(–1.6) mm long, (2/5–)½–¾ the length of the lemma; **rachilla** absent; **anthers** 0.9–1.6 mm long.

Distribution and ecology. Widespread and cosmopolitan or Eurasian origin, introduced to South America from Europe. While no specimens of *A. stolonifera* were verified from Departamento Boyacá at US or encountered during extensive fieldwork in the region, the species is cited for Boyacá in the checklist (Giraldo-Cañas et al. 2016) and specimens were found at US from the neighboring Departamento Cundinamarca in the Cordillera Oriental meaning it likely that the species occurs in Boyacá.

Other specimens examined. Colombia. Cundinamarca: Sabana de Bogota, 2600 m alt., 29 Dec. 1938, J. Cuatrecasas 452 (US1772826); Tunjuelo, granja experimental "La Picota", [4.5331N, 74.1117W], 2600 m alt., 3 Feb. 1933, H. García-Barriga 6 (US2115003).

Agrostis tolucensis Kunth, Nov. Gen. Sp. [H.B.K.] 1: 135. 1816

Fig. 10

Agrostis tolucensis Willd. ex Steud., Syn. Pl. Glumac. 1: 164. 1855[1854], nom. inval.
= *Agrostis glomerata* (J. Presl) Kunth, Enum. Pl. [Kunth] 1: 219. 1833. *Vilfa glomerata* J. Presl, Reliq. Haenk. 1 (4–5): 239. 1830. Type: Peru. [Huánuco] [Hab. in

montanis Peruviae huanoccensibus], [1791; 1891 written on W isotype], T.P.X. Haenke s.n. [#196 written on W isotype] (holotype: [not found]; isotypes: HAL (HAL0106916 [image!]), PRC (PRC450953 [image!]), US (US00589472 fragm.), W (W0025326 [image!])).

= *Agrostis hoffmannii* Mez, Repert. Spec. Nov. Regni Veg. 18: 3. 1922. Type: Costa Rica. Irazu (holotype: [not found]; isotypes: [not found]).

= *Agrostis nana* var. *andicola* Pilg., Bot. Jahrb. Syst. 37 (5): 505. 1906. Type: Ecuador. Chimborazo: Chimborazo, N-Seite, Páramo-Region, 4500 m alt., July 1903, H. Meyer 146 (syntypes: JE (JE00020226 [image!]; JE00020228 [image!])); Napo: Antisana, in frigidis alpinis, 4600 m alt., July 1903, H. Meyer 145 (syntypes: JE (JE00020225 [image!]; JE00020227 [image!])).

= *Agrostis nana* var. *aristata* Griseb., Abh. Königl. Ges. Wiss. Göttingen 24: 294. 1879. Type: Argentina. Salta: Umgebungen des Nevado del Castillo [around the Nevado del Castillo], 10–15000 ft. [3048–4572 m alt.], 19–23 Mar. 1873, P.G. Lorentz & G.H.E.W. Hieronymus 82 (holotype: GOET (GOET006541 [image!]); isotypes: B, BAA (BAA00000724 [image!] fragm. ex B; BAA00000723 [image!] fragm. ex B), CORD (CORD00004693 [image!]), W (W19160036588 [image!]; W19160036664 [image!])).

= *Agrostis virescens* Kunth, Nov. Gen. Sp. [H.B.K.] 1: 135. 1816. Type: Mexico. Toluca, Sep., F.W.H.A. Humboldt & A.J.A. Bonpland s.n (holotype: P (P00669395 [image!]); isotypes: LE-TRIN (LE-TRIN1668.01; LE-TRIN1668.02), P (P00136912 [image!])).

Type. Mexico. [prope Toluca et Islahuaca], F.W.H.A. Humboldt & A.J.A. Bonpland s.n. (holotype: P (P00669394 [image!]); isotypes: B (B-W1704), BAA (BAA00000235 [image!] fragm. ex P), BM, K (microfiche), LE-TRIN (LE-TRIN1660.01), P (P00136914 [image!]; P00136915 [image!]; P00740426 [image!]), US (US00156505! fragm. ex P)).

Description. Perennial herbs, tussock-forming or laxly to densely tufted, usually with short ascending rhizomes. **Tillers** extravaginal and intravaginal, with cataphylls usually present. **Culms** (3–)5.5–51(–80) cm tall, erect or arching, fairly firm, with 0(–2) nodes exerted at flowering, smooth or rarely scaberulous. **Leaves** mostly basal or more-or-less evenly spread along the culm, glabrous, smooth or scabrous; **ligules** 2–4(–6.2) mm long, of upper culm usually longer than those of lower culm and tillers, truncate to triangular, moderately to strongly decurrent with the sheath, abaxial surface usually scabrous, rarely scaberulous or smooth; **blades** 2.5–19 cm long, 1–3(–5) mm wide, at least in the upper culm filiform, folded or flat, usually lax to sometimes firm, sometimes basal and tiller blades involute or convolute and firm to rigid, smooth throughout or scabrous only on the margin and sometimes veins, apices blunt or slightly naviculate-acute. **Panicles** (1–)2–15 cm long, 0.1–1.5 cm wide, moderately to densely congested, sub-spikelike or spikelike, sometimes interrupted towards the base, subincluded in the basal foliage or slightly to greatly exerted, lateral branches with spikelets almost to the base, upper lateral branches short and held close to the cen-

