

Two new species of endemic Ecuadorean Amaryllidaceae (Asparagales, Amaryllidaceae, Amarylloideae, Eucharideae)

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Academic editor: L. Peruzzi | Received 19 December 2014 | Accepted 14 March 2015 | Published 2 April 2015

Citation: Meerow AW, Jost L, Oleas N (2015) Two new species of endemic Ecuadorean Amaryllidaceae (Asparagales, Amaryllidaceae, Amarylloideae, Eucharideae). *PhytoKeys* 48: 1–9. doi: 10.3897/phytokeys.48.4399

Abstract

New species of the genera *Stenomesson* and *Eucharis* (Amaryllidaceae) are described from Ecuador. *Stenomesson ecuadorensis* is the second species of the genus reported from that country, and the only endemic one. It is related to *S. miniatum* and *S. campanulatum*, both from Peru, with which it shares orange flower color and the fusion of the staminal corona to the perianth tube. It differs from *S. miniatum* by the non-urceolate perianth, from *S. campanulatum* by its shorter stamens and longer perianth, and from both by its lower montane, cloud forest habitat. *Eucharis ruthiana*, found in the vicinity of Zamora, is related to *E. moorei* from which it differs by the narrower leaves and tepals; short, deeply cleft staminal corona; the long teeth on either side of the free filaments; the narrowly subulate, incurved free filaments; and the shorter style. The green mature fruit and campanulate floral morphology place it in *Eucharis* subg. *Heterocharis*.

Resumen

Nuevas especies de los géneros *Stenomesson* y *Eucharis* (Amaryllidaceae) se describen para Ecuador. *Stenomesson ecuadorensis* es la segunda especie del género reportada de ese país y la única endémica. Está relacionada con *S. miniatum* y *S. campanulatum*, ambos de Perú, con la que comparte el color naranja de la flor y la fusión de la copa estaminal al tubo del perianto. Se diferencia de *S. miniatum* por el perianto no urceolado, de *S. campanulatum* por sus estambres más cortos y perianto más largo, y de ambos por su hábitat en bosque nuboso montano de baja altitud. *Eucharis ruthiana*, que se encuentra en las cercanías de Zamora, está relacionada con *E. moorei*, de cual difiere por las hojas y tépalos estrechos, copa estaminal corta y profundamente hendida, los dientes largos a ambos lados de los filamentos libres, filamentos libres incurvos y ligeramente subulados, y el estilo más corto. El fruto maduro verde y morfología floral campanulada lo posicionan en *Eucharis* subgénero *Heterocharis*.

Keywords

Bulb, Amaryllidaceae, Andes, South America, *Stenomesson*, *Eucharis*

Introduction

Ecuador is a major center of diversity for the Andean tetraploid clade of American Amaryllidaceae, specifically genera in the tribe Eucharideae (Meerow 1990), a monophyletic group characterized by pseudopetiolate leaves and the loss of the gene *ndhF* from the plastid genome (Meerow 2010; Meerow et al. 2000). In this paper, we describe two new species in the tribe, *Stenomesson ecuadorensis*, and *Eucharis ruthiana*, both endemic to Ecuador.

Materials and methods

No specimens matching these new species were observed in herbarium collections in Ecuador (with the exception of the single specimen cited below under *S. ecuadorensis*) housed at QCA, QCNE, HUTI, nor encountered by the first author in collections examined over the past 30 years at GB, K, MO, and NY.

Taxonomy

Stenomesson ecuadorensis Meerow, Oleas & Jost, sp. nov.

urn:lsid:ipni.org:names:77146127-1

Fig. 1

Diagnosis. *Stenomesson ecuadorensis* (Fig. 1) appears closely related to the Peruvian *S. miniatum* (Herb.) Ravenna (1978; Fig. 2A) and *S. campanulatum* Meerow (1985; Fig. 2B) by flower color and adherence of the staminal corona to the floral tube, consisting of six long teeth interposed between the free filaments, but differs from them by the moist habitat, occurrence on limestone and relatively low elevation (Table 1). *S. miniatum* has an urceolate corolla. *S. campanulatum* has a non-patent limb and long-exserted stamens. The perianth of *S. ecuadorensis* has flaring tepals as does *S. miniatum*, but is long campanulate in morphology.

Type. ECUADOR: Zamora-Chinchipec, Tapala, on limestone cliffs above Río San Luis, near its confluence with the Río Numbala; 4°32.478'S, 79°03.985'W, ca. 1295 m elevation, 18 March 2006 (observed in flower and fruit; specimens made from flowering cultivated plants 10 Apr 2012), *Lou Jost* 7949 (Holotype: QCA!, Isotypes: QCNE!, HUTI!, MO!, NA!, NY!).

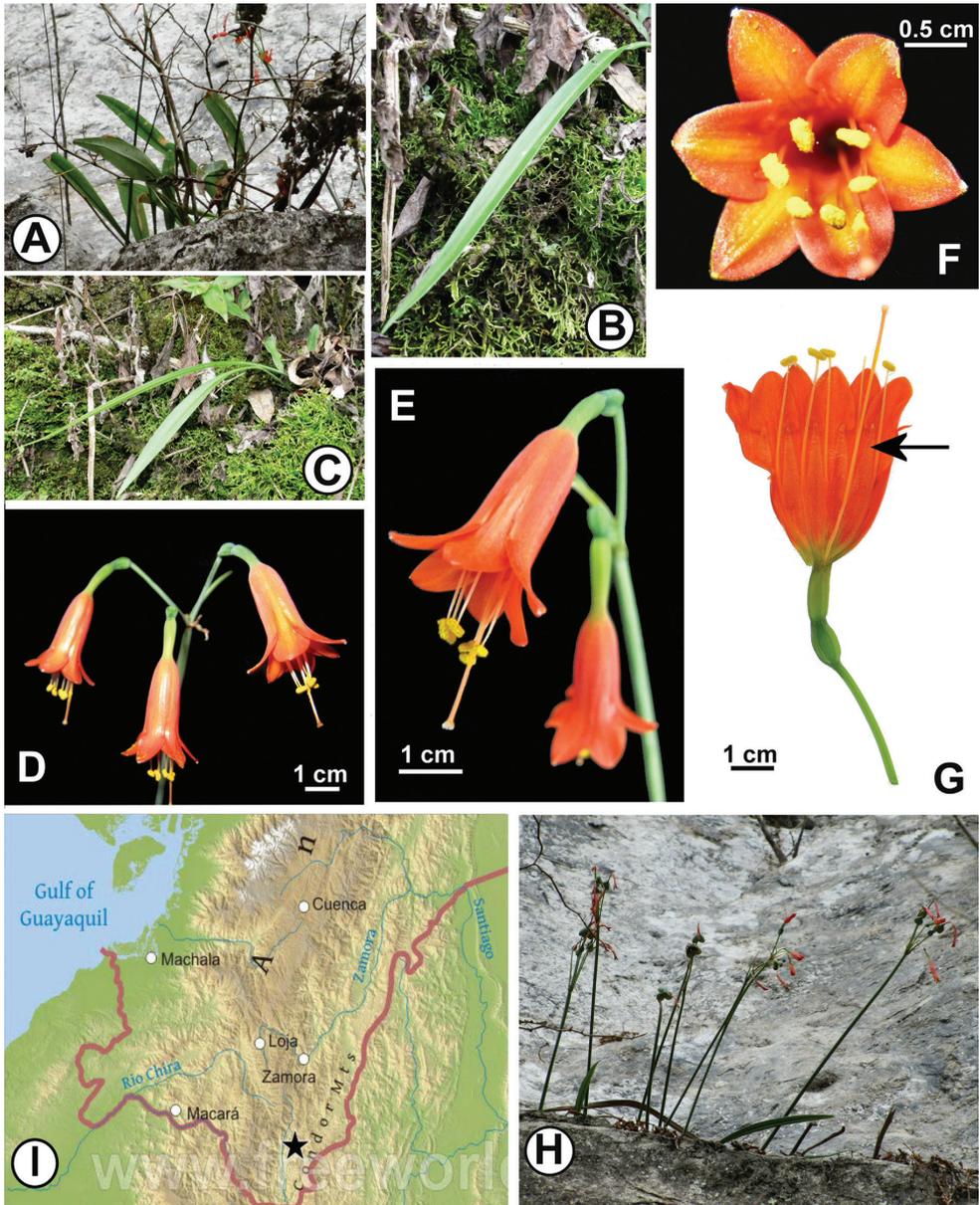


Figure 1. *Stenomeson ecuadorensis*. **A–C** Plants in habit on limestone cliff **D–G** Inflorescence and flowers. Arrow in **G** denotes androecial teeth interposed between the free filaments **H** Plants in fruit in habitat **I** Distribution in Ecuador (black star). Map courtesy of www.freeworldmaps.net. The apparent yellowish stripes in Fig. 1F are artifacts of camera flash reflectance and are not visible by eye.

Description. Geophytic, hysteroanthous, perennial from tunicate bulbs. Bulbs globose to ovoid, offsetting readily, tunics brown, 2–4 cm diam, apically forming a neck 1–5 cm long. Leaves (Fig. 1A–C) 1–2 per bulb, glabrous, 18.5–30 cm long, tapering at

Table 1. Contrasting features of *Stenomesson ecuadorensis*, *S. campanulatum* and *S. miniatum*.

Character	<i>Stenomesson ecuadorensis</i>	<i>S. campanulatum</i>	<i>S. miniatum</i>
Pedicle length	19–28 mm	25–40 mm	12–25 mm
Perianth morphology	Long-campanulate	Campanulate	Urceolate
Limb morphology	Flaring	Non-patent	Flaring, apically recurved
Exsertion of stamens beyond perianth	ca. 10 mm	25–30 mm	5–10 mm
Elevation	< 1300 m	2200–2600 m	2500–3500 m

**Figure 2.** Species closely related to the new taxa described in this paper. **A** *Stenomesson miniatum* (Meerow 1148, FTG) **B** *S. campanulatum* (Meerow 2445 (NA)) **C** *Eucharis moorei* (Meerow & Meerow 1141, FLAS).

base to a ca. 5 cm long hemiterete pseudopetiole; lamina lanceolate, sometimes slightly falcate, 14–14.5 × 1.8–3.0 cm wide at the middle, midrib inconspicuous adaxially, prominent abaxially, acute at apex, Royal Horticultural Society Color Chart (RHSCC, Royal Horticultural Society 1995) green 137A adaxially, 137D abaxially. Inflorescence scapose, 1–4 flowered, scape 25–30 cm tall, 3.7–3.9 mm diam, terete, glaucous, solid for most of its length with a narrow lumen apically, terminated by 2 marcescent ovate-lanceolate bracts enclosing the buds in the early stages of elongation, 20.9–21.6 mm long, 3.4–3.6 mm wide at base, 6 mm wide at middle, acute at apex. Flowers (Fig. 1D–G) pendulous via the spreading pedicels and curvature of the tube, 3.6–4 cm long from base of ovary to limb apex; pedicels 19–28 × ca. 0.5 mm. Perianth (Fig. 1D, E) actinomorphic, cylindrical proximally, distally campanulate, consisting of six tepals in two whorls, fused below the throat into a tube that is 2.7–3 mm diam, cylindrical, and green in the proximal 1–1.2 cm, constricting to 1.8–2.3 mm in its distal 3–4 mm

before abruptly dilating to 7.3 mm and becoming orange (RHSCC orange red 33A). Limb of free tepals (Fig. 1F) spreading ca. 60° from the throat, 1.7–1.9 cm wide; outer tepals 9.8–10.6 mm × 4.8–5.6 mm (at middle), acute, with a white, papillose apiculum; inner tepals 7.5–8.5 mm long, 6.5–7 mm wide, minutely apiculate. Stamens joined at base into an inconspicuous membranous staminal corona in the form of six 0.8–1.0 cm long lanceolate, acute teeth, fused to the perianth tube except for the apical 1.0 mm of each tooth (Fig. 1G), with the filaments inserted between; free filaments filiform, light orange for their proximal third, then white in their distal 2/3, 1.7–1.8 cm long, exerted ca. 1 cm beyond the limb; anthers 1.8–2 mm long, oblong, dorsifixed, introrse; pollen yellow. Style 3.5–3.7 cm long, exerted 5–6 mm past stamens, orange, fading to light orange distally; stigma obscurely tri-lobed, 1–1.4 mm wide. Ovary ellipsoid, ca. 6.7 mm long, ca. 3.2 mm wide, ovules 20 or more per locule, axile in placentation. Mature fruit (Fig. 1H) a trigonous, papery, tri-loculicidal capsule ca. 1 cm long and 1.5 cm wide; seeds numerous, papyraceous, flattened, shortly obliquely winged, with a dark brown phytomelanous testa.

Distribution and ecology. *Stenomesson ecuadorensis* is so far only known from the type locality in southern Ecuador (Fig. 1I) where it grows on what appear to be limestone cliffs above the Río San Luis, just below 1300 m. It was first found by LJ in 2006 and subsequently examined in the field by AM and NO in 2009. As so far known, the species is restricted to these cliffs where it grows in cracks, crevices and narrow shelves on the rock where pockets of humus accumulate. We estimate the population that we observed to consist of several hundred individuals. The full extent of occurrence is not yet known.

Etymology. The species is named for the nation of Ecuador, to where it so far appears to be endemic.

Additional material examined. ECUADOR: Zamora Chinchipe, same locality as type, 1254 m elev., 04°33'38"S, 79°04'39"W, flowering. 23 June 2014, Pérez A. J., et al. 7260 (QCA).

Notes. The genus *Stenomesson* Herb. (*sensu* Meerow et al. 2000) includes about 15 spp., and is primarily found in Peru, with only *S. aurantiacum* Herb. previously reported from Ecuador (Meerow 1990). The genus usually occurs in seasonally dry, grassy vegetation or at the margins of cloud forest above 2000 m elevation, but is also found in Peruvian inter-Andean valleys below 2000 m (Meerow and van der Werff 2004), and the loma formations along the coast of Peru. The new species, *S. ecuadorensis*, is found below 1300 m elevation in relatively wet habitat.

Stenomesson ecuadorensis appears closely related to *S. miniatum* (Peru, Bolivia; Fig. 2A) and *S. campanulatum* Meerow (Peru; Fig. 2B) by the orange flower color and fusion of the staminal corona to the floral tube, but differs from them (Table 1) by the unusual limestone habitat and relatively low elevation. *S. miniatum* has an urceolate corolla, and is always found above 2000 m in elevation to as high as 3500 (unpubl. herbarium data). *S. campanulatum* has a non-patent limb and long-exserted stamens (Meerow 1985). The perianth of *S. ecuadorensis* has flaring tepals as does *S. miniatum*,

but is long campanulate in morphology. It is only the second species of the genus (*sensu* Meerow et al. 2000) reported from Ecuador, and so far the only endemic one.

***Eucharis ruthiana* Jost, Oleas & Meerow, sp. nov.**

urn:lsid:ipni.org:names:77146128-1

Fig. 3

Diagnosis. *Eucharis ruthiana* appears closely related to *E. moorei* (Baker) Meerow (Meerow 1987a), placing it in *E.* subg. *Heterocharis* Meerow, characterized by large campanulate, fragrant flowers, numerous ovules per locule, and green mature capsules (Meerow 1989). It differs from this species by the narrower leaves and tepals, mild (vs. strong) fragrance, deeply cleft staminal corona with long marginal teeth, the incurved free filaments, and the short style (Table 2). From the putative hybrid *E.* × *grandiflora* Planch. & Lind., (1853) it differs by the long staminal teeth and its fertility.

Type. ECUADOR: Zamora-Chinchi, near Zamora, on rocky soil in the understory of lower montane forest ca. 1100 m elevation, June 2006, Jost 8278 (Holotype: QCA!, Isotypes: QCNE!).

Description. Geophytic, evergreen perennial from tunicate bulbs, tunics reddish brown, thin; immature bulb ca. 3 cm × 2.5 cm. Leaves (Fig. 3A–C) 2–5 per bulb, glabrous, tapering at base to a 19–18 cm long pseudopetiole that is 6–8 mm thick; lamina elliptical, ca. 28 cm × 9 cm, dark green adaxially and shallowly plicate, light green abaxially, acute at apex. Inflorescence scapose, scape 8–16 flowered, ca. 40 cm tall, 4 mm diam, terete, glaucous, solid, terminated by 2 greenish-white, eventually marcescent ovate-lanceolate bracts enclosing the buds in the early stages of elongation, ca. 3 cm long, ca. 5 mm wide at base, acute at apex. Flowers (Fig. 3D–G) slightly declinate, white, mildly fragrant, 4.5–5.0 cm long; pedicels 2–6 cm long, the last flowers to reach anthesis with the longest, with a narrow bracteole subtending each. Perianth (Fig. 3D, E) actinomorphic, funnel-form-campanulate, consisting of six tepals in two whorls, fused below the throat into a slightly curved tube that is 15–2.0–2.2 cm long 2.7–3 mm diam, white for its entire length, cylindrical in the proximal 1.3–1.5 cm, then funnel-form distally, dilating to 0.85–10.0 mm at throat, limb spreading ca. 60° from the throat, 5–6 cm wide; outer tepals 28–36 mm × 15 mm, acute, with a white, ca. 3 mm long papillose apiculum; inner tepals 27–35 × 17–19 mm, minutely apiculate. Stamens joined at base into a 2.5–3.0 × 1.5–2.0 cm staminal corona deeply divided into six pairs of lanceolate, free, tooth-like processes, such that only the lower 2.6–3.0 mm of the corona is connate, stained yellowish-green along the filamental traces, most prominently on the inside surface; each tooth 7.5–8 mm long, acute at the apex and slightly recurved above the middle, with the six free filaments inserted between the teeth of each pair; free filaments narrowly subulate, slightly incurved towards center of the corona, 3–4 mm long, anthers oblong, 3–4 × < 1 mm, white, dorsifixed, introrse; pollen white. Style 2.3–2.6 cm long, not exerted past stamens, white; stigma tri-lobed, papillate, ca. 2 mm wide. Ovary ellipsoid, 4–5 mm long, ca. 3.2 mm

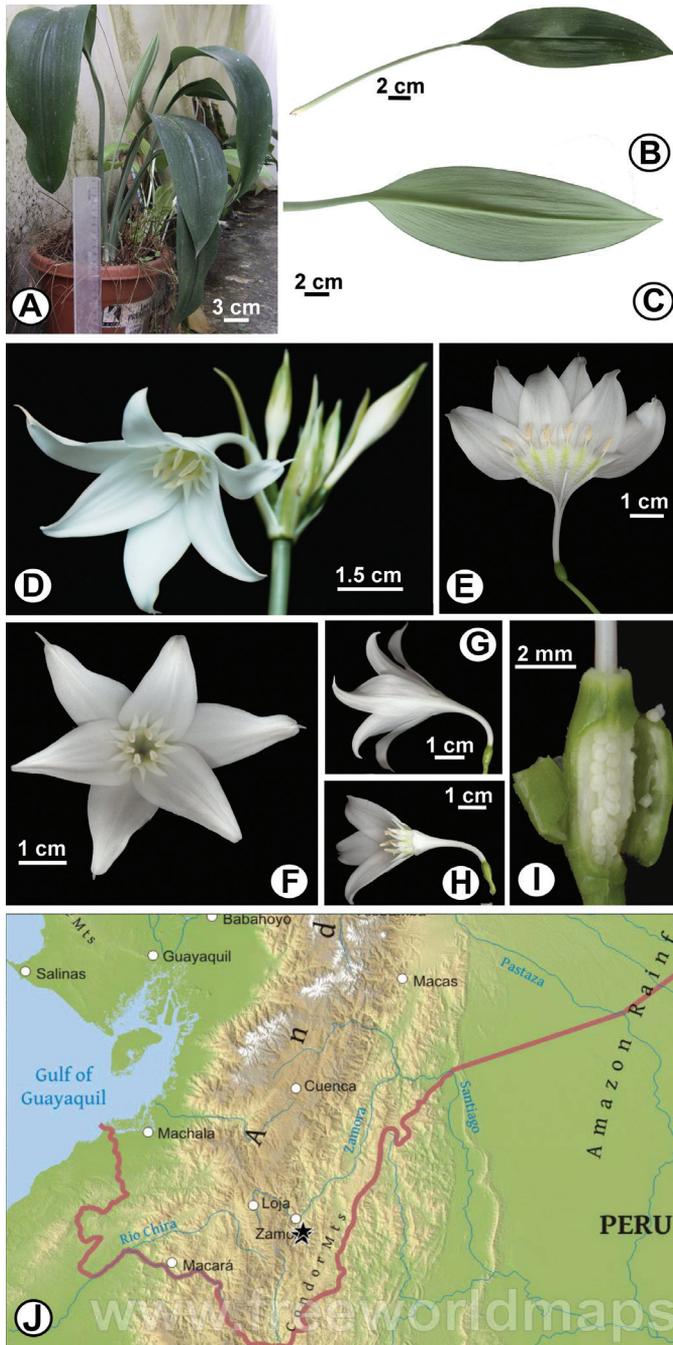


Figure 3. *Eucharis rubiana*. **A** Plant in cultivation **B–C** Leaves **B** Adaxial view **C** Abaxial view **D–H** Flowers **D** Upper portion of inflorescence showing flower habit **E** Flower cut and spread to show staminal corona **F** Dorsal-ventral view of limb showing the spread of the androecium **G** Lateral view **H** Lateral view with three tepals removed to show androecium **I** Ovary dissected to show numerous, superposed, globose ovules **J** Distribution of *E. rubiana* in Ecuador (black stars). Map courtesy of www.freeworldmaps.net.

Table 2. Contrasting features of *Eucharis ruthiana* and *E. moorei*.

Character	<i>Eucharis ruthiana</i>	<i>E. moorei</i>
Leaf/width ratio	3:1	< 2:1
No. flowers	8–16	4–7
Tepal width	15–19 mm	17–27 mm
Staminal corona	Deeply incised	Connate for most of its length
Length of staminal teeth	7.5–8 mm	2.5–3 mm
Habit of free staminal filament	Incurved	Straight
Style length	2.3–2.6 cm	6–7 cm
Floral Fragrance	Mild	Strong

wide, ovules 16–20 per locule, superposed, axile in placentation. Ripe fruit green, seed globose, bluish-black.

Distribution and ecology. *Eucharis ruthiana* is only known from the type locality and a private reserve in southern Ecuador (Fig. 3I), in lower montane rain forest where it grows on stony soil in the understory of dense forest at ca. 1100 m elevation. A large population occurs on the Copalinga private reserve near Zamora according to the property owner.

Etymology. The species is named in honor of the late Ruth Moore, ardent supporter of conservation efforts in Ecuador.

Notes. *Eucharis* subg. *Heterocharis* was erected by Meerow (1989), even though it appeared paraphyletic in his cladistic analysis of morphological characters. The large, fragrant flowers; numerous ovules per locule, and mature green fruits were considered symplesiomorphic for the genus. The subgenus previously included only two fertile species, *E. sanderi* Baker (1883), endemic to the Chocó region of Colombia, and *E. moorei* (Baker) Meerow (1987a), found on both the eastern and western declivities of the Ecuadorean Andes. The group also contains two apparently sterile taxa, *E. × grandiflora* Planch. & Lind. (1853), a putative hybrid of *E. moorei* and *E. sanderi*, found in southern Colombia and northern Ecuador (Meerow 1989), most often in cultivation, and *E. amazonica* Lind. ex Planch. (Meerow and Dehgan 1984). The latter, most commonly found in the lower Huallaga Valley of Peru, never sets seed, has a triploid-derived chromosome number ($2n = 68$), and impaired pollen fertility (Nagalla 1979; Meerow 1987b). *Eucharis ruthiana* appears most closely related to *E. moorei*, but is easily separable (Table 2) by the narrower leaves and tepals, the deeply cleft staminal cup with long marginal teeth, the short, nearly filiform, incurved free filaments, and the relatively short style.

Acknowledgements

We thank the Ecuadorean Ministerio del Ambiente for granting collecting permits 001 IC–FLO–DNBAPVS/MA and 002 IC–FLO–DNBAPVS/MA to LJ. We thank Dee Snijman and Nicolás García for their careful review of an early version of this paper.

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Psephellus vanensis (Asteraceae), a new species from east Turkey

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Academic editor: A. Sennikov | Received 31 October 2014 | Accepted 24 March 2015 | Published 2 April 2015

Citation: Dogan B, Behçet L, Duran A, Avlamaz D (2015) *Psephellus vanensis* (Asteraceae), a new species from east Turkey. *PhytoKeys* 48: 11–19. doi: 10.3897/phytokeys.48.8870

Abstract

A new species, *Psephellus vanensis* A.Duran, Behçet & B.Dogan (Asteraceae) from Anatolia, Turkey, is described and illustrated. The species grows on the serpentine stony field of the village of Çaldıran in the district of Başkale (Van province) in eastern Anatolia. It is morphologically similar to *Psephellus pyrrohoblepharus* (Boiss.) Wagenitz. Diagnostic characters are discussed, and a key to the most similar species is provided. Ecology, conservation status and notes on biogeography of the species are also presented. In addition, the geographical distribution of the new species and other related species in Turkey is mapped.

Keywords

Anatolia, Compositae, taxonomy

Introduction

The genus *Psephellus* Cass. embraces 75–80 species. Its distribution is centered in east Anatolia, the Caucasus and northwest Iran; only few species occur outside this area (Wagenitz and Hellwig 2000).

In Wagenitz and Hellwig (2000), 12 sections that had been included in the genus *Centaurea* were transferred to the genus *Psephellus*, namely *P.* sect. *Psephelloideae* (Boiss.) Wagenitz & Hellwig, *P.* sect. *Psephellus* (Cass.) Wagenitz & Hellwig, *P.* sect. *Hyalinella* (Tzelev) Wagenitz & Hellwig, *P.* sect. *Aetheopappus* (Cass.) Wagenitz & Hellwig, *P.* sect. *Odontolophus* (Cass.) Wagenitz & Hellwig, *P.* sect. *Xanthopsis*

(DC.) Wagenitz & Hellwig, *P.* sect. *Amblyopogon* (DC.) Wagenitz & Hellwig, *P.* sect. *Heterolophus* (Cass.) Wagenitz & Hellwig, *P.* sect. *Czerniakovskya* (Czerep.) Wagenitz & Hellwig, *P.* sect. *Odontolophoideae* (Tzvelev) Wagenitz & Hellwig, *P.* sect. *Uralepis* (DC.) Wagenitz & Hellwig and *P.* sect. *Sosnovskya* (Takht.) Wagenitz & Hellwig. New combinations under the genus *Psephellus* were provided for these sections and 35 species, especially from Turkey and Iran. Some of these species occur only in Turkey.

In Turkey, *Psephellus* is represented by 31 species including some recently described species. After Wagenitz and Hellwig (2000), *P. turcicus* A.Duran & E.Hamzaoglu, *P. recepui* Wagenitz & Kandemir, *P. erzincanii* Wagenitz & Kandemir, *P. coruhensis* A.Duran & M.Öztürk, *P. yusufeliensis* O. Tugay & Uysal were described (Duran and Hamzaoglu 2005, Wagenitz and Kandemir 2008, Duran et al. 2009, Tugay et al. 2009). *Psephellus yusufeliensis* was reduced to a synonym of *P. coruhensis* (Duran et al. 2014).

During a field trip, some specimens of the genus *Psephellus* were collected in eastern Anatolia, in the Van province. After examining carefully the specimens and the descriptions of *Psephellus* species in Wagenitz (1975), Dostal (1976), Davis et al. (1988), Wagenitz et al. (1998), Wagenitz and Hellwig (2000), Güner (2000), Duran and Hamzaoglu (2005), Wagenitz and Kandemir (2008), Duran et al. (2009), as well as comparing with specimens in the Herbaria KNYA, ANK, GAZI, GOET, HUB, E, K and BM, it was determined that our specimens represent a species new to science. In this paper, this new species of *Psephellus* is described and illustrated.

In the description below, each numerical value is the average of ten measurements from different specimens. Our specimens of *Psephellus vanensis* sp. nov. were examined and compared with specimens of the related species *P. pyrrhoblepharus* and *P. gilanicus* collected in Turkey. With the new species described here, the total number of taxa in the genus *Psephellus* has risen to 32 in Turkey.

Taxonomic treatment

Psephellus vanensis A. Duran, Behçet & B. Doğan, sp. nov.

urn:lsid:ipni.org:names:77146129-1

Figs 1–3

Diagnosis. *Psephellus vanensis* differs from *P. pyrrhoblepharus* in its stem 13–20 cm tall and tomentose (vs. (20–)30–50 cm, floccose-tomentose), basal leaves usually undivided and elliptic to lanceolate, rarely lyrate with 2–3 pairs of lateral segments (vs. lyrate with very large broadly lanceolate terminal segment and 1–2 pairs of small lateral segment), involucre 11–17 × 11–14 mm, bowl-shaped (vs. 20–25 × 15–25 mm, ovoid to nearly globose), achenes 4–5 mm long (vs. 6–7 mm), pappus 5–6 mm long (vs. 4–7 mm long), inner row of scales 1–2 mm long (vs. 3–4 mm long).

Type. TURKEY. Van: Başkale, Çaldıran village, steppe fields, 2000–2050 m a.s.l., 17 Jun 2009, Behçet & D. Avlamaz 1603 (holotype: KNYA, isotypes: GAZI, ANK, HUB, Bingöl Univ. Herb.).

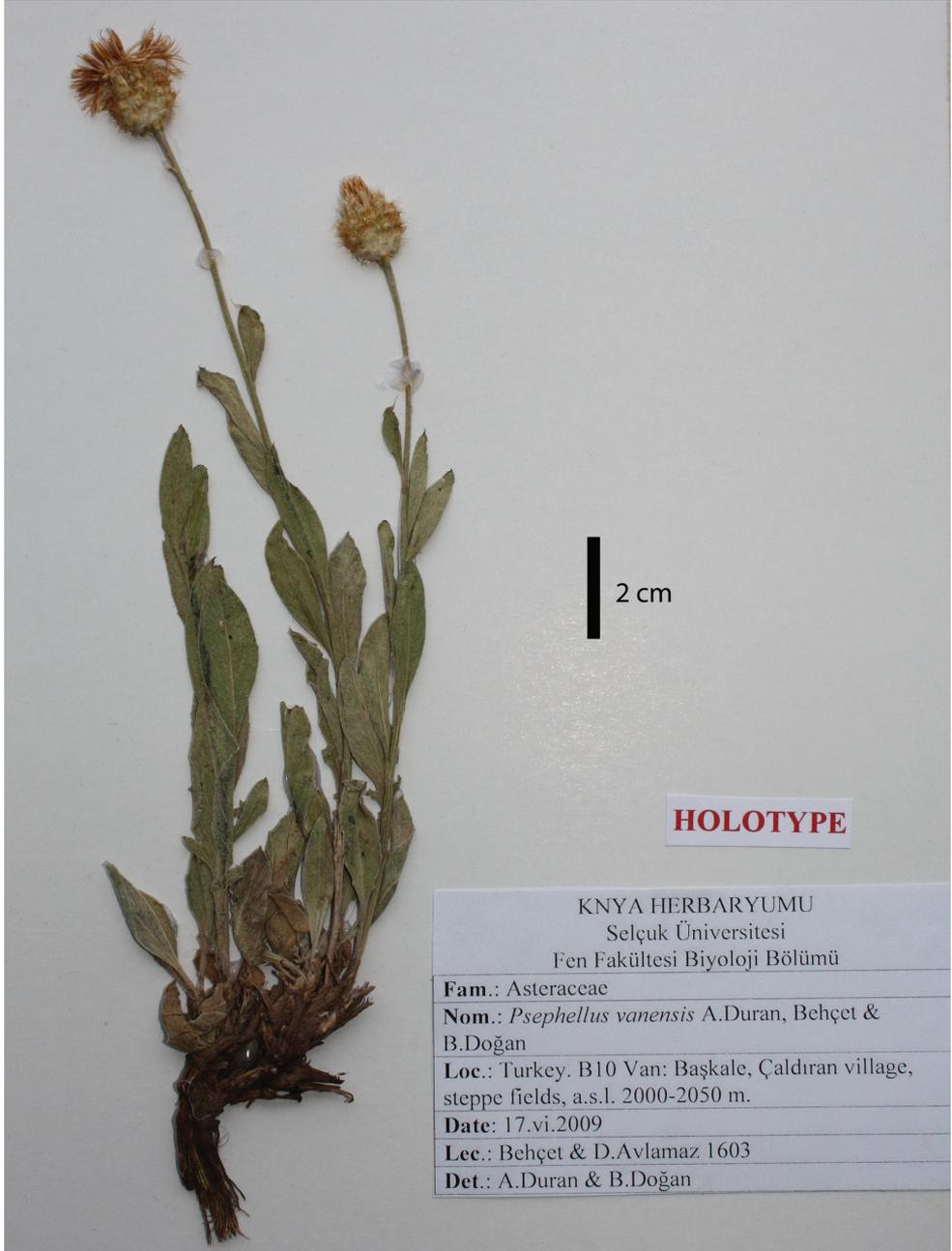


Figure 1. Holotype of *Psephellus vanensis* A.Duran, Behçet & B.Doğan.

Description. Perennial herb with a woody rootstock. Stem erect, striate, densely tomentose, 13–20 cm tall, 1.3–2 mm in diameter at base, simple, upper parts of stems leafless. Leaves concoloured, green, densely tomentose; basal leaves usually undivided

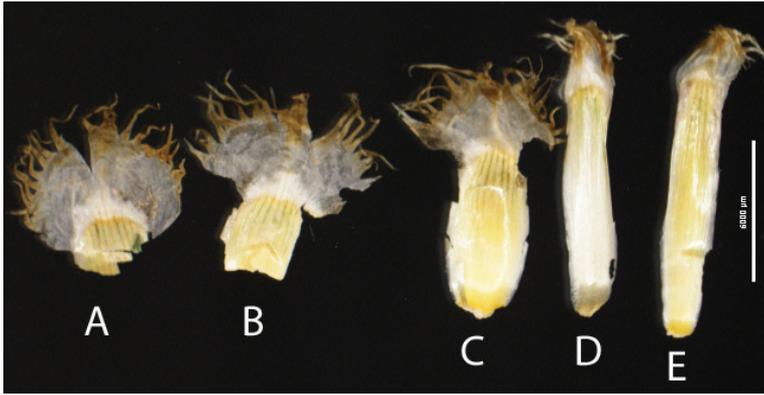


Figure 2. Phyllaries of *Psephellus vanensis*. **A, B** Outer phyllaries **C** Median phyllaries **D, E** Inner phyllaries. Scale bar: 6000 μm .

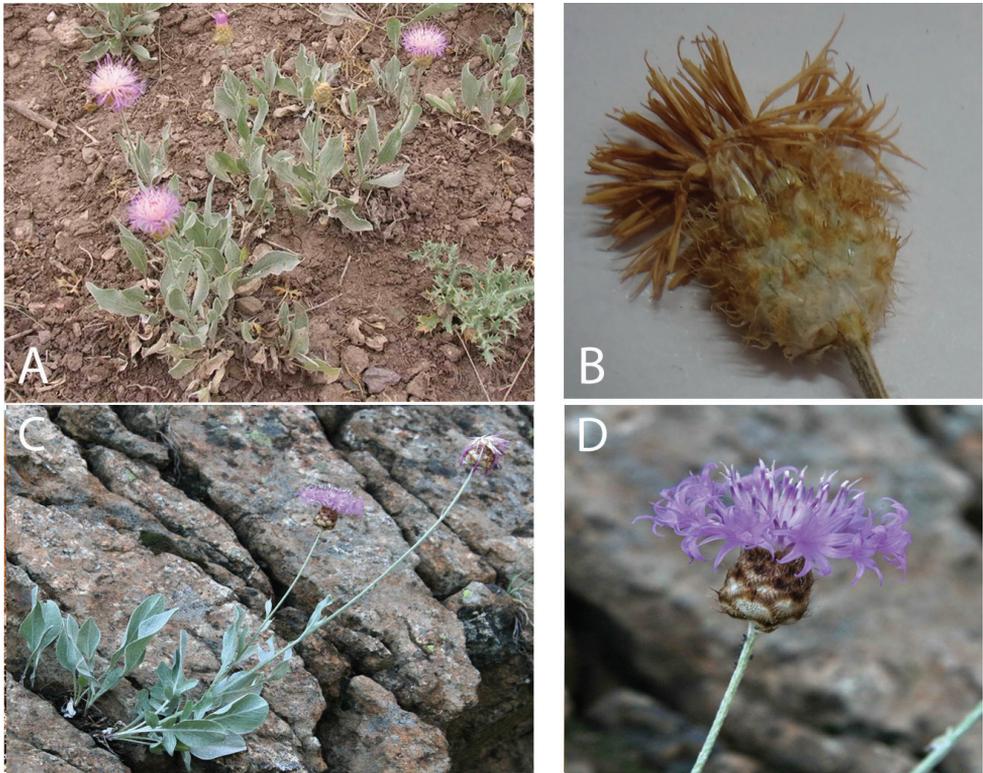


Figure 3. *Psephellus vanensis*. **A** Habit **B** Capitulum at anthesis. *Psephellus pyrroblepharus*. **C** Habit **D** Capitulum at anthesis.

and elliptic to lanceolate, 3–7 \times 0.6–1.2 cm (including petiole), rarely lyrate with 2–3 pairs of lateral segments; cauline and upper cauline leaves undivided and lanceolate, partly decreasing in size towards capitula, 1–2.5 \times 0.2–0.9 cm. Capitula solitary,

18–28 × 11–15 mm (including flowers). Involucre 11–16 × 11–14 mm, bowl-shaped. Phyllaries nearly imbricate, glabrous; appendages conspicuous, large, concealing most of the basal part of phyllaries, scarious, pale-brownish, with distinct cilia, cilia 1–2 mm long, 8–10 cilia on each side. Corolla pink-violet. Marginal florets slightly longer than central florets, radiant, 12–13 mm long, without staminode, with 5 narrowly linear-lanceolate lobes 3–4 mm long; central flowers radiant, 10–11 mm long, without staminode, with 5 lobes 2–3 mm long. Achenes 4–5 mm, straw-colored to brownish, smooth, glabrous; pappus 5–6 mm, inner row of scales 1–2 mm, scabrous. Flowers in June–July and fruits in July–August.

Ecology. The new species occurs on steppe fields, whereas *Psephellus pyrrhoblepharus* is found on rocks and slopes. *Psephellus vanensis* grows in plant communities with *Asyneuma pulchellum* (Fischer & C.A.Mey.) Bornm., *Campanula conferta* DC., *Tanacetum kotschyi* (Boiss.) Grierson, *Bromus danthoniae* Trin., *Bromus tomentellus* Boiss., *Eryngium billardieri* Delar., *Helichrysum plicatum* DC., *Thymus kotschyanus* Boiss. & Hohen. var. *kotschyanus*, *Ziziphora clinopodioides* Lam., *Achillea vermicularis* Trin., *Gundelia tournefortii* L. var. *tournefortii*, *Erysimum echinellum* Hand.-Mazz., *Iris paradoxa* Steven, *Dactylis glomerata* L. subsp. *glomerata*, *Stipa pontica* P.Smirnov, *Prangos pabularia* Lindley and *Dianthus orientalis* Adams.

Distribution and conservation status. *Psephellus vanensis* is endemic to east Anatolia, where it seems to be very local. It belongs to the Irano-Turanian element (Fig. 4). The species is known only from type gatherings and from an area of approximately 0,006 km² (criterion B1). Because of overgrazing, the habitat of this species is under threat, and this situation leads to potential reduction in the number of individuals (criterion A). The population is in a poor condition, and the number of individuals is estimated to approximately 120–125 (criterion C2). Therefore the species should be regarded as Critically Endangered (IUCN 2014).