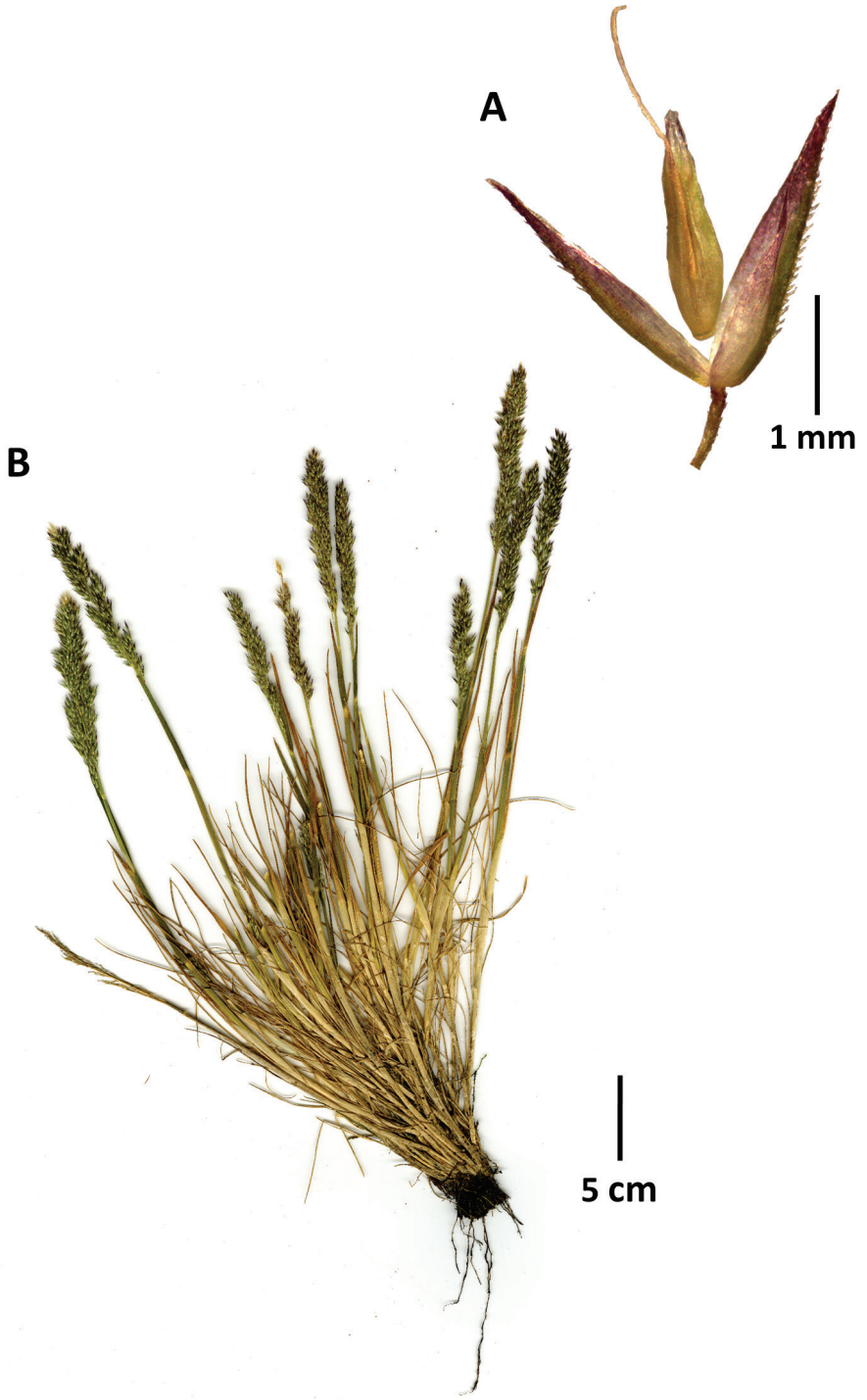

Figure 10. *Agrostis tolucensis* **A** spikelet, glumes in lateral view, floret in dorsal view, detached and raised above the glumes **B** whole plant. Images of Cuta-Alarcon 376 (FMB).

tral inflorescence axis, central axis and panicle branches scabrous; **pedicels** 0.7–3(–4.5) mm long, usually shorter than their spikelets, not or slightly dilated at their apex, scabrous. **Spikelets** (not including awn, if present) 2–3(–3.6) mm long; **glumes** equal or subequal, 1-veined, lower glume keel and surface usually scabrous at least in the distal half, infrequently smooth throughout, upper glume keel and surface scabrous for almost their entirety to at least in the distal half or surface sometimes smooth throughout, apices acute or acuminate; **floret** ½–2/3(–3/4) the length of the glumes; **calluses** lightly pilose with 2 sparse tufts of short hairs on the lateral sides; **lemmas** 1.4–2.8 mm long, glabrous, smooth, 5-veined, apex truncate, denticulate, usually awned, awn 2–3.5 mm long, inserted in the lower, middle, or upper 1/3 of the dorsal keel, exerted from the glumes, geniculate, twisted, very rarely muticous or with a short straight awn, < 1 mm long, inserted in the upper half of the lemma (see notes below regarding *A. glomerata*); **paleas** absent or 0.1–0.2 mm long, < ¼ the length of the lemma; **rachilla** absent; **anthers** 0.5–1 mm long.