Key to the related *Psephellus* species

- 1 Stem taller than 20 cm, appendages straw-coloured, achenes 6–7 mm long... 2
- Stem shorter than 20 cm, appendages pale brownish, achenes 4–5 mm long....
..... *P. vanensis*
- 2 Cauline leaves pinnatilobate or undivided, appendages with ciliae 3–5 mm long, pappus 4–7 mm long..... *P. pyrrhoblepharus*
- Cauline leaves lanceolate to linear-lanceolate, appendages with ciliae 1–2 mm long, pappus 8–9 mm long..... *P. gilanicus*

Taxonomic position. The new species is placed in *P.* sect. *Psephelloidei* (Boiss.) Wagenitz & Hellwig according to the involucre and achene characters as determined by Wagenitz (1975), Wagenitz and Hellwig (2000).

Affinity. *Psephellus vanensis* is closely related to *P. pyrrhoblepharus*, which occurs in Central Anatolia and is endemic to Turkey. It mainly differs from *P. pyrrhoblepharus* in its stem 13–20 cm tall and densely tomentose (vs. 30–50 cm, floccose-tomentose),

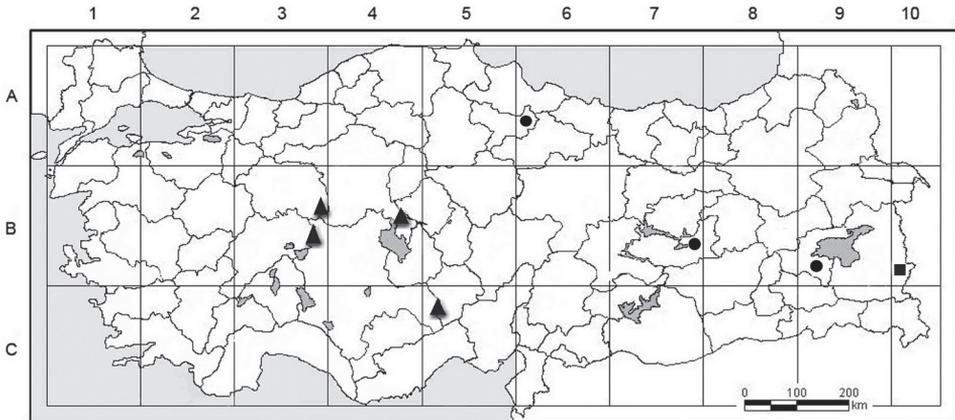


Figure 4. Distribution maps of *Psephellus vanensis* (■), *P. pyrrohoblepharus* (●) and *P. bornmuelleri* (▲) in Turkey.

basal leaves usually undivided and elliptic to lanceolate, rarely lyrate with 2–3 pairs of lateral segments (vs. lyrate with very large broadly lanceolate terminal segment and 1–2 pairs of small lateral segments).

Psephellus vanensis is also related to *P. gilanica*, which is endemic to Iran (Wagenitz 1980). It mainly differs from *P. gilanica* in its stem 13–20 cm tall (vs. 25–40 cm), tomentose (vs. sparsely floccose-tomentose), basal leaves usually undivided and lanceolate, rarely lyrate with 2–3 pairs of lateral segments (vs. lyrate with 2–3 pairs of lateral segments).

Additional characters of *P. vanensis* and the related species *P. gilanica* and *P. pyrrohoblepharus* are provided in Table 1.

Psephellus vanensis also resembles *P. bornmuelleri*, which occurs in Central Anatolia and is endemic in Turkey. It mainly differs from *P. bornmuelleri* in its stem 13–20 cm tall and tomentose (vs. 35–70 cm, sparsely tomentose to glabrescent), basal leaves usually undivided and elliptic to lanceolate, rarely lyrate with 2–3 pairs of lateral segments (vs. pinnatipartite or lyrate, with 4–6 pairs of lateral segments), involucre 11–17 × 11–14 mm, bowl-shaped (vs. 15–20 × 15–25 mm, ovoid to nearly globose), appendages pale brownish (vs. straw-coloured), flowers pink-violet (vs. purple), achenes 4–5 mm long (vs. c. 7 mm long).

Phytogeography. The east Anatolia region is a botanically interesting area, occupying the Irano-Turanian phyto-geographical region. The area is very rich in local endemic plants (Akman et al. 2011; Koçyiğit and Bona 2013). Recently many articles were published on new species from this particular region, notably *Ferula mervynii* M. Sağiroğlu & H. Duman (Sağiroğlu and Duman 2007), *Silene dumanii* Kandemir, G. Ecevit Genç & İ. Genç (Kandemir and Genç 2009), *Jurinea tortumensis* A. Duran & B. Dogan (Dogan et al. 2010), *Campanula hacerae* A. İlçim (İlçim et al. 2011), *Silene gevasica* Hamzaoğlu (Hamzaoğlu et al. 2011), *Allium shirnakiense* L. Behçet & Rüstemoğlu (Behçet and Rüstemoğlu 2012), *Rhabdosciadium urusakii* E. Akalın

Table I. Diagnostic characters of *Psephellus vanensis*, *P. gilanicus* and *P. pyrrhoblepharus*.

Characters	<i>Psephellus vanensis</i>	<i>Psephellus pyrrhoblepharus</i>	<i>Psephellus gilanicus</i>
Stem	13–20 cm tall, tomentose	30–50 cm tall, floccose-tomentose	25–40 mm tall, sparsely floccose-tomentose
Basal leaves	usually undivided and elliptic to lanceolate, rarely lyrate with 2–3 pairs of lateral segment	lyrate with very large broadly lanceolate terminal segment and 1–2 pairs of small lateral segments	lyrate, 2–3 pairs of lateral segments
Cauline leaves	undivided, lanceolate	pinnatilobate or simple	lanceolate to linear-lanceolate
Involucre	11–17 × 11–14 mm, bowl-shaped	20–25 × 15–25 mm, ovoid to nearly globose	(14–)16–20 × (11–)14–18 mm, subglobose
Appendages	pale-brownish	straw-coloured	straw-coloured
Appendages, cilia	8–10 cilia on each side, 1–2 mm long	7–8 cilia on each side, 3–5 mm long	8–14 cilia on each side, 1–2 mm long
Flowers	pink-violet	rose-purple	pink-purple
Achenes	4–5 mm long	6–7 mm long	6–7 mm long
Pappus	5–6 mm long, inner row of scales 1–2 mm long	4–7 mm long, inner row of scales 3–4 mm long	8–9 mm long, inner row of scales 2–3 mm long

(Akalin and Akpulat 2012), *Onosma atila-ocakii* O Koyuncu & Yaylacı (Koyuncu et al. 2013) and *Crocus yakarianus* Yıldırım & O. Erol (Yıldırım and Erol 2013).

Additional specimens examined. *Psephellus pyrrhoblepharus*: Turkey, B7 Elazığ: Harput, around the Anguzu Baba Türbesi, 1560 m., 14 Jun 2007, *A. Duran 7464*, *B. Dogan & M. Öztürk* (KNYA!); A6 Amasya: Akdağ, above Zefe köy, 1700 m., *Tobey 1207* (E, photo!); B9 Bitlis: Kambos Da., above Hürmüz, 1800 m., 31 Jun 1954, *Davis 23403* (E, photo!).

Psephellus bornmuelleri: Turkey, C5 Konya: between Ereğli-Niğde, 1400 m, 1904, *W.Siehe* (E, photo!); B3 Eskisehir: c. 15 miles from Polatlı to Sivrihisar, 800 m, 12 Jun 1965, chalky fields, *Coode & Jones 2252* (E, photo!); Ankara: Polatlı, Acıkır vicinity, 840–860 m, 2 Jun 1995, gypsum places, *Aytaç 6893 & Adigüzel* (GAZI!); Ankara: Polatlı, Acıkır vicinity, 840–860 m, 22 Jun 1993, *Duman 4812 & Aytaç* (GAZI!); Ankara: Polatlı, Acıkır vicinity, 840–860 m, 4 Jun 1991, *Aytaç 3822 & Duman* (GAZI!); B4 Ankara, between Şereffikoçhisar-Ankara, 10 km, saline places, 900–950 m, 5 Jun 2002, *Aytaç 8374 & M.Ekici* (GAZI!).

Psephellus gilanicus: Iran, Tehran: prope Shekerabad, 2200 m, *Bornmüller 7266* (B, photo!).

Note: Davis's grid system was used for the coordinates.

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Dianthus aticii, a new species from Turkey (Caryophyllaceae)

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Academic editor: C. Morden | Received 4 January 2015 | Accepted 24 March 2015 | Published 2 April 2015

Citation: Hamzaoğlu E, Koç M, Aksoy A (2015) *Dianthus aticii*, a new species from Turkey (Caryophyllaceae). PhytoKeys 48: 21–28. doi: 10.3897/phytokeys.48.4446

Abstract

During the taxonomic revision of the Turkish *Dianthus* species, specimens collected from Bilecik, Seben (Bolu), and Nallıhan (Ankara) were discovered that represent a new species. Its description, images, chorology, ecology, and threat category are provided. It was compared with a closely related species, *D. zonatus*, and differences are based on its general morphology and seed micromorphology.

Keywords

Dianthus, new species, section *Dentati*, taxonomy, Turkey

Introduction

The genus *Dianthus* L. (or carnation, pink, sweet william) is easily distinguished from the other genera in the family Caryophyllaceae by its epicalyx scales, tubular calyx, and peltate seeds. Furthermore, it is the second largest genus of the family in Turkey, with the highest number of species after *Silene* L. (Reeve 1967, Bojňanský and Fargašová 2007). This genus consists of approximately 300 species and is mainly distributed across the Mediterranean region of Europe and Asia (Bittrich 1993).

The most comprehensive taxonomic revision of *Dianthus* species of Turkey was carried out by Reeve (1967), who recognized 67 species from this region. Since Reeve's revision, nine species have been added (Davis et al. 1988, Gemici and Leblebici 1995,

Güner 2000, Menemen and Hamzaoğlu 2000, Aytaç and Duman 2004, Özhatay and Kültür 2006, Vural 2008, Yılmaz et al. 2011, İlçim et al. 2013), bringing the current total to 76 species.

In the course of performing a taxonomic revision of *Dianthus* species of Turkey, specimens from Bilecik, Seben (Bolu), and Nallıhan (Ankara) were identified as *D. zonatus* Fenzl based on their appearance and present-day key characteristics. However, on further study, it was revealed that they belonged to a new species. This study was undertaken to recognize this new species and to characterize the differences between these two species.

The specimens collected from Bilecik, Seben (Bolu), and Nallıhan (Ankara) were found to be distinct from those of *D. zonatus* on the basis of vegetative, floral, and seed characteristics (Table 1). Vegetative characters of the new species include a suffruticose habit as opposed to herbaceous in *D. zonatus*, and leaves that are subulate and subcanaliculate rather than linear and flattened. Floral characters of the epicalyx and petals are smaller than those of *D. zonatus*, and seed shape and seed cell traits are distinctive between the two species. Based on these differences, it was clear that these specimens represent a previously undescribed species.

Materials and methods

Dianthus specimens were thoroughly evaluated using the relevant literature (Fenzl 1842, Boissier 1849, Tchihatcheff 1860, Reeve 1967, Bojňanský and Fargašová 2007) and the specimens present in GAZI herbarium. Furthermore, the specimens collected from the Bilecik population included the material needed for the seed micromorphology studies. Images were taken using a Canon EOS 60D digital camera, and the seed surface micromorphology was visualized using a LEO 440 scanning electron microscope. Normal visualization of the specimens was carried out using a Leica EZ4 HD microscope. The vegetative characters were measured using a ruler with 0.5 mm accuracy; floral characters were measured using an ocular micrometer. Seed morphology is described following the nomenclature of Bojňanský and Fargašová (2007). Specimens have been deposited in the herbaria of Gazi (GAZI) and Ankara Universities (ANK).

Taxonomic treatment

Dianthus aticii Hamzaoğlu, sp. nov.

urn:lsid:ipni.org:names:77146130-1

Figs 1, 2

Diagnosis. Stems suffruticose (not herbaceous); sterile shoot leaves subulate, subcanaliculate (not linear, flattened or absent); inner epicalyx scales with scarious margin

0.2–0.4 mm wide, arista 1/10–1/7 as long as scale (not with scarious margin 0.3–0.8 mm wide, arista 1/7–1/3 as long as scale).

Type. TURKEY. Bilecik: Bilecik highway exit towards Eskişehir, 40°06'27"N, 29°59'47'E, 330 m, stony slopes and steppes, 16 June 2013 (fl, fr), *E. Hamzaoğlu et al. 6743* (holotype: GAZI; isotypes: GAZI, ANK); **Bolu:** Seben, between Bozyer and Korucuk villages, 1025 m, forest clearings, flowing slopes, 19 July 2013, *M. Koç & E. Hamzaoğlu 6868* (paratypes: GAZI, ANK); **Ankara:** Nallihan, Gökçeöz village, road of forest watchtower, 820 m, forest clearings, stony slopes, 19 July 2013, *M. Koç & E. Hamzaoğlu 6869* (paratypes: GAZI, ANK).

Specimens examined. *Dianthus aticii* Hamzaoğlu sp. nov. – TURKEY. Bilecik: Bilecik highway exit towards Eskişehir, 40°06'27"N, 29°59'47'E, 330 m, stony slopes and steppes, 16 June 2013, *E. Hamzaoğlu et al. 6743* (holotype: GAZI; isotypes: GAZI, ANK); **Bolu:** Seben, between Bozyer and Korucuk villages, 1025 m, forest clearings, flowing slopes, 19 July 2013, *M. Koç & E. Hamzaoğlu 6868* (paratypes: GAZI, ANK); **Ankara:** Nallihan, Gökçeöz village, road of forest watchtower, 820 m, forest clearings, stony slopes, 19 July 2013, *M. Koç & E. Hamzaoğlu 6869* (paratypes: GAZI, ANK); ***Dianthus zonatus* Fenzl – TURKEY. Manisa:** Spil Dağı National Park, road of Atalanı resting area, 1320 m, calcerous rocks, 2 July 2011, *M. Koç & E. Hamzaoğlu 6106* (GAZI); **Kütahya:** İsehisar, around Seydiler, 1150 m, rocks, 5 August 2012, *E. Hamzaoğlu et al. 6584* (GAZI); **Eskişehir:** Around Sivrihisar, 1115 m, rocks, 24 June 2012, *E. Hamzaoğlu et al. 6339* (GAZI); **Konya:** Between Kulu and Cihanbeyli, Kulu exit, 1130 m, steppe, 13 July 2011, *E. Hamzaoğlu et al. 6122* (GAZI); **Ankara:** Polatlı, above Babayokuş village, 900 m, stony places, 2 July 2010, *M. Koç et al. 1205* (GAZI); **Aydın:** Between Söke and Didim, after 4 km from Güllübahçe exit, 820 m, 25 June 2006, *E. Hamzaoğlu et al. 4071* (GAZI); **Muğla:** Köyceğiz, above Yayla village, from Gökçeova Lake to Sandras Mountain summit, 1950 m, serpentine rocks, 15 July 2011, *E. Hamzaoğlu et al. 6198* (GAZI); **Antalya:** Elmalı, N of Vahhabi Ümmi Türbesi, 1480 m, rocks, 12 June 2007, *M. Koç & Ü. Budak 2152* (GAZI); **Karaman:** Between Ermenek and Karaman, 16 km, 1670 m, Pine forest openings, stony places, 18 July 2005, *Ü. Budak et al. 1743* (GAZI); **Niğde:** Çamardı, above Demirkazık village, 1475 m, rocks, 11.7.2012, *E. Hamzaoğlu et al. 6449* (GAZI).

Description. Suffruticose, several-stemmed, subpruinose herbs. Stems erect, fragile, 20–35 cm tall, branching from upper nodes, 6–10-nodes, glabrous or puberulent. Leaves subcanaliculate, thick, glabrous or puberulent, margins scabrous, ciliate and scarious at base, apex acuminate; sterile shoot leaves subulate, equal or longer than cauline leaves; cauline leaves subulate to linear-filiform, 11–22 × 0.6–1.2 mm, appressed to stem, obviously shorter than internodes, rigid, 3-veined, sheaths equal or slightly longer than wide; upper similar but smaller. Flowers solitary or few in racemes; branches angled at 5–15°, glabrous or sparsely puberulent, up to 3 cm long; pedicels 5–15 mm, glabrous or sparsely puberulent, greenish. Epicalyx scales (4-)6–8(-12), cartilaginous, greenish or straw-coloured, glabrous or puberulent, appressed to calyx, apex acute to acuminate except arista; outer linear-lanceolate, veinless below, indistinctly 5–9-veined above, 1/5–2/5 as long as calyx, 4–8 × 0.8–1.2 mm, with narrowly scari-

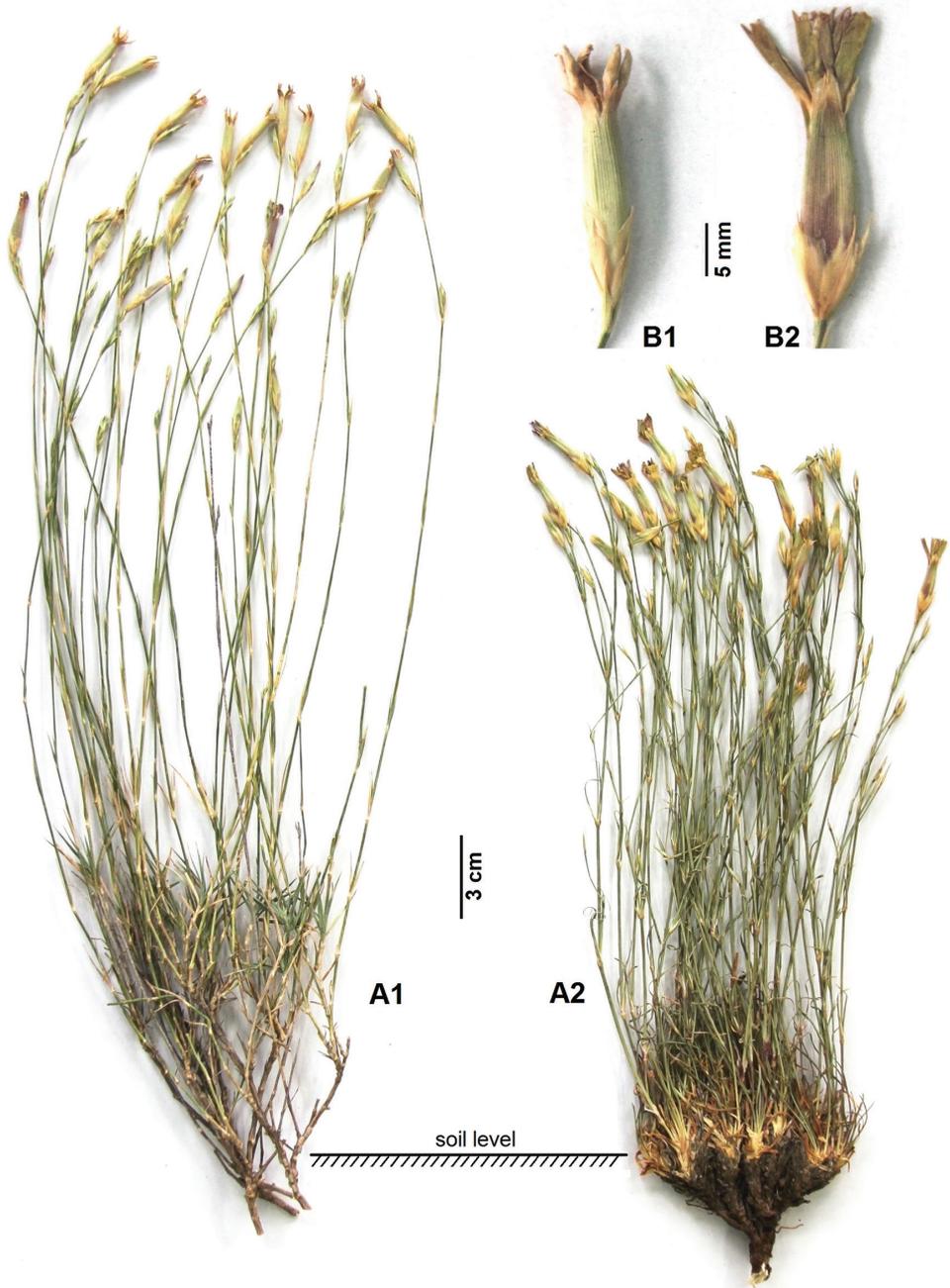


Figure 1. Photographs of plant habit and flowers of *D. aticii* and *D. zonatus*. *Dianthus aticii* – **A1** Habit **B1** Flower; *D. zonatus* – **A2** Habit **B2** Flower.

Table 1. Diagnostic characters between *Dianthus aticii* and *D. zonatus*.

Characters	<i>Dianthus aticii</i>	<i>Dianthus zonatus</i>
Stems	suffruticose	herbaceous
Sterile shoot leaves	subulate, subcanaliculate	linear, flattened
Cauline leaves	subcanaliculate, subulate to linear-filiform	flattened, linear to linear-filiform
Outer epicalyx scales	4–8 mm long	5–15 mm long
Inner epicalyx scales	6–9 mm long, scarious margin 0.2–0.4 mm wide, arista 1/10–1/7 as long as scale	8–16 mm long, scarious margin 0.4–0.8 mm wide, arista 1/6–1/3 as long as scale
Petals	20–23 mm long; limbs 7–8 mm long; claw 12–15 mm long	24–31 mm long; limbs 8–10 mm long; claw 16–21 mm long
Seed shape	elliptical	suborbicular
Cell edges of dorsal surface of seed	V-undulate	S-undulate
Cell edges of ventral surface of seed	S-undulate	V-undulate

ous (c. 0.2 mm) margins, arista 1/2–2/3 as long as scale; inner oblong-oblancheolate, veinless below, indistinctly 7–9-veined above, 2/5–1/2 as long as calyx, 6–9 × 2.5–3.5 mm, with scarious (0.2–0.4 mm) margins, arista 1/10–1/7 as long as scale. Calyx cylindrical-lanceolate, 16–22 × 3–4.5 mm, distinctly 36–40-veined above, glabrous or puberulent, pale green or sometimes purplish; teeth triangular-lanceolate, 4–5.5 × 1.2–2 mm, 7-veined, with ciliate and scarious margins, apex acute to acuminate, sometimes short mucronate. Petals 20–23 mm long; limb broadly cuneate, 7–8 × 6–7 mm, c. 1/3 as long as petal, completely exerted from calyx, usually spotted, barbulate, pink, yellowish-green beneath, 7–11-toothed to apex, teeth triangular, up to 1/6 as long as limb; claw 12–15 × 1.5 mm, collar almost as wide as claw. Capsule equal in length to calyx. Seeds elliptical, 2–3 × 1.4–2 mm, blackish.

Distinction from other taxa. *Dianthus aticii* shows close similarities to *D. zonatus* Fenzl because of toothed and barbulate petals, solitary or double flowers, and epicalyx scales that reach up to half of its calyx length (Fenzl 1842, Boissier 1849, Tchihatcheff 1860, Reeve 1967). Despite these similarities, there are very distinctive differences between *D. aticii* and *D. zonatus* such as stem morphology, leaf shape, and size of epicalyx scales and petals (Table 1, Figure 2).

Key to the two closely related *Dianthus* species

- 1 Stems suffruticose; sterile shoot leaves subulate and subcanaliculate; inner epicalyx scales with scarious margin 0.2–0.4 mm wide; petals 20–23 mm long ***D. aticii* sp. nov.**
- Stems herbaceous; sterile shoot leaves linear and flattened or absent; inner epicalyx scales with scarious margin 0.3–0.8 mm wide; petals 24–31 mm long ***D. zonatus***

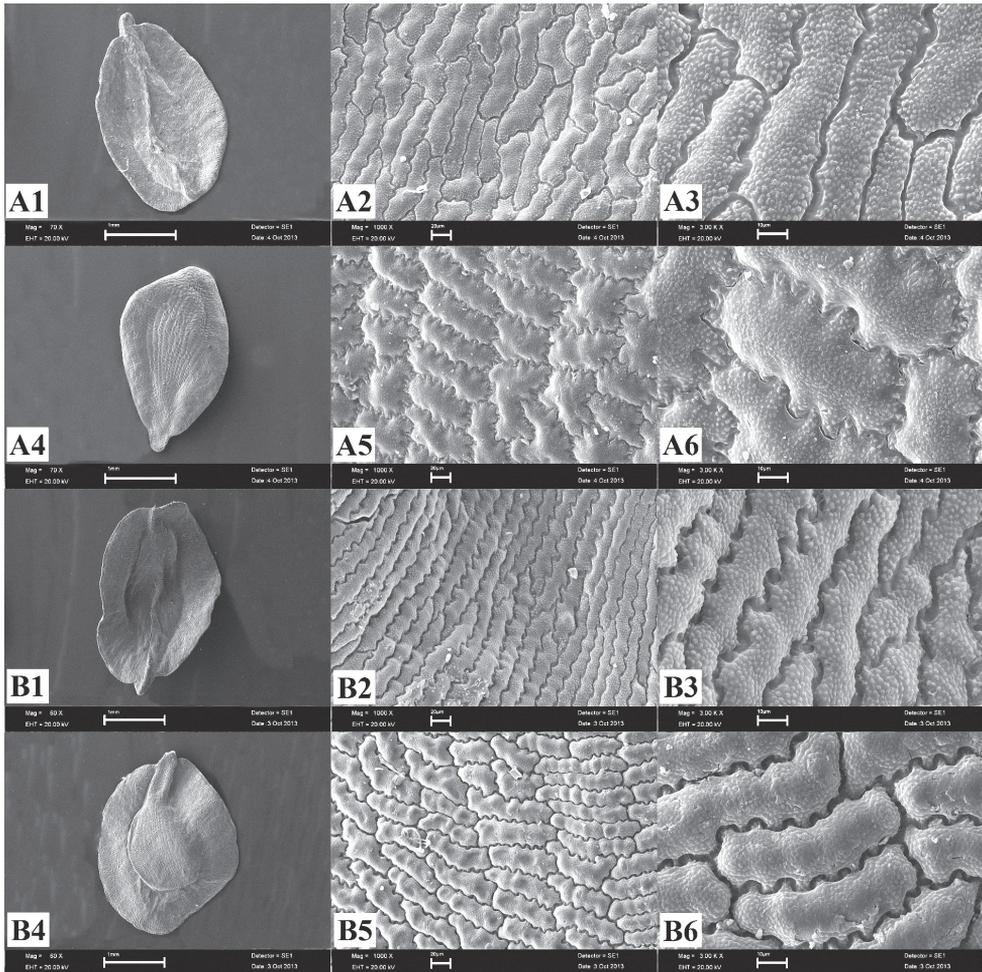


Figure 2. SEM photographs of the seed coat. **A** *Dianthus aticii* **B** *D. zonatus* **1–3** dorsal surface **4–6** ventral surface (scale bars: **1** and **4**: 1 mm, **2** and **5**: 20 μm , **3** and **6**: 10 μm).

Seed morphology. Seeds of *Dianthus aticii* are elliptical, 2–3 \times 1.4–2 mm, black, granular; dorsal surface convex, with regular rectangular cells, tuberculate, with 4–7 teeth on each margin, teeth V-undulate, apparent; ventral surface flat, with irregular rectangular cells, tuberculate, with 4–7 teeth on each margin, teeth S-undulate, not apparent; apex beaked. The seeds of *D. aticii* are different from the seeds of *D. zonatus* in terms of shape and cell edges of both the dorsal and ventral surfaces (Table 1, Figure 2).

Phenology. The new species was observed flowering in June and July, in stony slopes and steppes, between 330 and 1025 m.

Chorology and ecology. *Dianthus aticii* grows in relatively sub-arid forest clearings in Bilecik, Seben (Bolu), and Nallihan (Ankara); it grows in moist areas where the Euro-Siberian and Irano-Turanian phytogeographic regions coincide in the northwest part of Turkey (Davis 1965). The forest clearings of these areas that are sub-arid,

compared with the oceanic climate zone, were occupied by some semi-xeric species. These areas where the forest and steppe formations co-exist are the ideal habitats for *D. aticii*. The species grows on stony slopes within forest openings together with *Quercus pubescens* Willd., *Juniperus oxycedrus* L., *Crataegus monogyna* Jacq. subsp. *monogyna*, *Cistus creticus* L., *Jasminum fruticans* L., *Helianthemum nummularium* (L.) Miller, *Fumana thymifolia* (L.) Verlot, *Alyssum sibiricum* Willd., *Silene italica* (L.) Pers., *Pilosella piloselloides* (Vill.) Sojak, *Onosma tauricum* Pallas ex Willd., *Veronica multifida* L., *Teucrium polium* L., *Acantholimon acerosum* (Willd.) Boiss., *Hypericum perforatum* L., *Genista tinctoria* L., *Vicia cracca* L. subsp. *stenophylla* Vel., *Astragalus vulnerariae* DC., *Astragalus microcephalus* Willd., *Rosa canina* L., and *Centaurea urvillei* DC.

Conservation status. According to the current data *Dianthus aticii* grows in the Bilecik, Seben (Bolu), and Nallıhan (Ankara) districts, which have an area of approximately 7000 km². This has a discontinuous distribution due to dense forests, settlement, and farming areas. The open areas, which this species prefers, have the potential of possible settlements and agricultural activities. Therefore, the habitat of this species is under danger of being decreased and disturbed/destroyed in the future. Therefore, it is proposed that the species should be classified as *Vulnerable* [VU (B1b-iii) according to the International Union for Conservation of Nature (IUCN) categories (IUCN 2014)].

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

Acknowledgements

We wish to thank TÜBİTAK (Project number: KBAG-111T873) for financial support and the Curator of the Herbaria Gazi University (GAZI), who allowed us to study their *Dianthus* specimens.

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Two new species of *Indigofera* L. (Leguminosae) from the Sneeu berg Centre of Floristic Endemism, Great Escarpment (Eastern and Western Cape, South Africa)

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Academic editor: C. Morden | Received 27 February 2015 | Accepted 23 March 2015 | Published 2 April 2015

Citation: Clark VR, Schrire BD, Barker NP (2015) Two new species of *Indigofera* L. (Leguminosae) from the Sneeu berg Centre of Floristic Endemism, Great Escarpment (Eastern and Western Cape, South Africa). *PhytoKeys* 48: 29–41. doi: 10.3897/phytokeys.48.4798

Abstract

Two new species of *Indigofera* L. (Leguminosae) are described from the Sneeu berg Centre of Floristic Endemism on the southern Great Escarpment, Eastern and Western Cape Provinces, South Africa. Both species are localised high-altitude endemics. *Indigofera magnifica* Schrire & V.R. Clark is confined to the summit plateau of the Toorberg–Koudeveldberg–Meelberg west of Graaff-Reinet, and complements other western Sneeu berg endemics such as *Erica passerinoides* (Bolus) E.G.H. Oliv. and *Faurea recondita* Rourke & V.R. Clark. *Indigofera asantasanensis* Schrire & V.R. Clark is confined to a small area east of Graaff-Reinet, and complements several other eastern Sneeu berg endemics such as *Euryops exsudans* B. Nord & V.R. Clark and *E. proteoides* B. Nord. & V.R. Clark. Based on morphology, both new species belong to the Cape Clade of *Indigofera*, supporting a biogeographical link between the Cape Floristic Region and the Sneeu berg, as well as with the rest of the eastern Great Escarpment.

Keywords

Biodiversity, Cape Clade, Eastern Cape, endemic species, field exploration, Great Escarpment, *Indigofera*, Leguminosae, new species, Sneeu berg Centre, South Africa, Western Cape, taxonomy

Introduction

The genus *Indigofera* L. (Leguminosae) is a large genus comprising some 750 taxa worldwide, with the majority (ca. 550) occurring in Africa and Madagascar (Schrire et al. 2009). In South Africa, *Indigofera* is represented in all biomes, but is particularly well represented in the Cape Floristic Region and the eastern Great Escarpment. The discovery of two new *Indigofera* species from the Sneeuwberg Centre of Floristic Endemism (Clark et al. 2009) supports the view that continued field exploration is essential for biodiversity and biogeographical research in South Africa (Robertson and Barker 2006). This paper describes these two *Indigofera* species, complementing the descriptions of several other Sneeuwberg discoveries since 2005 (Goldblatt and Manning 2007, Nordenstam et al. 2009, Stirton et al. 2011, Rourke et al. 2013).

Materials and methods

The species were originally discovered in 2006 during intense plant collecting on the Sneeuwberg as part of a plant diversity and biogeographical study of the southern Great Escarpment (Clark 2010, Clark et al. 2009). Extensive sampling from 2006–2012 in areas adjacent to the known populations of each species has not revealed other populations. Several return trips to the respective populations since their discoveries were necessary before suitable fruiting material could be obtained.

Species treatments

Indigofera magnifica Schrire & V.R. Clark, sp. nov.

urn:lsid:ipni.org:names:77146131-1

Figs 1, 2; Plate 1

Diagnostic characters. *Indigofera magnifica* is morphologically similar and most closely related to *I. meyeriana* Eckl. & Zeyh., but differs in its prostrate, compact, densely matted habit (vs. laxly spreading, less dense and diffuse habit), sparsely to moderately strigose becoming reddish-maroon and glabrescent stems (vs. green-grey to canescent), fewer flowers (± 3 –8) per raceme (vs. > 8), brighter, more vivid pink flowers (vs. paler pink), and sparsely, appressed hairy pods (vs. spreading hairy pods). The overall colour of plants of *I. magnifica* is a darker green than the generally grey-green to grey appearance of *I. meyeriana*. *Indigofera meyeriana* is common and widespread in the Western Cape and western Northern Cape Provinces, and also occurs on the Sneeuwberg.

Type. South Africa, Western Cape Province, 3224AA, Plaas 113: summit plateau of the Koudeveldberge, Murraysburg District, Sneeuwberg. 32°10'32"S, 24°01'41"E,

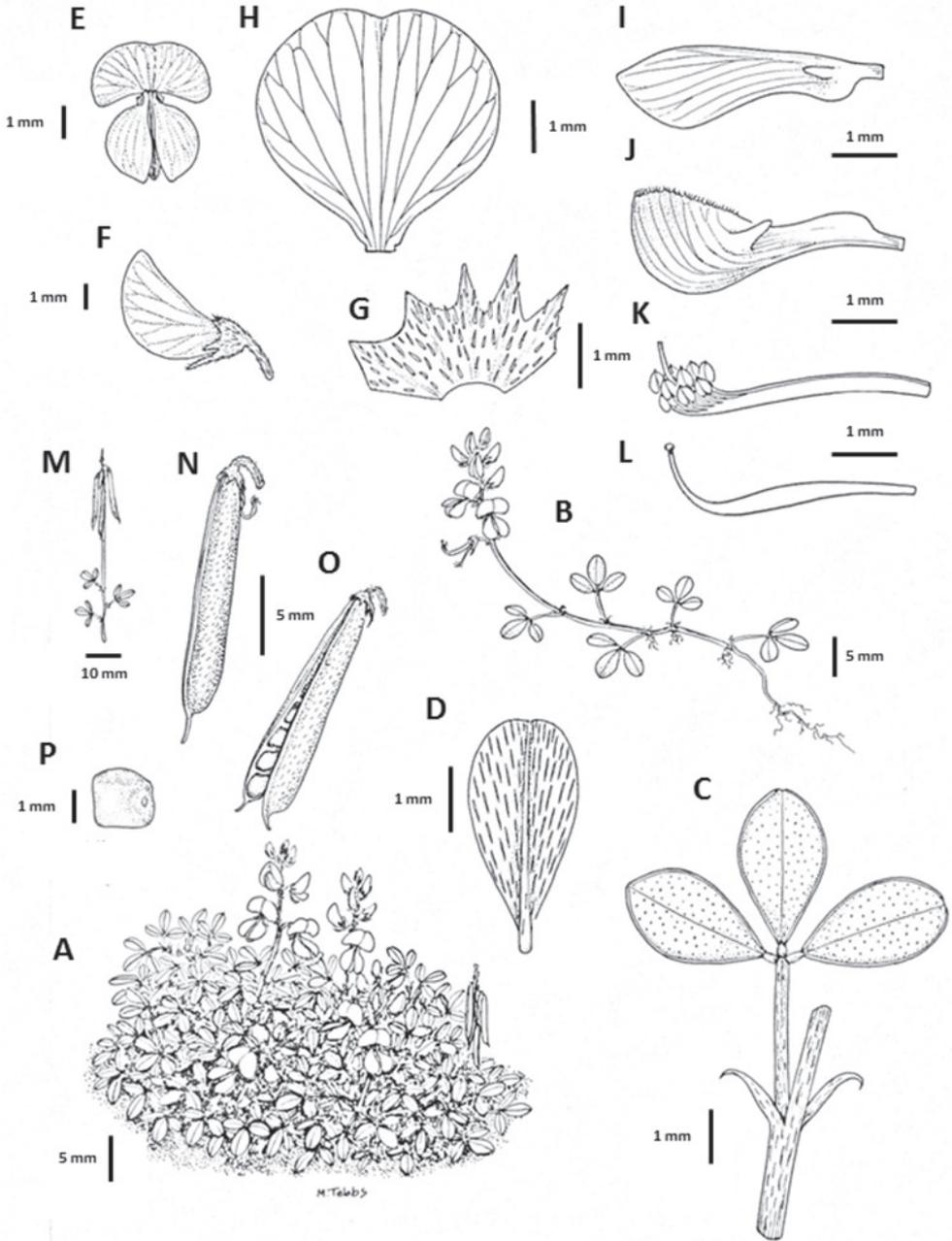


Figure 1. Analytical drawings of *Indigofera magnifica* Schrire & V.R. Clark, all drawn from the type collection (*Clark VR & Moholwa TT 206*) **A** growth habit **B** stoloniferous habit **C** trifoliate leaf with stipules **D** terminal leaflet, underside **E** flower, front view **F** bud, side view **G** calyx **H** standard petal **I** wing petal **J** keel **K** staminal sheath **L** pistil **M** infructescence **N** pod **O** dehiscent pod **P** seed. Drawings by M. Tebb's.

2134 m, 9 December 2011, *Clark VR & Moholwa TT 206* (K, holotype; GRA, MO, NBG, NSW, PRE, S, isotypes).