Distribution and ecology. Mexico, Guatemala, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Chile, Argentina. High-elevation open grasslands and forests, 2700–4900 m alt.

Other specimens examined. Colombia. Sin loc., 1760–1808, J.C. Mutis 5521 (US1561906). **Boyacá**: Munic. Arcabuco, Páramo El Valle, 5.7445833N, 73.37118W, 3744 m alt., 16 Nov. 2017, S.P. Sylvester 3081 (FMB, K, US); Munic. Arcabuco, Páramo El Valle, just below high point of ridge to the W of site 14, 5.75436N, 73.38722W, 3747 m alt., páramo seco dominado por *Espeletia barclayana* [Cuatrec.], 16 Nov. 2017, S.P. Sylvester 3083 (K, US); Munic. Belén, Páramo de La Rusia, border with Santander, Boqueron El Consuelo, unprotected private land, 6.03598N, 72.57056W, 3975 m alt., páramo with limited grazing by horses and rodents with *Espeletia brachyaxiantha* [S. Díaz] and *E. annemariana* [Cuatrec.], steep slope on rock outcrop, 23 Nov. 2017, M. Vorontsova 2260 (FMB, K, SI, US); Munic. Belén, Páramo de La Rusia, near Páramo Le Consuelo, unprotected private land, somewhat disturbed páramo on top of the ridge, 6.02416N, 72.57242W, 3894 m alt., grazed by horses and rodents, with *Espeletia boyacensis*, 22 Nov. 2017, M. Vorontsova 2231 (K, UPTC, US); Munic. Chiscas, Páramo de Chacaritas, asociado a rocas de 4 m de altura, 6.62227N, 72.3904W, 4192 m alt., 4 Mar. 2018, S.P. Sylvester 3115 (US); Munic. Chiscas, Páramo de Chacaritas, límites entre páramo y superpáramo, 6.62865N, 72.3944W, 4064 m alt., 4 Mar. 2018, S.P. Sylvester 3104 (FMB, K, US); Munic. Chiscas, Páramo El Peñon, Chiscas, 6.63012N, 72.40073W, 4172 m alt., 5 Mar. 2018, S.P. Sylvester 3152 (UPTC); Munic. Chiscas, Páramo El Peñon, Chiscas, 6.62876N, 72.40283W, 4255 m alt., vegetación de pajonal frailejonal, páramo húmedo, 5 Mar. 2018, S.P. Sylvester 3153 (FMB, K, US); Munic. Mongua, Páramo de Ocetá, Valle de Laguna Negra, 5.69525N, 72.79133W, 3694 m alt., 29 Nov. 2017, L.E. Cuta-Alarcón 355 (FMB, K, UPTC, US); Munic. Mongui, Vereda Vallado, Sector La Pedrisca, Páramo de Ocetá, 5.69969N, 72.80891W, 3751 m alt., 30 Nov. 2017, L.E. Cuta-Alarcón 376 (FMB, US). **Cauca**: Macizo Colombiano, Valle de las Papas, alrededores de Valencia, [1.8831N, 76.6828W],

2910 m alt., 11 Sep.-1 Oct. 1958, Idrobo, Pinto & Bischler 3682A (US2540528). **Cundinamarca**: Páramo de Chisaca, [4.2747N, 74.2006W], 3750–3962 m alt., 5 Oct. 1966, T.R. Soderstrom 1312 (US3136708).

Notes. Although in Bolivia (Renvoize 1998) and austral South America (Rúgolo de Agrasar 2012) *A. tolucensis* is mentioned to be notably rhizomatous, lateral tending rhizomes were not notable on specimens from the páramos of Boyacá, which had short, ascending rhizomes/pseudostolons and formed small tussocks or were laxly to densely tufted. Type specimens and original material of *A. tolucensis* and other species now considered synonyms of *A. tolucensis*, i.e. *Agrostis glomerata*, *A. nana* var. *andicola*, *A. nana* var. *aristata*, and *A. virescens*, also had either short ascending rhizomes or lacked notable rhizomes, but with all having obvious extravaginal cataphyllous shoots.

Discrepancy was sometimes also found in the form of the leaf blades, with specimens encountered in Boyacá, Colombia, and Venezuela sometimes having more rigid, convolute to folded, often recurved, basal leaf blades instead of the lax and filiform leaf blades more common to this species. These specimens did usually still have flat upper culm blades to help differentiate them from e.g. *A. laegaardii* (see notes on similar species below). While Renvoize (1998) and Rúgolo de Agrasar (2012) state the blades in *A. tolucensis* to be flat, folded, or filiform and generally lax, the type material also has fairly firm blades which are narrow and folded to slightly convolute and sometimes cylindrical in outline. *Agrostis nana*, here considered a synonym of *A. tolucensis*, also has more convolute, curved and rigid leaf blades.