Description. *Prostrate suffrutex* 20–50 mm tall, densely to laxly matted, much branched. *Stems* slender, terete to ribbed, sparsely to moderately strigose with whitish biramous hairs, glabrescent later, reddish-maroon; stoloniferous, often rooting from nodes, arising from a woody rootstock. *Leaves* alternate, digitately trifoliolate, petiole 2–8 mm long, scattered with pearl bodies at base of leaflets. *Stipules* 1–2 mm long, up to 0.5 mm wide at base, lanceolate, attenuate, falcate, often recurved at apex, ± membranaceous, gland-tipped, reddish. *Stipels* absent. *Terminal leaflet* 1.5–5.5 mm × 1–3 mm, obovate, apex emarginate, truncate or rounded, base cuneate, upper surface glabrous or sparsely appressed strigose, paler than below; lower surface more densely strigose and slightly rugose; margins somewhat thickened, often appearing slightly involute, often reddish; lateral leaflets similar. *Racemes* (10)20–70 mm long, many times longer than the subtending leaf, including a peduncle of (6)11–55 mm, becoming flattened, appearing soft-tissued on drying; ±3–8 flowered; bracts 0.5–1.5 mm long, lanceolate-subulate, recurved at apex, caducous. *Pedicels* 0.75–1.5 mm long, becoming recurved in fruit. *Flowers* 4.5–6.5 mm long. *Corolla* vivid fuchsia-pink. *Calyx* 1.5–2.5 mm long, lobes triangular, 0.75–1.4 mm, ± equaling the tube, ± sparsely strigose appressed. *Standard* 5.5–6.5 mm long, up to 5 mm wide, broadly obovate, tapering to a short claw at the base; blade sharply reflexed upwards for distal half of length; apex rounded to emarginate; dorsal surface glabrous, often with translucent, short stripes. *Wings* 5–6 mm long, unguiculate, shortly clawed at base, asymmetrically obovate towards apex. *Keel petals* 5–6.5 mm long, valvately connate distally, lateral spurs to 1 mm long, distal margin curving upwards to base of the keel to an obtuse apex; claws ± 2 mm long, broadening from the base. *Stamens* 4–5 mm long, alternately long and short, the 9 fused stamens free for ± 1 mm distally; anthers uniform. *Ovary* densely strigillose laterally, glabrous along upper margin; stigma capitate. *Pods* (9)11–15 mm long, up to 3.5 mm wide, cylindrical, inflated, shiny, reddish-green becoming reddish-brown, sparsely strigose, explosively dehiscent with the valves twisting. *Seeds* 4–6, 1.5 × 1.5 mm, ± quadrate, dark green.

Etymology. The specific epithet *magnifica* is derived from the Latin adjective *magnificus* –a –um (a. splendid, magnificent) and is named for the magnificent, showy, vivid fuchsia-pink flowers.

Distribution and ecology. *Indigofera magnifica* is confined to the summit plateau of the Toorberg–Koudeveld–Meelberg in the western Sneeuberg, between 1700–2150 m. The species is occasional to abundant, found exclusively on the dolerite-derived loamy-clays and black turf soils typical of this plateau. The vegetation type is Karoo Escarpment Grassland (Gh1, Mucina and Rutherford 2006), typical of high altitudes in the Sneeuberg mountain complex, with the dominant grass species being *Tenaxia* (= *Merxmuellera*) *disticha* (Nees) N.P. Barker & H.P. Linder. *Indigofera magnifica* is particularly abundant on the highest parts of the plateau near the eastern and southern scarps, where it forms large colonies. It compliments a suite of several local endemics only found in the western Sneeuberg, including *Acmadenia* sp. nov., *Erica passerinoides*

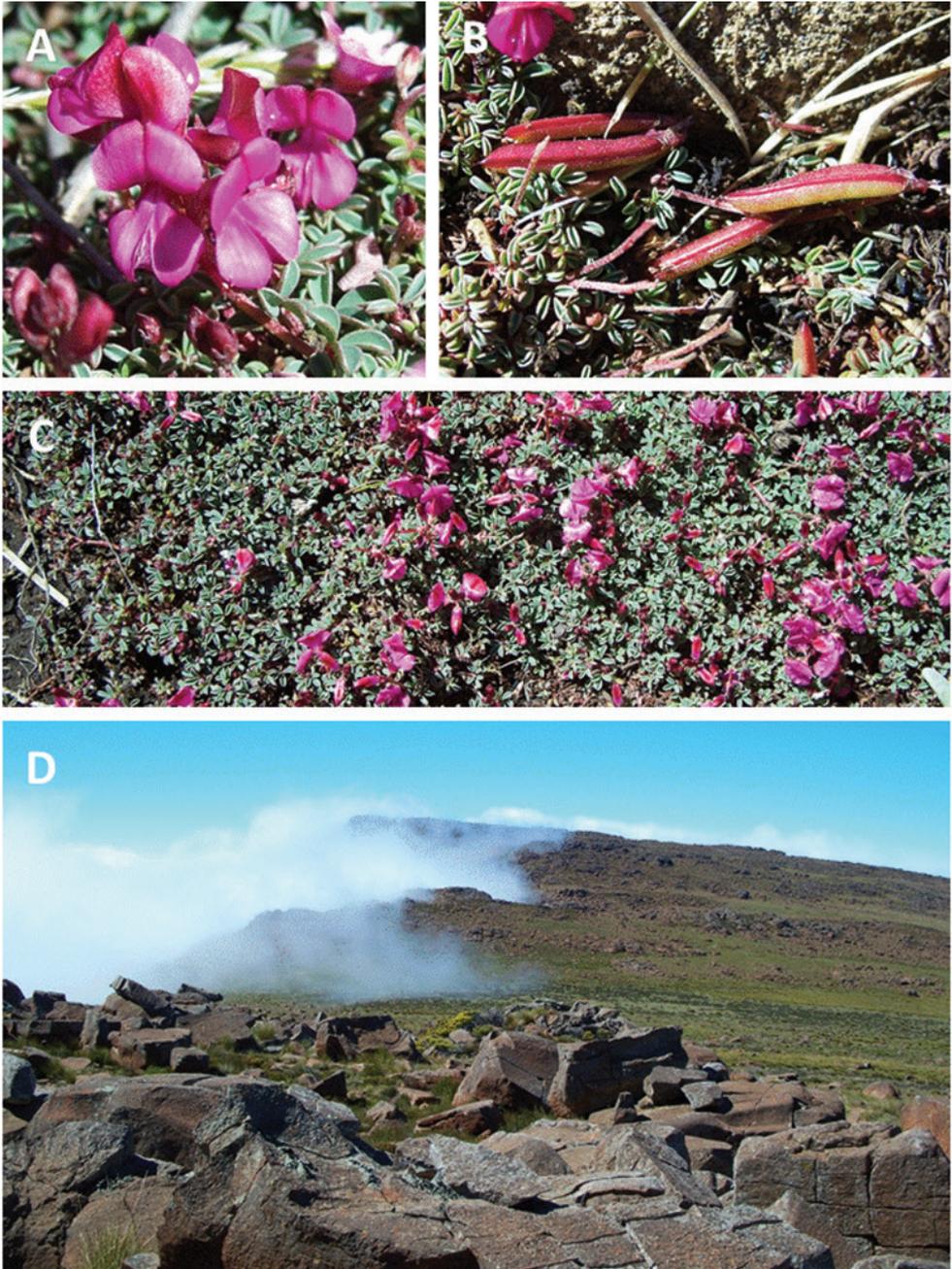


Plate I. *Indigofera magnifica* Schrire & V.R. Clark, plants *in situ* on the Koudeveldberge, Sneeuwberg (Western Cape Province; *Clark VR & Moholwa TT 206*) **A** inflorescence **B** fruits **C** typical prostrate growth habit **D** mountain summit habitat. Photographs by V.R. Clark.

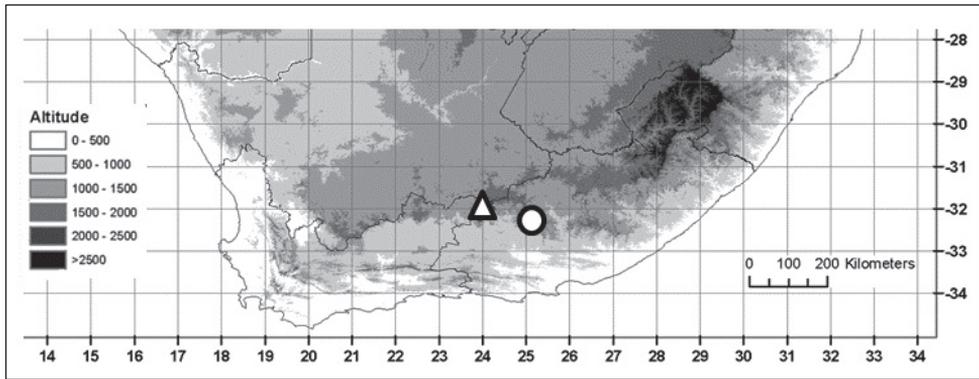


Figure 2. Known distributions of *Indigofera magnifica* Schrire & V.R. Clark (△) and *I. asantasanensis* Schrire & V.R. Clark (○).

(Bolus) E.G.H. Oliv., *Euryops dentatus* B. Nord. and *Faurea recondita* Rourke & V.R. Clark (Clark et al. 2009, 2012, Rourke et al. 2013).

Conservation status. While the extent of occurrence (EOO) of *Indigofera magnifica* is small (ca. 30 km²), it is common (probably >10 000 individuals) in its restricted area. There are no obvious risks from the current land-use of livestock grazing: plants do not show evidence of damage from foraging or trampling. The remote, rocky high-altitude habitat renders it relatively safe from other detrimental land-use. Already restricted to summit elevations, it is however potentially at risk from global climate change. Any potential wind farm proposals for the Toorberg–Koudeveld–Meelberg would place this species at serious risk. The category VULNERABLE (Vu D2) is thus recommended.

Further collections and localities. South Africa, Western Cape Province (straddling the provincial boundary with the Eastern Cape Province), 3223BB & 3224AA, Farms Plaas 113, Annex Koudeveld 114, Koudvelds Hoogte 117, Annex Onder Hoogde 116: summit plateau of the Koudeveldberge and Meelberg, Graaff-Reinet and Murraysburg Districts, Sneeuberg, ca. 32°10′–11′S 23°59′E, ca. 2100 m, 25 November 2006, *Clark VR & Te Water Naudé T 335* (GRA, K).

—Western Cape Province, 3224AA, Farm Quaggas Drift 108: Toorberg summit plateau, next to stream ca. 100 m from edge of escarpment, Murraysburg District, Sneeuberg. 32°08′46″S, 24°04′31″E, 1780 m, December 2007, *Clark VR & Pienaar C 511* (GRA, K).

***Indigofera asantasanensis* Schrire & V.R. Clark, sp. nov.**

urn:lsid:ipni.org:names:77146132-1

Figs 2, 3; Plate 2

Diagnostic characters. *Indigofera asantasanensis* is similar to *I. alpina* Eckl. & Zeyh., but differs in its (3)5–7 foliolate leaves (vs. consistently trifoliolate leaves), leaflets 1.5–3 mm wide (vs. 4–16 mm wide), and stipules 1–1.6 mm wide (vs. 2–10 mm).

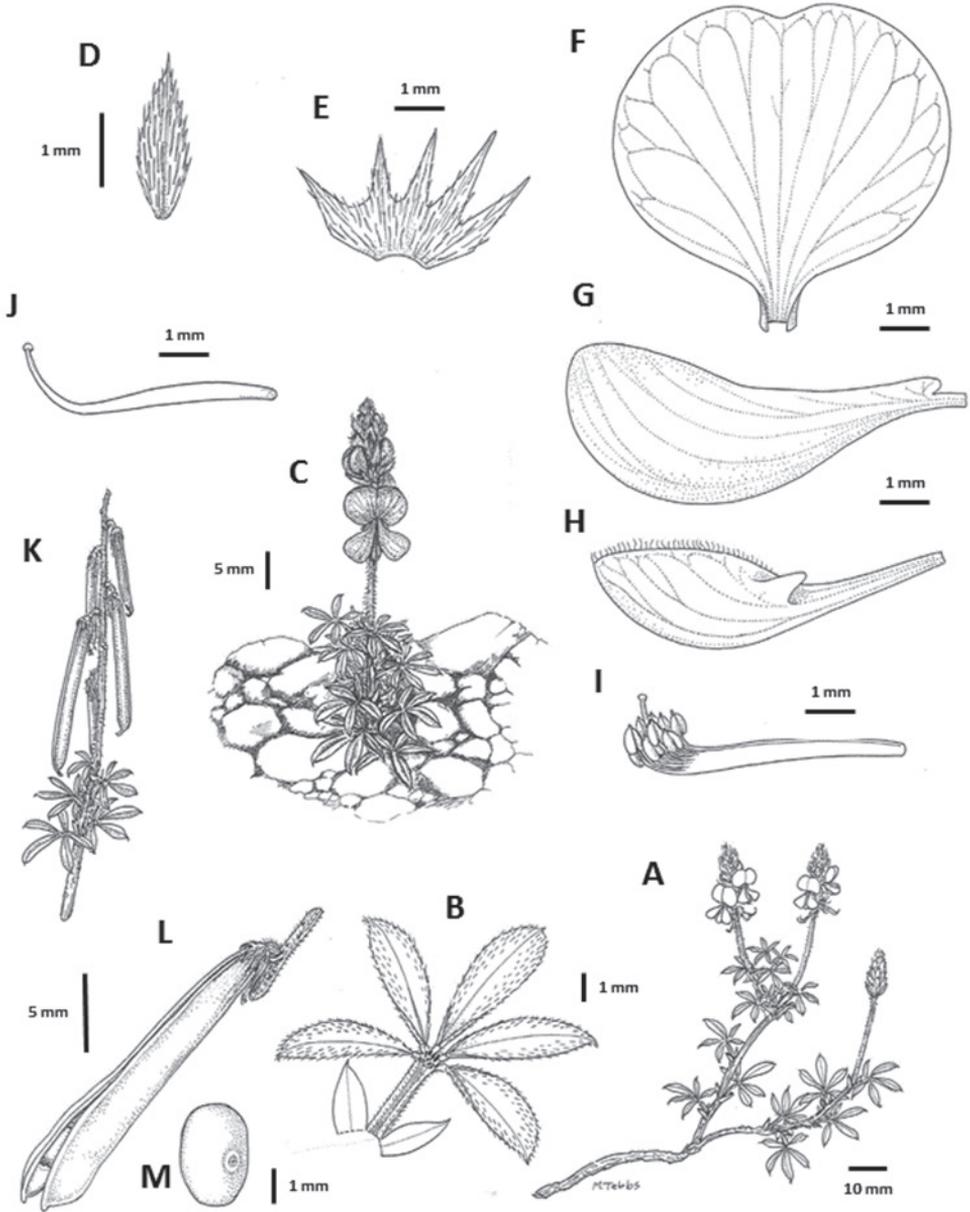


Figure 3. Analytical drawings of *Indigofera asantasanensis* Schrire & V.R. Clark, all drawn from the type collection (*Clark VR & Mabolwa TT 211*) **A** growth habit **B** digitately foliolate leaf with stipules **C** growth habit **D** stipule **E** calyx **F** standard petal **G** wing petal **H** keel **I** staminal sheath **J** pistil **K** inflorescence **L** dehiscent pod **M** seed. Drawings by M. Tebbs.

Indigofera asantasanensis may also be confused with *I. burchellii* DC., being similar in having digitately 5–7 foliolate leaves, but it has wider stipules (1–1.6 mm vs. < 0.5 mm). *Indigofera alpina* is mostly confined to the mountains of the Eastern Cape, while

I. burchellii is almost exclusively a southern Great Escarpment species, centred from the Roggeveldberge to the Eastern Cape Drakensberg; both of these species also occur in the Sneeuberg.

Type. South Africa, Eastern Cape Province, 3225AC, Farm 360: mountain slopes above Suurkloof, behind the old town of Petersburg, east of the Nardousberg, now included in Asante Sana Private Game Reserve, Graaff-Reinet District, Sneeuberg. 32°15'18"S, 25°00'10"E, 1708 m, 10 December 2011, *Clark VR & Moholwa TT 211* (K, holotype; GRA, MO, NBG, NSW, PRE, S, isotypes).

Description. *Decumbent to erect suffrutex* 100–200 mm tall, much branched, densely leafy.

Stems slender, terete to strongly ribbed, angular, or longitudinally wrinkled, scattered with pearl bodies; moderately to densely strigose with spreading biramous hairs often crisped at the tips; reddish-brown, becoming woody below; a rhizomatous colony, diffusely branching from an indistinct woody rootstock. *Leaves* alternate, digitately (3)5–7-foliolate, petiole 1.5–5 mm long, deeply channelled above, scattered with pearl bodies at base of leaflets. *Stipules* 1.5–5 mm long, (0.75)1–1.6 mm wide, triangular to obliquely ovate-lanceolate, acuminate; amplexicaule, leaving annular sheath around stems, ± membranaceous. *Stipels* absent. *Terminal leaflet* (2.5)4–10 mm × (1)1.5–3 mm, obovate to oblanceolate, apex rounded, apiculate, often complicate; sparsely to moderately spreading or appressed strigose on both surfaces, hairs often coarser above than below, secondary venation ± prominent below; margins somewhat thickened, often appearing slightly involute; lateral leaflets similar. *Racemes* 25–120 mm long, many times longer than the subtending leaf, including a peduncle of 15–50 mm, moderately to densely strigose, scattered with pearl bodies; ± 12–35 flowered; bracts 3–4 mm long × ca. 1.5 mm, ovate-lanceolate, acuminate, caducous. *Pedicels* 0.5–2 mm long, reflexed. *Flowers* 6–7.5 mm long. *Corolla* deep pink, darker wine-red in bud. *Calyx* 2–3 mm long, lobes triangular to lanceolate, 1–2 mm long, ± equaling to twice as long as the tube, ± sparsely to densely strigose. *Standard* 5.5–6 mm × 5.5–6.5 mm, broadly obovate, tapering to a short claw at the base; blade sharply reflexed upwards for distal half of length; apex round to emarginate, dorsal surface glabrous, often with translucent, short stripes. *Wings* 5.5–6.5 mm long, unguiculate, shortly clawed at base, asymmetrically obovate towards apex. *Keel petals* 5–6 mm long, valvately connate distally, lateral spurs to 1 mm long, distal margin curving upwards to base of the keel to an obtuse apex; claws ± 2 mm long, broadening from the base. *Stamens* 4.5–5.5 mm long, alternately long and short, the 9 fused stamens free for ± 1 mm distally; anthers uniform. *Ovary* glabrous, stigma capitate. *Pods* 17–25 mm long, up to 3.5 mm wide, cylindrical, reddish-brown, glabrous, explosively dehiscent with the valves twisting. *Seeds* 4–5, 3 × 2 mm, subcylindrical, green.

Etymology. The species is named for the Asante Sana Private Game Reserve, the owners and managers of which have been generous and instrumental in facilitating biodiversity research in the Sneeuberg. The known range of this species is almost entirely confined to this property.

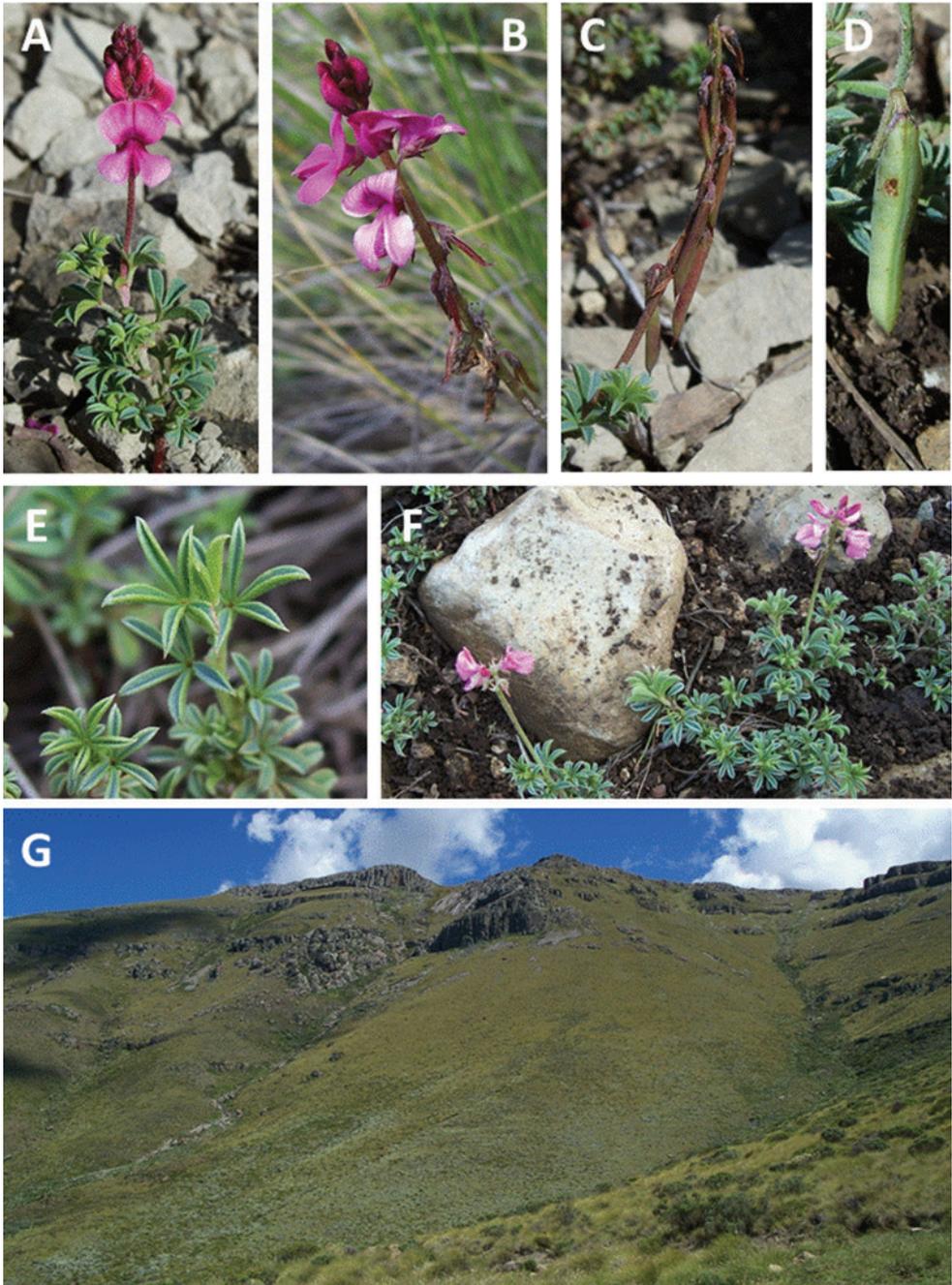


Plate 2. *Indigofera asantasanensis* Schrire & V.R. Clark, plants *in situ* on the slopes above 'Suurkloof', Asante Sana Private Game Reserve, Sneeuwberg (Eastern Cape Province; *Clark VR & Moholwa TT 211*) **A** inflorescence from the front **B** inflorescence from the side **C** infructescence **D** close up of a single pod **E** the digitately foliolate leaves **F** growth habit **G** Escarpment mountain habitat. Photographs by V.R. Clark.

Distribution and ecology. *Indigofera asantasanensis* is currently only known from a small area in the eastern Sneeuwberg from the Nardousberg to the Tandjiesberg–Coetszeesberg area behind the old town of Petersburg (now incorporated in the Asante Sana Private Game Reserve) and Pearston. The Tandjiesberg here is not to be confused with the more familiar Tandjiesberg (32°23'13"S, 24°42'13"E) of lower altitude and closer to Graaff-Reinet. *Indigofera asantasanensis* occurs from the mid-upper slopes to the summit plateau, ca. 1500–2200 m; it is locally abundant in Karoo Escarpment Grassland (Mucina and Rutherford 2006), dominated in this locality by *inter alia* *Tenaxia disticha*, *Euryops trilobus* Harv. and *Helichrysum splendidum* (Thunb.) Less. *Indigofera asantasanensis* occurs in loamy, rocky soils derived from both dolerite and Beaufort Group sandstone substrates. It complements several local endemics, including *Euryops proteoides* B. Nord. & V.R. Clark and *E. exsudans* B. Nord. & V.R. Clark (Nordenstam et al. 2009).

Conservation status. While the extent of occurrence (EOO) of *I. asantasanensis* is small (ca. 15 km²), it is abundant (probably >10 000 individuals) in its restricted area. There are no obvious risks from the current land-use of game farming. The remote, rocky high-altitude habitat renders it relatively safe from other detrimental land-use. Already restricted to the higher elevations, it is potentially at risk from global climate change. Local infestations of the highly invasive grass *Nassella trichotoma* (Nees) Hack. ex Arechav. on Asante Sana Private Game Reserve and adjacent properties do constitute a potential risk to the habitat of *I. asantasanensis*. The category Vulnerable (VU D2) is thus recommended.

Further collections and localities. South Africa, Eastern Cape Province, 3225AC, Farm 360: mountain slopes above Suurkloof, mountains behind the old town of Petersburg, east of the Nardousberg, now in Asante Sana Private Game Reserve, Graaff-Reinet District, Sneeuwberg. 32°15'17"S, 25°01'04"E, 1853 m, 6 December 2005, *Clark VR & Coombs G 208* (GRA, K).

—Farms Paardekom 5 and Annex Waterkloof 2: upper mountain slopes (Tandjiesberg–Coetszeesberg) ca. 15 km east of the Nardousberg (Sneeuwberg), behind Pearston, Graaff-Reinet District. 32°16'47"S, 25°05'25"E, ca. 1950 m, 13 December 2006, *Clark VR & Coombs G 635* (GRA).

—Farm 360: mountain slopes above Suurkloof, mountains behind the old town of Petersburg, east of the Nardousberg (Sneeuwberg), now in Asante Sana Private Game Reserve, Graaff-Reinet District 32°15'40"S, 25°10'10"E, 1550–2000 m, 31 March 2008, *Clark VR & Crause C 2* (GRA).

—3224BB, Upper Waterkloof 352: eastern end of Nardousberg ridge-line (Sneeuwberg), Asante Sana Private Game Reserve, Graaff-Reinet District. 32°14'48"S, 24°55'58"E, 2171 m, 2 April 2008, *Clark VR & Crause C 34 & 65* (GRA).

Biogeography

Including these two described species, some 20 of the Sneeuwberg's ca. 26 endemic species are concentrated in the moister south-western and south-eastern scarp areas.

Sixteen species are local to one or the other of these two areas, the other four species with populations separated by the internal 'Sunday's River Interval' (Clark et al. 2009, Stirton et al. 2011). Only one endemic (Hilliard and Burt's 1985, *Conium* sp. no. 4) occurs throughout the Sneeuberg, and a further three can be considered arid-adapted. This suggests that endemism in the Sneeuberg is driven by the availability of moisture, or that the moister scarp slopes and adjacent summits are climatic refugia for previously more widespread species (Clark and Barker 2014). This mirrors the patterns evident in the Main Drakensberg (Pooley 2003) and the Great Winterberg–Amatholes (Clark et al. 2014), where endemism is also highest on the wettest scarps and summits. *Indigofera magnifica* and *I. asantasanensis* show extreme versions of this localism, being confined to unusually small areas on the summit in the west (*I. magnifica*) and on the moist scarp slope in the east (*I. asantasanensis*). Both are also located in the Cape Clade of *Indigofera* (Schrire et al. 2009), supporting a biogeographical connection between the Sneeuberg and the Cape Floristic Region, as well as with the rest of the eastern Great Escarpment.

Acknowledgements

The fieldwork that led to the discovery of these species comprised part of a Rhodes University PhD supported by the National Research Foundation (NRF, grant GUN 2069059), a freestanding South African Biosystematics Initiative grant (2006–2009), the National Geographic Society (USA) Committee for Research and Exploration Grant (8521-08), Buk'Indalo Consultancy cc, and a Dudley D'Ewes Scholarship from the Cape Tercentenary Foundation. Further fieldwork (to collect complete material) and the publication costs of this paper were covered by a free-standing grant from the Cape Tercentenary Foundation. Anton & Marietjie van Rensburg (Farm Koudeveld), Geoff Kroon (Farm Onbedacht), Antonie Trotsky (Farm Quaggas Drift) and Richard & Kitty Viljoen (managers of Asante Sana Private Game Reserve) kindly gave permission to access their properties, assisted with mountain transport, and provided generous hospitality. Collecting permits were authorised by the Eastern Cape Department of Environmental Affairs and CapeNature (Western Cape). Charl Pienaar, Cherry-Mae Smith, Gareth Coombs, Ivan Crause, Theo Te Water Naudé and Tlou Moholwa supplied invaluable assistance in the field. The artwork was done by Margaret Tebbs. This paper was constructed during a Swiss Government Excellence Scholarship at the University of Zürich, Switzerland (2013), and a NRF Scarce Skills Fellowship at Rhodes University, South Africa (2014 & 2015). A trip to The Royal Botanical Gardens, Kew, to finalise the descriptions was generously supported by the University of Zürich. The Curator of the Selmar Schonland Herbarium (GRA), Tony Dold, is thanked for assistance in preparing the isotypes, and for the use of Herbarium facilities. Peter Linder is thanked as VRC's academic host in Zürich.

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Paepalanthus serpens, a new microendemic species of Eriocaulaceae from the Espinhaço Range, Minas Gerais, Brazil

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Academic editor: P. Wilkin | Received 28 November 2013 | Accepted 9 March 2015 | Published 15 April 2015

Citation: Echternacht L, Trovó M (2015) *Paepalanthus serpens*, a new microendemic species of Eriocaulaceae from the Espinhaço Range, Minas Gerais, Brazil. *PhytoKeys* 48: 43–49. doi: 10.3897/phytokeys.48.6713

Abstract

We describe and illustrate *Paepalanthus serpens*, a microendemic species of Eriocaulaceae from the Espinhaço Range. The species is known from a single population growing in rocky areas of the Serra do Cipó, Minas Gerais. It is placed in *Paepalanthus* ser. *Paepalanthus*, and is easily distinguished from its congeneric species by its elongated, lignescent stem, thickened by the marcescent sheaths of the linear leaves, which are arranged in a rosette at the stem apex, scapes equalling the leaf height, and capitulae with straw-coloured involucral bracts. Comparisons with the morphologically similar species are provided, as well as comments on distribution, ecology, phenology and conservation status.

Resumo

Descrevemos e ilustramos *Paepalanthus serpens*, espécie microendêmica de Eriocaulaceae da Cadeia do Espinhaço. Esta espécie é conhecida por apenas uma população, que cresce nos campos rupestres da Serra do Cipó, Minas Gerais. A espécie é classificada em *Paepalanthus* ser. *Paepalanthus* e é facilmente distinguida das demais espécies do gênero pelo caule alongado e lignificado, espessado pelas bainhas mascescentes das folhas lineares, as quais estão dispostas em roseta no ápice do caule, escapos na altura das folhas e capítulos com brácteas estramíneas. Comparações com as espécies morfológicamente mais próximas são providas, assim como comentários sobre distribuição, ecologia, fenologia e estado de conservação.

Keywords

Campo Rupestre, Microendemism, Paepalanthoideae, Poales, Threatened species

Introduction

Paepalanthus Mart. is the largest genus of Brazilian Angiosperms, comprising around 360 species in the country (Forzza et al. 2010). The genus is highly diversified in the Espinhaço Range, in both of its subunits, in Bahia and Minas Gerais states. Elevated areas in Goiás state are a secondary center of diversity in Brazil (Giulietti and Hensold 1991, Giulietti et al. 2012). As a large genus, have some authors subdivided *Paepalanthus* into many series, based mostly on rough external morphology (Koernicke 1863, Ruhland 1903). *Paepalanthus* ser. *Paepalanthus* (= *Paepalanthus* ser. *Variabiles* Ruhland) is the largest category, encompassing around 200 species (Ruhland 1903, Silveira 1908, 1928). Species placed in this series present trimerous flowers and a particular architecture, usually consisting of a short, horizontal, and subterraneous stem, rarely lignose and elongated, with congest leaves at the apex, which are mostly arranged in rosettes (Ruhland 1903). *Paepalanthus* ser. *Paepalanthus* appears polyphyletic (Andrade et al. 2010, Giulietti et al. 2012, Trovó et al. 2013), but further taxonomic and phylogenetic researches are necessary to enhance a stable classification. Therefore, assignments of species to it are possibly provisional. Recent fieldwork and herbarium studies revealed that in spite of the large number of species in this series, there are still many others to be described (e.g. Trovó et al. 2012, Trovó et al. 2013). Based on herbarium specimens and recent field efforts, we describe a remarkable new species of *Paepalanthus*, and place it within *P.* ser. *Paepalanthus*.

Taxonomy

Paepalanthus serpens Echtern. & Trovó, sp. nov.

urn:lsid:ipni.org:names:77146543-1

Figures 1, 2

Type. Brazil. Minas Gerais, Santana do Pirapama, Reserva Particular do Patrimônio Natural (RPPN) Toucan Cipó, Trilha da Captação, 19°00'13.2"S, 43°45'23.3"W, SAD69, 927 m, 27 Jul 2013, L. Echternacht, T. V. Bastos, M. Stallegger, C. A. Ferreira Júnior 2316 (holotype HUFU; isotypes BHCB, NY, P, R, SPF)

Diagnosis. *Paepalanthus serpens* differs from the other species of the genus by its elongated, lignescent stem, thickened by the marcescent sheaths of the linear leaves, which are disposed in rosette at the stem apex, scapes equalling the leaf length and capitula with straw-coloured involucre bracts.

Description. Perennial herbs. Stem elongate, lignescent, with a thick cover of marcescent leaf sheaths, ca. 1.0–30.0 cm long × 1.0–3.5 cm wide (without the leaf sheath coat), unbranched, pilose, with simple, filamentous trichomes ca. 1.0 cm long. Leaves arranged in rosette at the stem apex, flat to semi-terete, linear, chartaceous, 5.0–10.0 cm long × 0.3–1.5 mm wide, green, pubescent to glabrescent on both surfaces, trichomes ca. 0.1–0.2 mm long, simple, filamentous, cream to

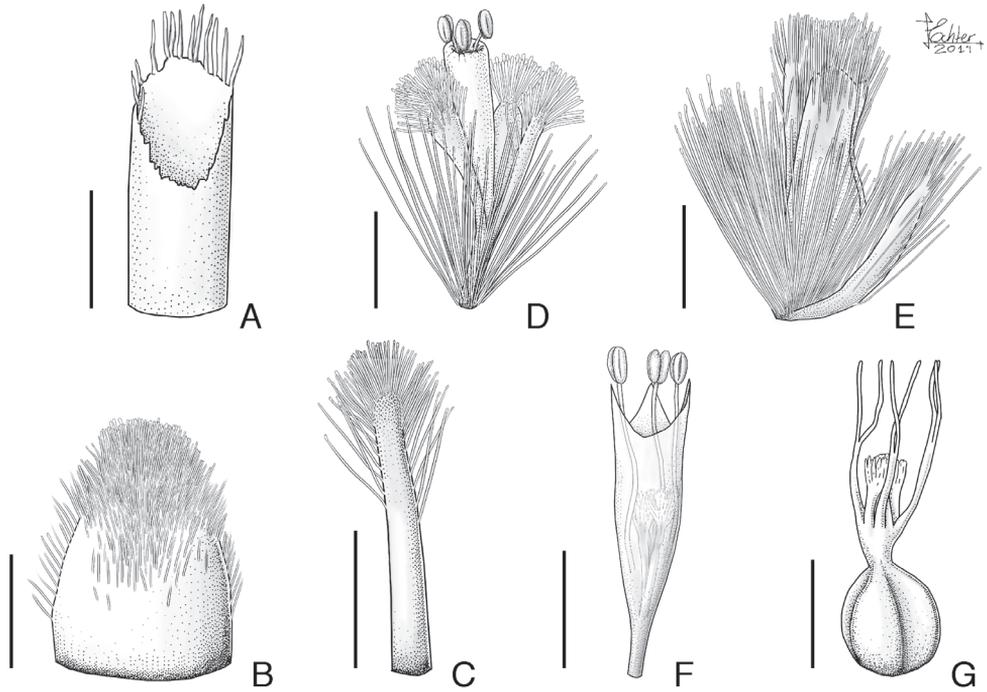


Figure 1. Illustration of *Paepalanthus serpens* Echtern. & Trovó: **A** Spathe apex **B** Involucral bract abaxial surface **C** Floral bract abaxial surface **D** Staminate flower **E** Pistillate flower with floral bract **F** Staminate flower with pedicel and sepals removed, at early anthesis **G** Gynoecium (Drawn from the holotype by L. Echternacht).

ferruginous, apex acute. Spathes appressed to scapes, membranaceous, ca. 0.6–1.0 cm long, lamina glabrescent, oblique opening, margins lacerate, ciliate. Scapes free, ca. 4–150 per plant, ca. 6.0–10.0 cm long, filiform, pilose as the leaves. Capitula 3.0–7.0 mm diam. × 3.0–4.0 mm high. Involucral bracts in 4–6 series, ovate-triangular, ca. 2.0–3.0 mm long × 1.0–2.0 mm wide, straw-coloured, darker on the margins, pilose on abaxial surface, mainly in the upper back, ciliate, tufted at apex, trichomes cream, occasionally yellowish at the apex, glabrous on adaxial surface, apex acute to obtuse. Floral bracts lanceolate, membranaceous, ca. 2 mm long, cream at the base, light-brown at the apex, pilose on abaxial surface, ciliate on the margins, cilia shortening toward the obtuse and tufted apex, filamentous trichomes ca. 7–9 cells long, cream, occasionally the distal trichomes yellowish at the apex, glabrous on adaxial surface, apex obtuse. Flowers 3-merous, ca. 60 per capitulum. Staminate flowers ca. 2.0–2.5 mm long; pedicel ca. 0.3 mm long, densely pilose, with filamentous trichomes ca. 1.5 mm long; sepals free, oblanceolate, membranaceous, ca. 1.5–2.0 mm long, cream to straw-coloured, darker at the obtuse apex, pilose as the floral bracts; corolla tubular, apex with three acute lobes, soon involute, membranaceous, ca. 1.5–2.0 mm long, hyaline, glabrous; stamens ca. 2 mm long, filaments adnate to corolla on its lower third, anthers cream; pistillodes 3, ca. 0.8

mm long, fimbriate at the apex. Pistillate flowers ca. 2.0–3.0 mm long, pedicel ca. 0.3 mm long, densely pilose, with filamentous trichomes ca. 1.5 mm long; sepals free, oblanceolate, membranaceous, thickening during fruit maturation, hygroscopic, ca. 1.5–2.0 mm long, cream to light-brown, darker at the upper part, pilose as the floral bracts, apex cuspidate; petals free, oblanceolate, membranaceous, ca. 1.5–2.5 mm long, cream to light-brown at the apex, ciliate, tufted at the truncate apex; staminodes 3, scale-like; gynoecium ca. 2.0–3.0 mm long, stigmatic branches ca. 1.5 mm long, bifid, twice longer than the papillose nectariferous branches. Fruit a loculicidal capsule.

Additional specimens examined. Brazil. Minas Gerais: Santana do Pirapama, Trilha da Captação, 19°00'30.7"S, 43°45'53.1"W, 840 m, 8 Sep 2011, *C. A. Ferreira Júnior s.n.* (BHZB 8198); same locality, 19°00.52'S, 43°75.85'W DD, 854 m, 19 Mar 2011, *W. Milliken et al.* 4296 (SPF, K).

Distribution and ecology. *Paepalanthus serpens* is known from one population at the western slopes of the Serra do Cipó, southern Espinhaço Range, in Minas Gerais state. The habitat consists of a *campo rupestre* within the Cerrado biome. The species grows on gravelly soils of quartzite origin, on open areas, among herbaceous to shrubby vegetation. The encountered population consists of around 300 individuals.

Phenology. Individuals flower during the dry season, starting to develop the inflorescences in March and dispersing seeds until October. The sepals of the pistillate flowers are thickened and hygroscopic when fruits are mature, becoming revolute upon drying, probably favouring seeds dispersal through a catapult mechanism (further description of this dispersal mechanisms is provided by Trovó and Stützel 2012).

Conservation status. The species is considered critically endangered according to criteria B1a and B2a of the IUCN (2011). However, it occurs inside a conservation unit (RPPN Toucan Cipó) and is conserved *ex situ* at the Belo Horizonte Botanical Garden (Fundação Zoo-Botânica de Belo Horizonte, FZB-BH), factors that may attenuate its threatened status.