Similar species. See notes under *A. foliata* for how to differentiate from that species. *Agrostis breviculmis* and *A. laegaardii* bear similarities in having mainly basal, narrow, usually convolute, rigid, leaf blades and densely congested spikelike panicles that are usually short (< 5 cm long), and spikelets with an absent or reduced palea < ¼ the length of the lemma. *Agrostis tolucensis* principally differs from these by the leaf blades being usually laxer and folded or flat, at least in the upper culm. However, as noted above, specimens can be found with convolute basal blades that makes distinguishing these species more difficult. In these instances, *A. tolucensis* can be differentiated from *A. breviculmis* by its larger spikelets 2–3(–3.6) mm long (vs. 1.5–2.1(–2.5 in Bolivia?; Renvoize 1998) mm long in *A. breviculmis*), usually the presence of a well-developed geniculate and twisted awn inserted dorsally usually in the lower third of the lemma (lemmas very rarely muticous or with a short straight weak awn, < 1 mm long, inserted in the upper ½; see notes on *A. glomerata* below) (vs. lemmas muticous or with a short straight weak awn inserted above the middle in *A. breviculmis*), panicles generally wider, 1–15 mm wide (vs. 0.5–2(–6) mm wide in *A. breviculmis*), and short prickle hairs on the glume keels (vs. coarse and shiny in *A. breviculmis*). While *A. laegaardii* has characters of often larger spikelets and dorsally inserted awn, *A. tolucensis* can be differentiated from *A. laegaardii* by its extravaginal cataphyllous shoots and distinct ascending rhizomes with rhizome internodes usually > 7 mm long (vs. purely intravaginal innovations, without cataphyllous shoots or distinct ascending rhizomes, rhizome internodes < 2 mm long in *A. laegaardii*), generally wider panicles, 1–15 mm wide (vs. 0.5–2(–6) mm wide in *A. laegaardii*), and short prickle hairs on the glume keels (vs. coarse and

shiny in *A. laegaardii*). Specimens can sometimes have laxer inflorescences that could lead to confusion with *A. mertensii*, but this species does not form small tussocks.

Agrostis meyenii, a species known from drier high-elevation puna grassland and pampa of Argentina, Chile and Bolivia (Renvoize 1998; Rúgolo de Agrasar 2012), is similar in its overall appearance, usually being tufted and with rhizomes, having similar ligules and filiform or flat leaf blades, and having a condensed spikelike panicle with spikelets of similar size. *Agrostis tolucensis* can usually be differentiated from *A. meyenii* by the presence of an awn inserted in the lower third of the lemma, 2–3.5 mm long, twisted and bent and exerted from the glumes (vs. muticous or, if awn present, inserted in the middle or upper third of the lemma, to 1.2 mm long, straight or slightly flexuous in *A. meyenii*). However, specimens akin to *A. glomerata*, a species described from Peru and here considered a synonym of *A. tolucensis*, can sometimes be found in Colombia, albeit not in the Cordillera Oriental, which have muticous lemmas or with a short straight awn inserted in the upper half of the lemma (e.g. Idrobo 3882a, Mutis 5521). These can be differentiated from *A. meyenii* by the plants being generally taller, 20–60 cm tall, condensed panicles often > 10 cm long that are often interrupted and with the central inflorescence axis notably wider compared to the lateral branches, and the pedicels, panicle branches, and sometimes central inflorescence axis, being notably scabrous. The blades of these are variable and can be filiform to flat and to 5 mm wide. The characteristic of notably scabrous pedicels, panicle branches, and sometimes central inflorescence axis of *A. tolucensis* are considered to be key in differentiating these from *A. meyenii*, which are usually smooth or exceptionally lightly scaberulous.

Podagrostis **(Griseb.) Scribn. & Merr. Contr. U.S. Natl. Herb. 13 (3): 58. 1910**

Agrostis sect. *Podagrostis* Griseb. Fl. Ross. 4 (13): 436. 1852.

Type. *Agrostis canina* var. *aequivalvis* Trin. (lectotype, designated by Hitchcock 1920: 127).

Description. Perennials. Leaves mainly basal; **ligules** membranous. **Inflorescence** a panicle, lax and open to contracted and spikelike. **Spikelets** 1-flowered, disarticulating above the glumes, laterally compressed; **glumes** as long as the spikelet, equal or subequal, persisting on the plant after the florets have fallen; lower glume 1- or 3-veined; upper glume 1- (2-) or 3-veined; **floret** subequalling to equaling the apex of the glumes; **lemmas** membranaceous, often slightly thicker than the glumes, dorsally rounded, 3- or 5-veined, lateral veins not evident to distinct; **paleas** well-developed, reaching from (2/3) ¾ to subequaling the lemma, keels obscure to distinct, glabrous, usually smooth; **calluses** rounded, blunt, usually glabrous, or with two short lateral tufts of hairs to 0.5 mm long in some species, abaxially smooth; **rachilla** prolongation present, varying from rudimentary to 2/3 the floret in length, glabrous or sometimes with short strict hairs to 0.3 mm long emerging only from the apex, smooth or scaberulous. **Flowers** perfect; **anthers** 3 in number, 0.4–2.2 mm long. **Caryopses** hard.

Podagrostis trichodes **(Kunth) Sylvester & Soreng, PhytoKeys 148: 42. 2020**
Fig. 11

Vilfa trichodes Kunth, Nov. Gen. Sp. [H.B.K.] 1: 139. 1816.
Agrostis trichodes (Kunth) Roem. & Schult., Syst. Veg. (ed. 15 bis) 2: 361. 1817.
Aira trichodes (Kunth) Spreng., Syst. Veg., ed. 16 [Sprengel] 1: 276. 1824.
= *Agrostis bogotensis* Hack., Repert. Spec. Nov. Regni Veg. 8: 518. 1910. Type: Colombia. S. Cristobal prope Bogota [près de Bogota], [2500–3000 m alt.], 13 July 1908, *F. Apolliniaire s.n.* (holotype: W (W19160027256 [image!]); isotypes: BM (BM000938528 [image!]), MPU (MPU027104 [image!]), SI (SI000495 [image!] fragm. ex US), US (US75365 fragm.)).