Etymology. The epithet *serpens* refers to the serpent-like habit of the perennial individuals, which have an unbranched, thick woody stem that slowly elongates and becomes creeping, with an erect apex.

Comments. The extremely reduced population and restricted occurrence range probably contributed to this species remaining undescribed. It occurs on high slopes with difficult access from the closest trails and roads.

The species architecture and trimerous flowers place *Paepalanthus serpens* within *P.* ser. *Paepalanthus* (Ruhland 1903), which is the largest of the genus, encompassing most of its morphological, taxonomic and phylogenetic complexity (Andrade et al. 2010, Giulietti et al. 2012, Trovó et al. 2013). Usually species within this series are hard to identify (Andrino 2013), making the confident recognition of new species challenging. *Paepalanthus serpens*, however, is very different from the other species of the series in several aspects. It can be easily distinguished by its robust habit, with an elongate, lignescent stem, thickened by marcescent leaf sheaths, bearing at the apex a rosette of linear and erect leaves, numerous scapes equalling the leaf height and

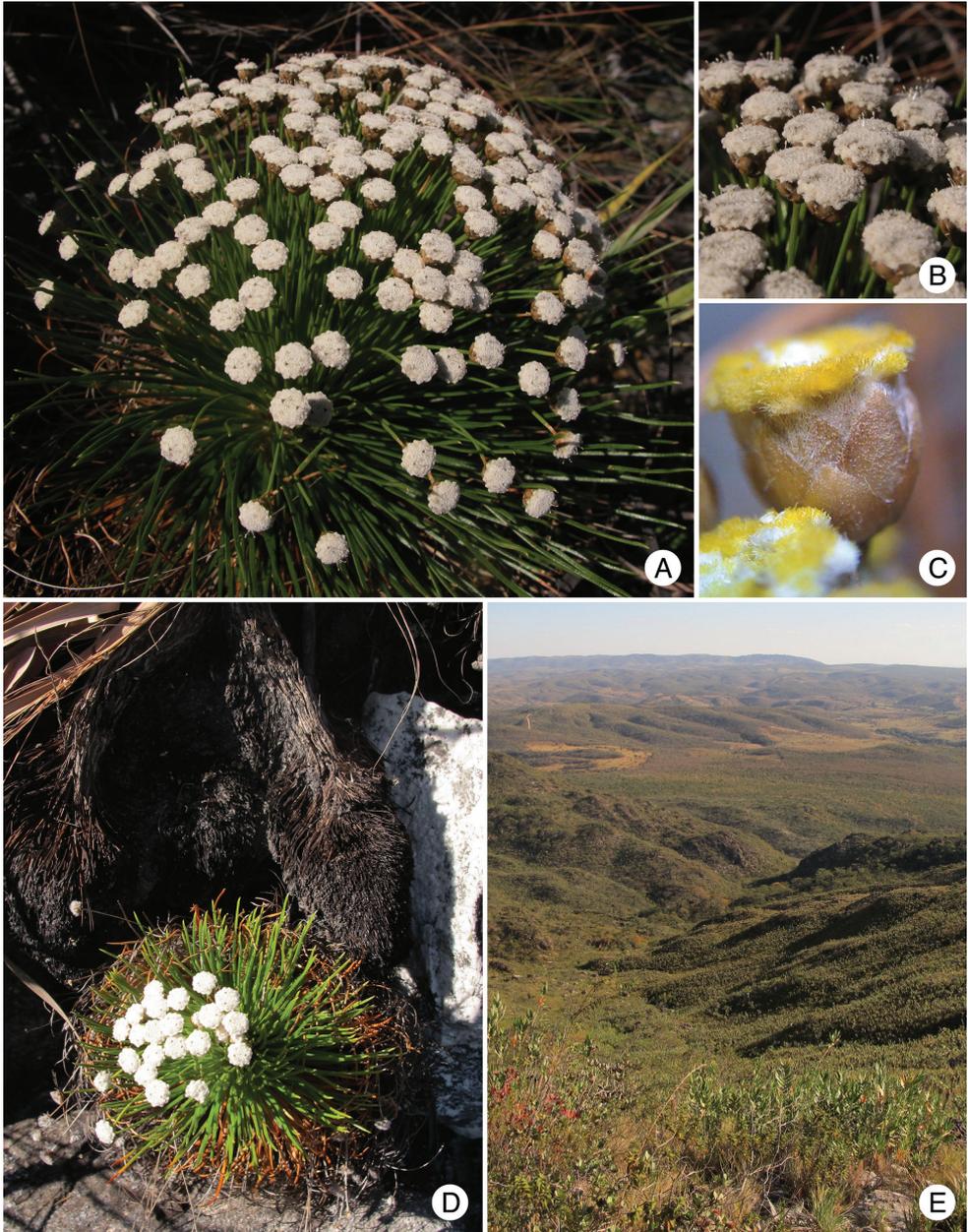


Figure 2. *Paepalanthus serpens* Echtern. & Trovó: **A** Habit **B** Capitula **C** Capitulum with yellowish hairs in a dried individual **D** Habitus showing the elongate, thick and creeping stem, with erect apex **E** Habitat (Photos by L. Echternacht).

capitula with straw-coloured involucre. This character set is unique within the genus. Other peculiar features are the scape spathes, which are quite short (up to 1 cm) and membranaceous, with lacerate margins, and short ferruginous trichomes on the leaves

and scapes. In addition, in some individuals, the trichomes on the bracts and flowers become yellowish after drying, which is an unusual feature within the genus.

The species of *Paepalanthus* with similar overall morphology to *P. serpens* are *P. caespititius* Mart. ex Koern. and *P. brunnescens* Ruhland. Both have a similar size and linear leaves, but more delicate habit and short, non-lignescens stem. These species are also not sympatric to *P. serpens*, as none of them are reported to the Serra do Cipó. *Paepalanthus caespititius* is morphologically the most similar species, with similar leaf width and short scapes, surpassing the leaves by no more than 5 cm. However, it shows dark involucre bracts and lanose stem with long ferruginous hairs. *Paepalanthus brunnescens* resembles *P. serpens* by its straw-coloured capitulum involucre, but can be easily differentiated by its short, branched stem, scapes greatly surpassing the leaf height, larger leaves, and elliptic to lanceolate involucre bracts.

Acknowledgements

We are grateful to Charles Frewen for welcoming us at the RPPN Toucan Cipó, allowing the collection of specimens and helping with logistics in field; to Carlos Alberto Ferreira Júnior, who accompanied us in the field and shows great devotion cultivating the species in the FZB-BH; to Daniela Zappi, who facilitated our access to the field; to Laurence Livermore for the English revision; to Inês Ribeiro, curator of the BHZB herbarium, for the loan of specimens; and to the team at the FZB-BH, for general support on the field and at the Botanical Garden; to the eMonocot project, for encouraging and supporting the team of taxonomists dedicated to Eriocaulaceae. Financial support was provided for M.T. by Alexander von Humboldt Foundation, UFRJ (ALV 2013) and FAPERJ (E-26/112.476 – INST).

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Clarifying the *Dioscorea buchananii* Benth. species complex: a new potentially extinct subspecies for South Africa

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Academic editor: S. Knapp | Received 13 December 2013 | Accepted 2 March 2015 | Published 15 April 2015

Citation: Wilkin P, Muasya AM (2015) Clarifying the *Dioscorea buchananii* Benth. species complex: a new potentially extinct subspecies for South Africa. *PhytoKeys* 48: 51–72. doi: 10.3897/phytokeys.48.6806

Abstract

The *Dioscorea buchananii* complex is shown to comprise three species, one of which is divided into two subspecies, based on morphological data. Two species, *D. rupicola* Kunth and *D. multiloba* Kunth, are endemic or subendemic to South Africa and of widespread occurrence in KwaZulu Natal. They differ markedly from each other in inflorescence and floral morphology and appear to be ecologically differentiated. The third species, *D. buchananii* Benth., is primarily found in southeastern tropical Africa, but a small number of specimens collected in South Africa in the late 19th and early 20th centuries are placed in an endemic subspecies, *D. buchananii* subsp. *undatiloba* (Baker) Wilkin. The latter taxon is a high priority in terms of rediscovery and conservation. Keys, descriptions, supporting information and illustrations are provided and made available online through eMonocot biodiversity informatics tools. Three nomenclatural acts are undertaken: two names are placed in synonymy and a new combination made.

Keywords

Africa, South Africa, *Dioscorea*, yam, species, taxonomy, vines, conservation, steroids, eMonocot scratchpad

Introduction

The *Dioscorea buchananii* Benth. group of species first came to the attention of science through the publication of three species with palmately lobed leaves from South Africa that had been collected by some of the early botanical explorers of the Cape: *D. diversifolia* Kunth, *D. multiloba* Kunth and *D. rupicola* Kunth (Kunth 1850). The first of those names was unfortunately a homonym of *D. diversifolia* Griseb., a Brazilian species for which a Sellow collection was cited (Grisebach 1842), although Kunth linked his name to Drège 4497 from the Cape. Two specimens of *D. multiloba* were cited by Kunth, Drège 4495 and 4496; both it and *D. diversifolia* were grouped as Cape taxa within one of Kunth's species groups based on floral morphological characters. *Dioscorea rupicola*, which was based on a plant cultivated in Berlin from material that had been received from Ecklon in South Africa, was treated separately, perhaps because it had 3, not 6 stamens unlike all its relatives. Baker (1897) recognised all 3 species described by Kunth and added a fourth, *Dioscorea undatiloba* Baker that he had described a few years earlier (Baker 1889) with pedicellate flowers and “repand-pinnatifid” central leaf lobes. They were separated in the key in the Flora Capensis treatment through pedicel presence or absence, stamen number and leaf shape. A further taxon, *D. junodii* Burt-Davy from Shilouvane in what is now Limpopo province was described by Burt-Davy (1924). It was said to differ from *D. rupicola* in possessing racemose male inflorescences with 6 stamens per flower and in its leaf shape. *D. junodii* was placed in synonymy with *D. sylvatica* Ecklon by Govaerts and Wilkin (2015). In tropical Africa, *Dioscorea buchananii* Benth. was described by Bentham (1882) based on a specimen from what is now Malawi with entire leaves and large flowers in a dense, short inflorescence. Bentham did not suggest any affinities for the species.

Knuth (1924) was the first taxonomist to formally group these species into an infrageneric taxon, *Dioscorea* sect. *Rhacodophyllum* Uline ex R. Knuth, following their placement as “*Eudioscoreae capenses*” by Uline (1897). He also described a further species, *D. digitaria* R. Knuth (Knuth 1924), based on a *Rudatis* specimen from Friedenau in what is now lowland coastal KwaZulu Natal. The Pflanzenreich account (Knuth 1924) stated that it differed in its narrow, acute central leaf lobe and shorter male inflorescence. Knuth's key to *D.* sect. *Rhacodophyllum* is based on similar characters to those used by Baker. A further new species, *D. natalensis* R. Knuth was placed in separate section containing South African species with entire leaves (Knuth 1924), but its inflorescence and floral morphology unequivocally link it to the *D. rupicola* group. The Pflanzenreich treatment also noted that a newly described variety of *D. buchananii* with palmately lobed leaves, var. *ukamensis* Uline ex R. Knuth linked *D. buchananii* to *D. undatiloba* and that perhaps those two species would be better combined. Knuth was the last taxonomist to study both the tropical and South African taxa of the *D. rupicola* species group.

Archibald (1968) covered only Eastern Cape specimens and populations of *D. rupicola* in her account of Cape *Dioscorea*. Von Teichman (1975) surveyed all the species of *Dioscorea* in South Africa. She lists *D. rupicola*, *D. undatiloba* and *D. diversi-*

folia though not *D. multiloba*. Her paper also reports a personal communication from Codd that a preliminary investigation into the taxonomy of the three species indicated that they represented a single taxon. Simultaneously in tropical Africa, Milne-Redhead (1975) sank var. *ukamensis* into *D. buchananii* with two later heterotypic names, *D. mildbraediana* R.Knuth and *D. rhacodes* R.Knuth. He stated that “the plentiful material now available shows that no taxonomic value can be placed on the leaf shape and degree of lobing”. Wilkin (2001; 2009) used the same broader taxon concept as Milne-Redhead but did not consider the species in South Africa except to highlight the floral differences between *D. buchananii* and *D. rupicola*.

The taxa of the *D. buchananii* complex share perennial, subterranean tubers, left-twining habit, a tendency to possess palmately lobed leaves (but with entire leaves in some to many populations), relatively short spicate to racemose inflorescences, paired floral bracts and flowers with well-developed receptacles and seeds that are winged all round the margin but with a wing that is longer than wide (often oblong-elliptic). The comments reported above by Knuth and von Teichman suggested that there are fewer morphological entities than species currently recognised; Govaerts and Wilkin (2015) listed *D. multiloba*, *D. natalensis*, *D. rupicola*, *D. undatiloba* and *D. buchananii* as accepted species names. Thus the morphology of all the taxa listed above was studied in more detail to test this hypothesis, focussing on specimens from South Africa but including data on *D. buchananii* from throughout its geographical and morphological ranges obtained for Wilkin (2001, 2009).

Materials and methods

The results and revised classification presented below are based on study of specimens at the following herbaria B (images), BOL, BM, K, P, PCE, PRE, NU (images) OXF, TCD and WAG and for *D. buchananii* COI, LISC, LMU, MAL and SRGH and include character data previously published in Wilkin (2001, 2009) for *D. buchananii*. The characters given in the descriptions were scored or measured using the naked eye, a dial caliper or a dissecting microscope with a graduated eyepiece. Leaf lobe lengths were made along the central vein from level with the base of the adjacent sinus to the lobe apex. The research undertaken was part of the eMonocot project and the nomenclatural and descriptive content and images form part of the Dioscoreaceae scratchpad (<http://dioscoreaceae.e-monocot.org>) and hence the eMonocot portal (<http://e-monocot.org/>).

Results and discussion

Floral morphology indicates that there are three taxonomic entities in the *D. buchananii* species complex, not one as reported in von Teichman et al. (1975). The most easily distinguished (see Table 1) has 3 stamens in its male flowers (rather than 6), male flowers that are pendent on an erect axis via recurved 0.6-1.5 mm long pedicels and erect to

Table 1. The principal characters differentiating *D. rupicola*, *D. multiloba* and *D. buchamanii* and their states in seven critical South African specimens. All measurements in mm.

	<i>D. rupicola</i>	<i>D. multiloba</i>	<i>D. buchamanii</i>	<i>Junod</i> 1416 (K sheet)	<i>Junod</i> 2182	<i>Breyer</i> in TM23387	<i>Medley Wood</i> 11673	<i>Medley Wood</i> 12969	<i>Gerrard & McKen</i> 1617	<i>Pole Evans</i> 4854
Leaf margin	(3-) 5(-7) shallow to deep basal lobes, very rarely entire	Entire to with 3, 5 or 7 shallow lobes often towards blade base	Entire to with 3, 5 or 7 shallow lobes towards blade base	3 or 5 basal lobes, weak lobing primarily on central lobe	3, 5 or 7 basal lobes, weak secondary lobing primarily on central lobe	Deeply 5 or 7-lobed, with irregular secondary lobing especially on central lobe margins	Palmately 5 or 7-lobed with irregular secondary lobing on each lobe	Palmately 5 or 7-lobed with irregular secondary lobing on each lobe	Palmately 5 or 7-lobed with irregular secondary lobing on each lobe	3 or 5 shallow to deep basal lobes
♂ infl. length	20–86	10–88	16–70	14–42	14–32	15–34	5–12	10–33	24–28	6–21
♂ infl. habit	Erect	Pendent to spreading	Pendent to spreading	Pendent	Pendent	Pendent to spreading	Pendent	Pendent to spreading	Pendent to spreading	Pendent
♂ infl. flower organisation on axis	Solitary	Solitary or rarely in clusters of 2-3	Solitary or rarely in cymes of 2-3 flowers	Solitary or rarely in cymes of 2-3 flowers	Solitary or rarely in cymes of 2-3 flowers	Solitary or rarely in cymes of 2-3 flowers	Solitary	Solitary	Solitary	Solitary
♂ floral orientation	Pendent on axis via recurved pedicels	Patent to axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis	Patent to pendent axis
♂ & ♀ tepals at anthesis	Erect to ascending	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	Spreading	♀ spreading, ♂ post anthesis	Spreading
♂ flowers pedicel length	0.6–1.5	(Sub)sessile	2.0–5.0	1.9–3.4	1.7–2.3	2.7–3.5	1.9–3.0	1.9–2.3	2.1–3.7	0.15–0.5
♂ Outer tepal L × W	2.0–3.8 × 0.6–1.3	1.4–2.1 × 0.7–1.5	2.5–4.7 × 1.1–2.3	2.9–3.6 × 1.9–2.1	2.3–3.3 × 1.8–2.2	2.5–3.7 × 1.3–1.8	2.7–3.7 × 1.3–1.6	2.3–3.2 × 1.4–2.0	2.5–3.0 × 1.1–1.3	1.9–2.7 × 1.6–1.9(-2.3)
♂ Inner tepal L × W	2.0–3.7 × 0.8–1.5	1.2–2.2 × 0.7–1.3	2.7–4.5 × 1.3–2.3	3.0–3.7 × 1.7–2.1	2.3–3.4 × 1.4–1.7	2.9–3.2 × 1.5–1.8	2.6–3.3 × 1.0–1.8	2.5–2.9 × 1.3–1.8	2.5–3.0 × 1.1–1.3	1.9–2.9 × 1.6–2.5
♂ torus diam.	1.0–2.1	1.5–2.3	2.3–5.0	2.5–3.1	2.3–3.1	2.2–3.1	1.9–3.4	2.2–2.9	1.5–1.9 (post-anthesis/withered)	2.7–3.3
Stamen no.	3	6	6	6	6	6	6	6	Unknown	6
Filament L	0.5–1.0	0.35–0.7	0.6–1.8	1.0–1.6	0.8–1.3	0.7–0.8	1.1–1.6	0.9–1.1	N/A	0.5–0.7

ascending yellow-green tepals with cucullate (rather than flat) apices in both male and female flowers. This corresponds to the type of *D. rupicola* and is usually encountered at altitudes between 2100 and 1200 m in the Eastern Cape and KwaZulu Natal. A second taxon has patent, (sub)sessile male flowers with spreading pale green tepals in both sexes. The earliest applicable name is *D. multiloba*. The types of *Dioscorea digitaria* and *D. natalensis* are lobed and entire-leaved forms of this species respectively. It is largely allopatric with *D. rupicola*, occurring below 800m in KwaZulu Natal and rarely at higher altitudes towards the edges of its range. The final entity has patent pale green or green-yellow to purple-, pink- or bronze-hued male flowers on pedicels at least 1.7 mm long. It also differs from *D. multiloba* in its male and female tepal and torus dimensions (Table 1), albeit that female specimens with flowers at anthesis are few in number. This is *D. buchananii*, which has a wide ecological range in southern tropical Africa.

During the study, six specimens from South Africa were encountered that possessed inflorescence and floral morphology similar to that of *D. buchananii* but whose leaves had at least a degree of secondary (pinnatifid) marginal lobing, especially on the central primary lobe (Figure 1A, H). This has not previously been recorded for the species. Milne-Redhead (1975) showed that both entire and palmately lobed leaves were found in *D. buchananii* and the collections made since 1975 confirm this hypothesis and support reducing *D. buchananii* var. *ukamensis* to synonymy. The secondary lobing, in combination with the observation that inflorescence and floral dimensions in the six specimens overlap with those of *D. buchananii* (Table 1), but are in the lower part of its ranges of variation, suggest that South Africa has a distinct subspecies of *D. buchananii* that corresponds with the types of both *D. undatiloba* and *D. junodii*. The former is the earlier name so *D. buchananii* subsp. *undatiloba* (Baker) Wilkin is applicable. A further specimen, *Pole Evans* 4954 collected from Ixopo in KwaZulu Natal but flowered in cultivation, was tentatively linked to *D. multiloba* due to the absence of secondary leaf lobing, a pendent inflorescence, flowers with spreading tepals and incurved filaments over three depressions in the centre of the torus. However, the presence of short pedicels and the tepal and torus dimensions suggest potential introgression with *D. buchananii* subsp. *undatiloba*. The two taxa are sympatric in KwaZulu Natal. In both this and the case above, an extensively sampled population-based study is needed using molecular marker data.