Type. Peru. Crescit in crepidinibus Andium Peruvianum justa Montan, Santa Cruz et Guambos, alt. 1350 hexap. [2469 m alt.], floret Augusto, *F.W.H.A. Humboldt & A.J.A. Bonpland s.n.* (holotype: P; isotypes: HAL (HAL0106929 [image!]), US (US75364! fragm. ex P)).

Description. Perennial herbs, forming short dense tufts, with the basal mats reaching c. 4–11 cm tall and inflorescences well-exerted from the basal foliage. **Tillers** intravaginal, without cataphylls. **Culms** 7–20(–30) cm tall, erect, simple, delicate, with 0(–1) nodes exerted at flowering, smooth. **Leaves** mostly basal, glabrous, finely to densely scabrous; **ligules** 0.7–1.7(–2.5) mm long, of basal leaves and tillers 0.7–1.2 mm long, of upper culm leaves generally longer, truncate to obtuse, slightly to usually strongly decurrent with the sheath, abaxial surface smooth or rarely scaberulous; **blades** 1–4 cm long, 0.3–0.4 mm wide in diameter, involute or convolute, acicular to capillaceous and filiform, usually curved, rigid, apices acute. **Panicles** 2–5(–6) cm long, 1–2(–3) cm wide, lax and open, ovoid, slightly to usually greatly exerted from the basal foliage, lateral branches with spikelets in the distal 1/3, the lower 2/3 naked, long, ascending to patent, not held close to the central inflorescence axis, central axis and panicle branches usually scaberulous or sometimes smooth; **pedicels** 1–2 mm long, usually longer than the length of the spikelets, not or slightly dilated at their apex, smooth to usually lightly scabrous. **Spikelets** 1–1.5 mm long; **glumes** equal or subequal, the lower often slightly longer than the upper, 1-veined, keels scabrous just in the distal 1/3 to throughout their length, surfaces smooth a scabrous distally, apices obtuse to acute; **floret** almost equaling the length of the glumes or slightly shorter; **calluses** glabrous; **lemmas** 1–1.5 mm long, glabrous, moderately to densely scabrous ('smooth' possibly mentioned by Tovar 1993!), sometimes granulose, apex obtuse, faintly to strongly 5-veined, awn lacking or to 0.5 mm long, straight, inserted medially or in the upper half of the lemma, not surpassing the glumes; **paleas** (0.7–)0.9–1.3 mm long, usually reaching from ¾ to subequaling the lemma, less often reaching 2/3 the length of the lemma; **rachilla** usually prolonged from the base of the floret (sometimes lacking in a small number of spikelets within the inflorescence), 0.2–0.5 mm long, glabrous, smooth to scabrous; **anthers** 0.4–1 mm long.

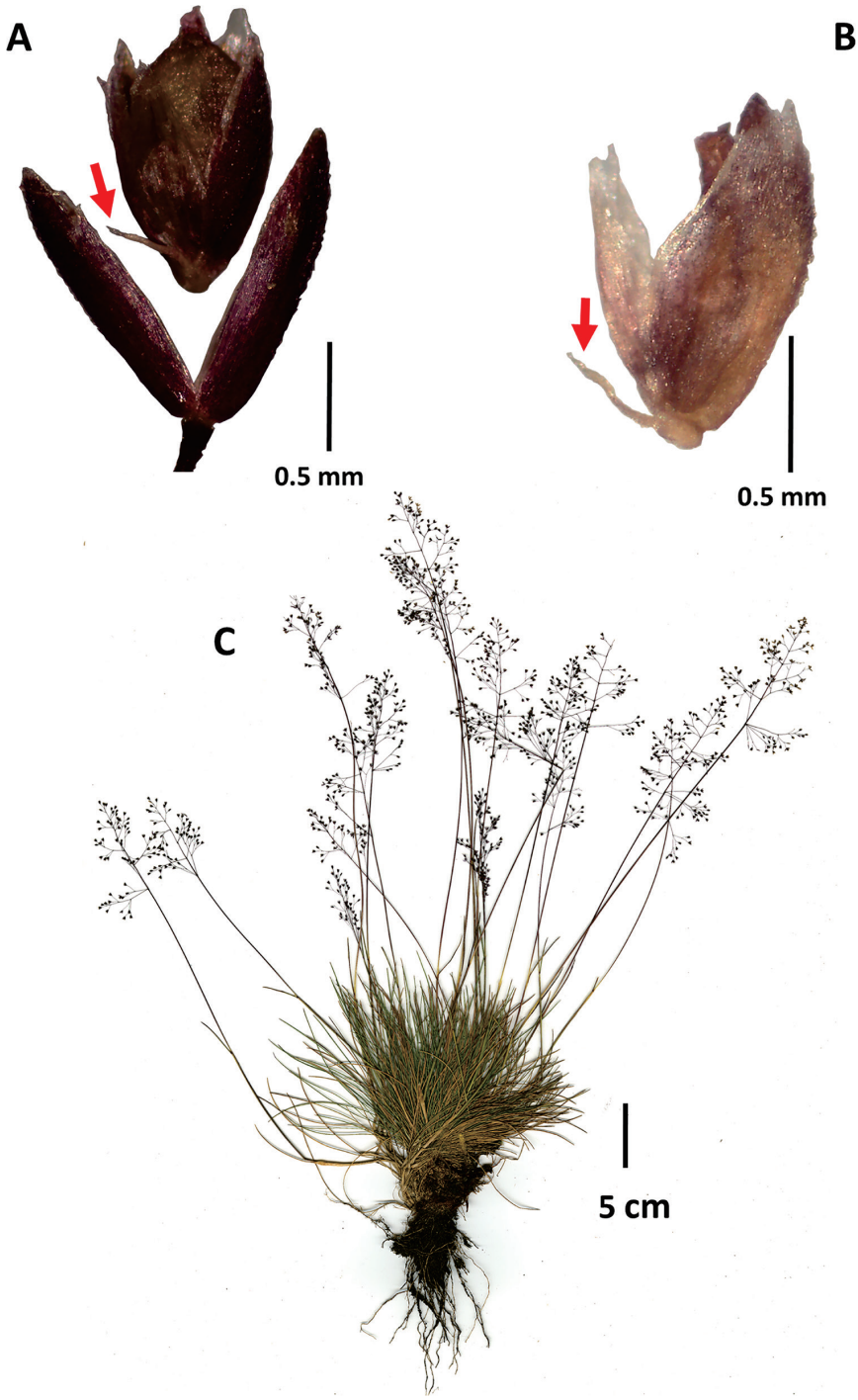

Figure 11. *Podagrostis trichodes* **A** spikelet, lateral view with floret detached and raised above the glumes, rachilla prolongation indicated by an arrow **B** floret, lateral view, rachilla prolongation indicated by an arrow **C** whole plant. Images: **A**, **B** Rodríguez (UPTC 22204), **C** Cuta-Alarcon 362 (FMB).

Distribution and ecology. Colombia, Ecuador?, Peru, Venezuela, 2800–4500 m alt. Relatively humid high-Andean puna grasslands of southern and central Peru and páramo grasslands of Ecuador, Colombia and Venezuela. May also occur in Bolivia according to Tovar (1993), although no specimens have been verified. No specimens have been verified from Ecuador, although it is mentioned to occur there (Hitchcock 1927; Tovar 1993; Jørgensen and Ulloa-Ulloa 1994; Jørgensen and León-Yánez 1999; Luteyn 1999). A common element in moderately grazed areas and path-sides of Boyacán páramo.

Other specimens examined. See Sylvester et al. (2020).

Notes. The combination of open panicle, spikelets < 1.5 mm long, florets which subequal the apex of the glumes, a palea reaching from (2/3) ¾ to subequaling the lemma, lemmas awnless or with a short (< 0.5 mm long) straight awn inserted in the upper ½ of the lemma, and a short glabrous rachilla prolongation emerging from under the palea are diagnostic for this species. The rachilla prolongation (Fig. 11, indicated by arrows) is sometimes difficult to see if it is tucked between the flanges of the palea, and so spikelet dissection is necessary. All species of *Podagrostis* from Colombia have involute or convolute leaf blades that can easily separate them from species of *Agrostis* with well-developed paleas.

Similar species. Aside from *Podagrostis bacillata* (Hack.) Sylvester & Soreng and *P. exserta* (Swallen) Sylvester & Soreng that are found in Central America (see Sylvester et al. 2020), *P. trichodes* could possibly be mistaken for shorter plants of *A. perennans* which can have short spikelets as small as 1.8 mm long. *Agrostis perennans* s.l. has florets which usually do not reach past ¾ the length of the glumes, a minute palea less than ¼ the length of the lemma, and lacks a rachilla prolongation.

Excluded species (from Boyacá, Colombia)

Agrostis gigantea **Roth, Tent. Fl. Germ. 1: 31. 1788**

Agrostis vinealis var. *gigantea* (Roth) Willd., Sp. Pl., ed. 4, 1: 369. 1797.
Triticum giganteum (Roth) Roth, Catal. Bot. fasc. iii. 22. 1806.
Vilfa gigantea (Roth) P.Beauv., Ess. Agrostogr. 16. 1812.
Agrostis alba var. *gigantea* (Roth) Lej., Rev. Fl. Spa: 15. 1825.
Agrostis alba var. *patula* Klett & Richt., Fl. Leipzig: 71. 1830, nom. illeg.
Agrostis stolonifera var. *gigantea* (Roth) Rchb., Fl. Germ. Excurs.: 26. 1830.
Agrostis stolonifera subsp. *gigantea* (Roth) Schübl. & G. Martens, Fl. Würtemberg Ed. 1: 64. 1834.
Agrostis stolonifera var. *gigantea* (Roth) Bréb., Fl. Normandie 390. 1835.
Agrostis stolonifera var. *gigantea* (Roth) Klett & H. Richt. ex Peterm., Fl. Lips. Excurs. 83. 1838.
Agrostis stolonifera var. *rothii* Heuff., Enum. Pl. Banat.: 226. 1856, nom. superfl.
Agrostis signata var. *gigantea* (Roth) Schur, Oesterr. Bot. Z. 9: 48. 1859.
Agrostis alba subsp. *gigantea* (Roth) Arcang., Comp. Fl. Ital.: 768. 1882.

Agrostis stolonifera subsp. *gigantea* (Roth) Maire & Weiller, Fl. Afrique N.: 2(XLV): 120. 1953.

Agrostis stolonifera subsp. *gigantea* (Roth) Beldie, Fl. Republ. Socialist. Romania 12: 152. 1972.

Type. Germany. [Inter arundinum et salices ad ripas Visurgis Ducatus Bremensis], A.W. Roth s.n. (lectotype, designated by Widén 1971: 97: G (G00195254 [image!]); isolectotypes: BM (BM001134107 [image!]), L).

Many heterotypic synonyms.

Notes. Giraldo-Cañas et al. (2016) cite this species based on the species *Agrostis tenuis* L. being recorded for Colombia by Hafliger and Scholz (1981). However, *A. tenuis* is a synonym of *A. capillaris*, and no specimens have been verified by us from either Departamento Boyacá or Colombia in general.

Agrostis lehmannii Swallen, Contr. U.S. Natl. Herb. 29 (6): 263. 1949

Type. Colombia. Cauca: collected on páramo de Purace, Central Cordillera, 3500 m alt., 26 May 1944, E.P. Kilip & F.C. Lehmann 38598 (holotype: US (US1856227)).

Notes. Only known from the type that was collected in the Cordillera Central of Colombia, but which was out on loan at the time of writing this publication. The protologue states the species to have a dense but rather lax inflorescence to 3 cm wide, florets lacking any notable palea, and a very long (c. 6 mm) awn inserted medially on the lemma dorsal surface. The length of the awn and ligule seems to differentiate this from *A. foliata* and *A. tolucensis*. This may be an odd *A. mertensii*, which is known to have panicle branches that can be appressed and congested when young while open when mature, although the ligule and awn length are all slightly past the limit for this species.

Agrostis scabrifolia Swallen, Contr. U.S. Natl. Herb. 29 (6): 264. 1949

Type. Colombia. Norte de Santander: Collected on páramo de Tama, above Cueva, 3100–3200 m alt., 27 Oct. 1941, J. Cuatrecasas, R.E. Schultes, & E. Smith 12608 (holotype: US (US1850358)).

Notes. Only known from the type, which was collected in the Cordillera Oriental, in Departamento Norte de Santander that is not too far from Departamento Boyacá and so may possibly occur there. The holotype was out on loan at the time of writing this publication to help clarify its identity. The open panicle and spikelets with palea minute or absent and lemmas with a well-developed dorsally inserted awn are very distinct characteristics which would place the species close to *A. mertensii*. The species is mentioned to have scabrous culms, at least below the nodes, scaberulous sheaths and

scabrous leaf blades while *A. mertensii* is generally smooth or only scaberulous in the leaf blade adaxial surface and margin. The leaf blades are also mentioned to be stiff and erect while those of *A. mertensii* are generally lax and soft.

Agrostis subrepens **(Hitchc.) Hitchc., N. Amer. Fl. 17 (7): 525. 1937**

Agrostis hiemalis var. *subrepens* Hitchc., U.S.D.A. Bur. Pl. Industr. Bull. 68: 44. 1905.
Agrostis hyemalis var. *subrepens* Hitchc., U.S.D.A. Bur. Pl. Industr. Bull. 68: 44. 1905.

Type. Mexico. Chihuahua: in wet places, pine plains, base of Sierra Madre Mountains, 28 Sep. 1887, C.G. Pringle 1420 (holotype: US (US00131756 [image!]); isotypes: BAB (BAB00000208 [image!] fragm. ex US), E (E00381793 [image!]), F (F0046565F [image!]), GH (GH00221377 [image!]), K (K000308371 [image!]), MSC (MSC0129855 [image!]), NY (NY00327645 [image!], NY00327646 [image!]), US (US00131757 [image!])).

Other specimens examined. Mexico. **Chihuahua**: [Munic. Casas Grandes], near Colonia García in the Sierra Madre, 1 Aug. 1899, E.W. Nelson 6195(US359911); Chichupa, 23 Aug. 1937, Harde LeSueur 198 (US1721671).

Venezuela. Sin loc., no date, Fendler 2541 (US843224).

Notes. Ambiguity surrounds the identity and placement of *A. subrepens*. Hitchcock (1905) initially described this as a variety of *A. hyemalis* (Walter) Britton, Sterns & Poggenb., but then raised it to the level of species 32 years later. Originally stated to occur in northern Mexico, and the states New Mexico, Nevada, Arizona of the USA, and Venezuela (Hitchcock 1905), in his later account, Hitchcock (1937) then restricts the distribution to wet places of the Sierra Madre, Chihuahua, Mexico, and also Venezuela based on the specimen Fendler 2541 (US843224). This Venezuelan paratype was seen by us at US but only comprised two fragments of an inflorescence and no leaves. As both *A. perennans* and *A. subrepens* have strikingly similar spikelet morphology, there was no way to be confident on its placement, raising ambiguity over whether *A. subrepens* occurs in South America. The species has been included in checklists or taxonomic treatments for Bolivia (Jørgensen et al. 2014), Colombia (Giraldo-Cañas et al. 2016), Peru (Tovar 1993), and Venezuela (Hokche et al. 2008). The identification key and description of *A. subrepens* in the treatment for Peru (Tovar 1993) do not match the type specimens and it may be that Tovar (1993) had not seen types as he distinguishes this from *A. perennans* (sub *A. humboldtiana*) and *A. imberbis* (sub *A. stenophylla*) in part by the leaf blades being flat and flaccid. Although Giraldo-Cañas et al. (2016) mention this species to occur in Departamentos Boyacá, Cundinamarca, and Santander of the Cordillera Oriental, and Antioquia, Huila, and Quindio of the Cordillera Central, no specimens have been verified by us, although we did not revise specimens outside of Boyacá while at COL and none were verified from these provinces while at US. While we have found certain characteristics to differentiate this from *A. imberbis*, such as culm

and panicle size, and ligule form, it may be that these are the same and that *A. imberbis* is a species more amply distributed. See comments under *Agrostis* cf. *imberbis* and *A. perennans* s.l. for how to differentiate these from *A. subrepens*.

Agrostis turrialbae Mez, Repert. Spec. Nov. Regni Veg. 18 (1–3): 4. 1922

= *Agrostis arcta* Swallen, Contr. U.S. Natl. Herb. 29 (9): 405. 1950. Type: Guatemala. Chimaltenango: moist roadside at Santa Elena, 2400–2700 m alt., 17 July 1933, A.F. Skutch 422 (holotype: US (US00131720)).

= *Agrostis vesca* Swallen, Contr. U.S. Natl. Herb. 29 (9): 405. 1950. Type: Guatemala. Chimaltenango: collected on open, moist roadside at Santa Elena, 2400–2700 m alt., 17 July 1933, A.F. Skutch 420 (holotype: US (US00131129)).

Type. Costa Rica. Cartago: Volcán Turrialba, 27 May 1884, H. Pittier 855 (holotype: B; isotype: US (US00131127)).

Specimen examined. Costa Rica. San Jose: Along Interamerican Highway ca 8.5 km E of road to La Cima, approximately 9°40'N, 83°51'W, 2600–2650 m alt., roadside and below highway, remnant evergreen forest, 30 July 1979, W.D. Stevens 13370 (MO2820979 [image!]).

Notes. Described from páramos of Costa Rica, and mentioned by Pohl and Davidse (1994) to also occur in alpine pastures of Guatemala and Mexico, *A. turrialbae* has also been included in checklists for Colombia (Giraldo-Cañas et al. 2016) and Venezuela (Hokche et al. 2008). However, there is a lack of consensus on the identity of *A. turrialbae* and how to differentiate it from *A. perennans* s.l., with all type material of *A. turrialbae* and its synonyms out on loan at the time of writing this publication to help clarify this. The principal discrepancy refers to the form of the leaf blades, with the protologue and Pohl (1980) mentioning filiform flat or folded leaf blades, while Pohl and Davidse (1994) and Morales-Quirós (2003) state the blades to be involute and narrow, 0.2–1 mm in diameter as rolled, and rarely the cauline leaf blades being flat, and use this character to differentiate it from the usually flat bladed *A. perennans*. This may relate to the species *A. arcta* and *A. vesca*, described from Guatemala and considered synonyms of *A. turriabae* by Pohl and Davidse (1994), with the protologues mentioning leaf blades being firm, folded and involute, curved, in *A. arcta*, or flat, filiform, or involute and straight in *A. vesca. Agrostis perennans*, in its broad sense, can also have involute or filiform leaf blades based on species currently considered synonyms of *A. perennans*, e.g. *A. aberrans* Steud., *A. kufium* Speg., *A. tenuifolia* M. Bieb. var. *fretensis* Hook. f., *Vilfa elegans*.

While all literature (Pohl 1980; Pohl and Davidse 1994; Morales-Quirós 2003) also differentiates *A. perennans* from *A. turrialbae* by stating there is a lack of conspicuous basal foliage in the former, this may not be a good differentiating character as *A. perennans* usually has blades concentrated at the base of the plant when it is young, and only in subsequent flowering seasons it begins to elongate and lose its basal foliage. Pohl (1980) also mentions that paleas are minute in *A. perennans*, while in *A. turrialbae*

paleas are absent, but this character appears to be too variable to be useful. Discrepancy in spikelet size is also apparent, with the *A. turrialbae* protologue stating 1.75 mm long and the *A. vesca* protologue stating 1.6–1.8 mm long, while all other publications describing the species (Pohl 1980; Pohl and Davidse 1994; Morales-Quirós 2003) state 2–2.1 mm or 2–2.8 mm long.

We here tentatively differentiate the two species by *A. turrialbae* having leaf blades filiform, 0.2–1 mm wide when opened out, thin and flaccid, leaves mainly basal at maturity, and plants generally smaller with culms to 40 cm tall and panicles to 12 cm long and 6 cm wide (vs. leaf blades flat or conduplicate, (1–)1.5–6 mm wide when opened out, rarely involute in the basal leaves, usually thickened at the margins and keel, firm, leaves mainly basal early in the flowering season but tending to become mostly cauline with maturity, and plants generally larger, with culms to 100 cm tall and panicles often larger, to 22 cm long and 11 cm wide in *A. perennans* s.l.). No specimens of *A. turrialbae* that fit this delineation have been found at US from either Colombia or Venezuela. Furthermore, *A. turrialbae* may be better included among the broad *A. perennans* complex until a satisfactory revision can be done of this species complex, which has been found to comprise evolutionarily distinct lineages in unpublished molecular phylogenies (Konstantin Romaschenko, pers. communication).

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