Taxonomy

Key to male flowering plants of the *Dioscorea buchananii* Benth species complex

- 1 Stamens 6, inflorescences spreading to pendent, tepals spreading, apices flat... 2
- Stamens 3, inflorescences erect, and bearing flowers patent to axis to recurved towards its base, tepals erect to ascending, apices cucullate..... *D. rupicola*
- 2 Flowers subsessile, tepals 1.2–2.2 mm long, buds (sub)globose.... *D. multiloba*
- Flowers on 1.7–5.0 mm long pedicels, tepals 2.3–4.7 mm long, buds turbinate... 3

- 3 Leaves entire to moderately lobed at stem base and on vegetative stems but then less strongly lobed to entire on reproductive shoots, lobe margins at most weakly undulate *D. buchananii* subsp. *buchananii*
 – Leaves consistently moderately to deeply 3, 5 or 7-lobed from stem bases to apices, with irregular, pinnate secondary lobing present on central lobe at least *D. buchananii* subsp. *undatiloba*

Key to female plants of the *Dioscorea buchananii* Benth species complex

- 1 Floral torus diameter 2.5–4.5 mm. Capsule oblong to obovate to very broadly so or rotund in outline, capsule width (13–)18–32 mm 2
 – Floral torus diameter 1.7–2.5 mm. Capsule oblong to narrowly obovate in outline, capsule width 13–20(–22) mm 3
 2 Leaves entire to moderately lobed at stem base and on vegetative stems but then less strongly lobed to entire on reproductive shoots, lobe margins at most weakly undulate *D. buchananii* subsp. *buchananii*
 – Leaves consistently moderately to deeply 3, 5 or 7-lobed from stem bases to apices, with irregular, pinnate secondary lobing present on central lobe at least *D. buchananii* subsp. *undatiloba*
 3 Tepals erect, staminodia 3 *D. rupicola*
 – Tepals spreading, staminodia 6 *D. multiloba*

Dioscorea buchananii Benth.

Dioscorea buchananii Benth., Hooker's Icon. Pl. 14:76, t. 1397, 1398 (1882).

Dioscorea buchananii var. *ukamensis* R.Knuth in H.G.A Engler (ed.), Pflanzenr. 4, 43: 185 (1924). Type: Tanzania, Morogoro Dist., Ukami, without date, *Stuhlmann* 8283 (holotype: B†).

D. mildbraediana R.Knuth, Notizbl. Bot. Gart. Berlin-Dahlem 11: 1059 (1934).

Type: Tanzania, Kilwa, Mswega, ♂ fl. 22 Jun 1932, *Schlieben* 2495 (holotype: B!; isotype BR!).

D. rhacodes Peter ex R.Knuth, Repert. Spec. Nov. Regni Veg. 42: 162 (1937).

Type: Tanzania, Ukami, east of Morogoro, ♂ fl. 1926, *Peter* 46419 (holotype: B!).

Types. MALAWI: Shire Highlands, ♂ fl. 1881, *Buchanan* 173 (syntype: K!) ♀ fr. 1881, *Buchanan* 358 (syntype: K!).

Description. Twining vine to 10 m in height, vegetative growth annual, usually 1 shoot per year from apex of perennial, woody tuber, to ca 20 cm in diam., usually globose to ovoid, sometimes elongate or irregular, shape varying perhaps based on rockiness of substrate, externally dark grey to brown, fissured, bark-like. Indumentum absent. *Stems* left-twining, to 5 mm in diam., terete to shallowly longitudinally ridged, more so when

dry, unarmed from base, green or purple-hued, herbaceous, cataphylls not seen. *Leaves* alternate, blade variable, 2.8–13.5 × 1.1–14.7 cm, entire or with 3, 5 or 7 shallow to deep lobes, ovate to broadly so, veins 7(–9), primary venation in shallow channels on upper surface in fresh material, primary and secondary venation prominent below, base cordate, with a shallow to deep basal sinus, rarely truncate, texture chartaceous, where lobes present central lobe to 116 mm long, lateral lobes to 35 mm long, lobes usually found primarily in vegetative stem leaves with reproductive stem leaves more weakly lobed to entire, rarely consistently lobed to shoot apices, lobes inserted from around mid-point to point of petiole insertion, lobe margins entire to (rarely) weakly undulate or in some leaves lobed to stem apices with weak to strong irregularly pinnate secondary lobing, blade or central lobe apex acute to triangularly short-acuminate, rarely obtuse or truncate, bearing a 1.5–10 mm long, thickened, very narrowly triangular, brown forerunner tip fed by the 3 central veins of blade; petiole 0.6–6.3 cm long, ridged like stem and with a narrow channel on upper surface, colour as stem, pulvinii sometimes paler or purple-hued; lateral nodal organs absent but petiole base broader where inserted onto stem, axillary bulbils absent. Inflorescences simple, usually 1 per axil, axes straight, angular, pale green or purple or brown-hued; male 1.6–7 cm long, peduncle 2–11 mm long, racemose, pendent to spreading, usually dense with flowers 0.3–4.1 mm apart and solitary or rarely in cymules of 2–3 flowers, on a 1.7–5.0 mm long pedicel that is angular and slightly broader towards apex, buds patent to axis, pendent at developing inflorescence apex only in very early development; female inflorescence 9–77 mm long, accrescent to ca 30 cm long in fruit, peduncle 12–20 mm long, spicate, pendent, lax, flowers subpendent only at the earliest stages of development, patent to axis at anthesis but ascending to erect soon thereafter. Flowers turbinate in bud, tepals 6, free, inserted on margin of a saucer-shaped, weakly thickened torus, spreading at anthesis, sometimes ascending thereafter, whorls scarcely differentiated, 3-veined, brown, green, olive or bronze, sometimes with a pink or yellow hue or mottled; male flower with floral bract and bracteole sheathing pedicel base, bract 1.6–2.6 mm long, ovate, long-acuminate, membranous, bracteole similar, narrower, usually offset from bract; outer tepals 2.5–4.7 × 1.1–2.3 mm, inner tepals 2.7–4.5 × 1.3–2.3 mm, narrowly ovate to lanceolate or triangular, chartaceous, apex acute to short-acuminate, flat; filaments 0.6–1.8 mm long, erect but incurved over 2.3–5 mm diam. torus, anthers 0.5–1.2 × 0.4–0.8 mm, introrse; pistillode to ca 0.1 mm high, 3 centrally fused triangular ridges at 120° to each other in flat central part of concave torus; female flower with floral bract and bracteole sheathing ovary base, bract 1.6–2.4 mm long, ovate, long-acuminate, membranous, bracteole similar, narrower, usually offset from bract; ovary 5–10 mm long, 3-angled, lorate to very narrowly elliptic in outline, colour as axis, apex constricted; outer tepals 2.9–4.5 × 0.8–1.9 mm, inner tepals 2.9–4.4 × 0.9–2 mm, more or less erect, narrowly ovate to lanceolate, apex acute to short-acuminate, flat, each tepal with 0.2–0.7 mm long basal staminode inserted at the boundary with the torus at the tepal base midpoint, usually fleshy and ovoid but sometimes substaminiform; torus 2.5–4.5 mm in diam. both tepals and torus accrescent as ovary enlarges; style 1.8–3.2 mm long, erect, divided into 3 spreading branches towards apex, stigmas bifid, oblong to clavate. Capsule 2.2–3 × (1.8–)2–3.2 cm, pedicel reflexed and thus ascending to erect at dehiscence, lobes obovate to oblong-obovate in outline, thick-chartaceous, base and apex

usually truncate, dry and withered flowers persistent until relatively late in development on a ca 1.2–2.0 mm long stipe, light brown with chestnut-brown to coppery brown mottling, dehiscing apically at least at first. Seed 2.5–4 × 3–4 mm, irregularly lenticular, dark brown wing 1–2 × 0.7–1.3 cm, broadly oblong-elliptic to rotund to irregularly so, wing extending all around seed margin although elongated towards rounded to obtuse base and apex, pale brown, translucent with fine paler speckling.

Dioscorea buchananii* subsp. *buchananii

Description. Leaves entire to moderately 3, 5 or 7-lobed at stem base and on vegetative stems but then less strongly lobed to entire on reproductive shoots, lobe margins at most weakly undulate; where lobed central lobe usually the largest, maximum length as in species as a whole, broadly ovate to lanceolate or deltoid, lateral lobes oblong to rounded. Male flower pedicel, tepal and torus dimensions as in species as a whole.

Distribution. Tanzania and Southern and Eastern Congo (Kinshasa) to southern Mozambique, Zimbabwe and Angola.

Vernacular name(s). See Wilkin (2001, 2009).

Ecology. Frequently associated with rocky habitats, often in *Brachystegia* woodland, but also on termitaria, in riverine forest and near mangrove swamps, on limestone and granite substrates; sea level to 1600 m (Wilkin 2001, 2009).

Conservation. The broad southeastern African distribution of this species indicates that its EOO and AOO will greatly exceed the threshold for threatened IUCN categories (20, 000 km²/2000 km²) (IUCN 2001) and its provisional status is LC.

Uses. None known.

Specimens examined. Representative specimens are cited in Milne-Redhead (1975) and Wilkin (2001, 2009).

***Dioscorea buchananii* subsp. *undatiloba* (Baker) Wilkin, comb. & stat. nov.**

urn:lsid:ipni.org:names:77146550-1

Figure 1

Dioscorea undatiloba Baker, J. Bot. 27: 8 (1889); R.Knuth in H.G.A Engler (ed.), Pflanzenr. 4, 43: 184 (1924).

Type: South Africa. KwaZulu Natal: Port Natal, Mandini District, Tugela, ♂ fl. & ♀ fl. without date, *Gerrard & McKen* 1617 (holotype: K post anthesis ♂ fl. & ♀ fl. [K000098906!]; isotype: TCD!, ♀ fl.!)

Dioscorea junodii Burtt-Davy, Kew Bull. 1924: 231 (1924), **synon. nov.**

Type: South Africa. Limpopo: Mopani District, Valley of Schambock's Stadt, near Shilouvane, (Shiluvane) Sanatorium, 24°02'20"S, 30°16'59"E, ♂ fl. *Junod* 1416 (holotype: K [K00098905!]), *non* PRE [PRE0093186-0, digital image!]

Type. Based on *Dioscorea undatiloba* Baker.

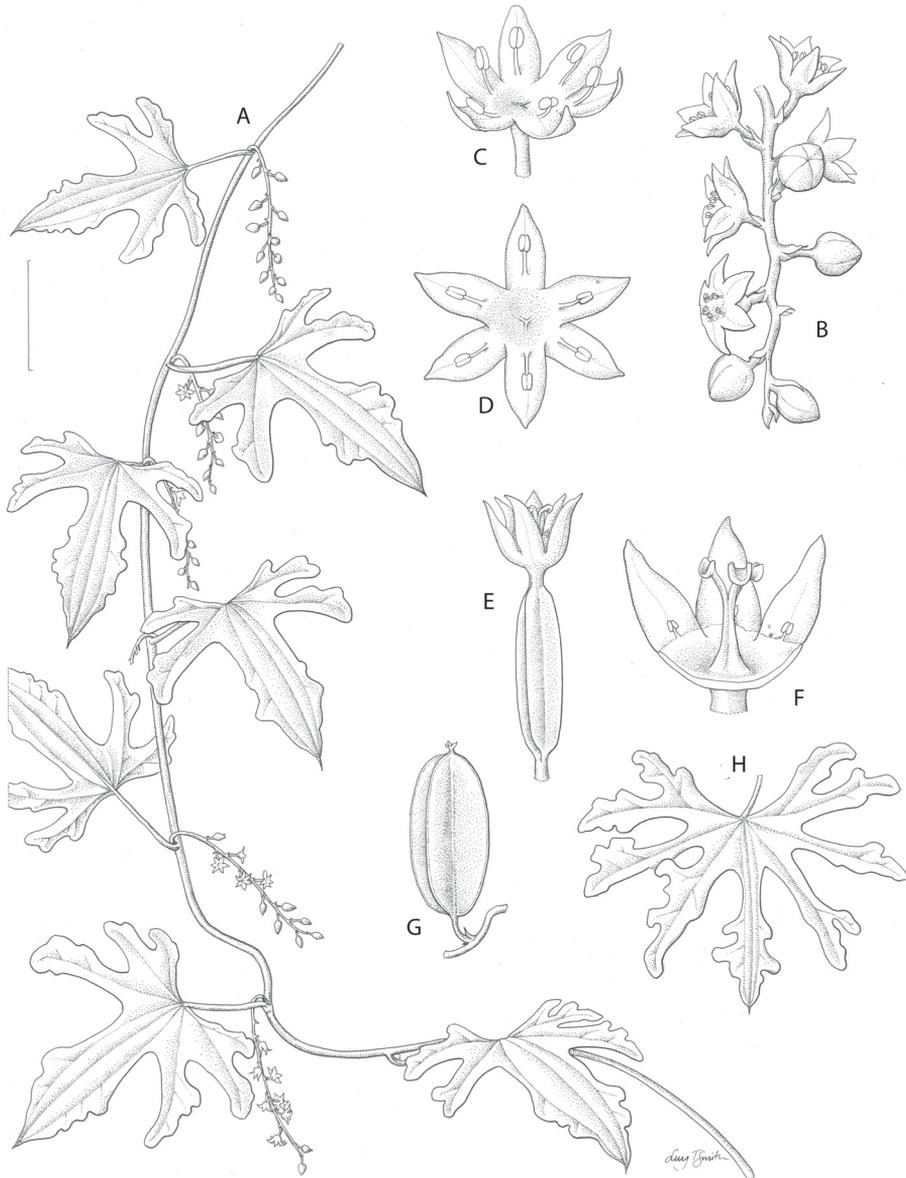


Figure 1. *Dioscorea buchananii* Benth. subsp. *undatiloba* vegetative and reproductive morphology **A** Habit of male plant with axillary inflorescences **B** Apical part of male inflorescence showing tepal shape and habit and bud shape **C** Rehydrated male flower with apical part of pedicel showing stamen morphology (NB tepal and stamen habit influenced by specimen preparation) **D** Fully opened out rehydrated male flower from above showing tepal shape, torus and pistillode **E** Female flower with ovary at late anthesis, tepals ascending **F** Female flower with 3 tepals removed showing torus, staminodia and gynoeceum **G** Immature capsule with pedicel, floral bract and persistent tepals at apex **H** Leaf of KwaZuluNatal form of *Dioscorea buchananii* Benth. subsp. *undatiloba*. Scale bar: **A**, **H** 3 cm; **B** 7 mm; **C**, **D**, **E** 5 mm; **F** 3 mm; **G** 2 cm. From Breyer in TM 23387 (**A**), Junod 2182 (**B**, **G**), Medley Wood 11673 (**C**, **D**) Gerrard & McKen 1617 (**E**, **F**) Medley Wood 12969 (**H**). Drawn by Lucy Smith.

Description. Leaves consistently moderately to deeply 3, 5 or 7-lobed from stem bases to apices, with irregular, pinnate secondary lobing present on central lobe at least; central lobe to 50 mm long, lanceolate to elliptic or rhomboid, lateral lobes to 33 mm long, oblong to narrowly so, central lobe largest to lobes more or less equal in length and width. Male flowers on 1.7–3.7 mm long pedicels, tepals 2.3–3.7 × 1.0–2.2 mm, torus (1.5–)1.9–3.4 mm in diam.

Distribution. Endemic to South Africa in Limpopo and KwaZulu Natal provinces. The Limpopo specimens are from localities relatively close to those of the type subspecies in Gaza province of Mozambique.

Vernacular name(s). Not known.

Ecology. *Ca.* 50 to 600 m altitude in KwaZulu Natal, and 700 to 1000 m in Limpopo. Associated geology, soils and vegetation unknown.

Conservation. *Dioscorea buchananii* subsp. *undatiloba* has not been recorded since 1921 in either Limpopo or KwaZulu Natal and is known from only six specimens. However, pending urgently needed searches to find extant populations in Limpopo, KwaZulu Natal and the intervening areas and further research on the relationships between those populations, the most appropriate provisional conservation status assessment is DD. It is conceivable that this taxon is already extinct in part or all of its range, especially extensively developed lowland KwaZulu Natal.

Uses. None known

Notes. The specimen labelled *Junod* 1416 at PRE [PRE0093186-0] is male flowering material of *D. sylvatica* Ecklon. This explains the placement of *D. junodii* in the synonymy of that species in Govaerts and Wilkin (2015). However, Burt Davy would have examined and described the K sheet cited above, hence its holotype status and synonymy under *Dioscorea buchananii* subsp. *undatiloba*. No specimen of *Junod* 1416 appears to be preserved at G or Z based on their online databases.

Specimens examined. **SOUTH AFRICA. Limpopo:** Mopani District, Shiluvane, 24°02'20"S, 30°16'59"E, ♂ fl. & ♀ fr. May 1905, *Junod* 2182 (Transvaal Museum 7164), (PRE!); Louis Trichardt, ♂ fl. Jan 1921, *Breyer in TM* (Transvaal Museum) 23387 (K!, PRE). **KwaZulu Natal:** uThungulu District, Umvuzaan (uMvuzane) Valley, 28°46'21"S, 31°20'29"E, ♂ fl. buds Jan 1915, *Medley Wood* 12969 (K!); Pietermaritzburg, Camperdown 29°43'59.91"S, 30°31'59.87"E ♂ fl. Mar 1910, *Medley Wood* 11673 (K!).

***Dioscorea multiloba* Kunth**

Figure 2, 3A, B

Dioscorea multiloba Kunth, Enum. Pl. 5: 376 (1850); R.Knuth in H.G.A Engler (Ed.), Pflanzenr. 4, 43: 183 (1924).

Dioscorea diversifolia Kunth, Enum. Pl. 5: 375 (1850), *non* Griseb. in C.F.P.von Martius (Ed.), Fl. Bras. 3(1): 41 (1842), type only.

Type: South Africa. Eastern Cape: Pondoland, between Umtentu and Umzimkulu Rivers, ♂ fl. & ♀ fr., Feb, year unknown, *Drège* 4497 (holotype: B

[B_10_0278736 ♂ fl. digital image!]; isotypes: G [G00018717 ♂ fl. digital image!]; K [K000098903, K00098904 ♂ fl. & ♀ old fr.!]; OXF [OXF0004195 ♂ fl. & ♀ old fr.!]; P [P00440190! ♀ fr.!]; TCD ♂ fl.!).

Dioscorea natalensis R.Knuth in H.G.A Engler (ed.), *Pflanzenr.* 4, 43: 94 (1924), **synon. nov.**

Type: South Africa. KwaZulu Natal: Durban [Kingsburgh], Winkle Spruit, ♂ fl. 28 Feb 1912, *Rudatis* 1609 (holotype: B [B_10_0160974 digital image!]; isotypes K! [K000815875, K000815874] WAG [WAG0027134!]; Z [Z-000065671, Z-000065672, digital images!].

Dioscorea digitaria R.Knuth in H.G.A Engler (ed.), *Pflanzenr.* 4, 43: 184 (1924).

Type: South Africa. KwaZulu Natal: Friedenau, Umgayeflat (Alexandria), ♂ fl. 1 Oct 1909, *Rudatis* 724 (holotype: B [B_10_0160991 digital image!]).

Type. South Africa. KwaZulu Natal: “Probably collected in Pondoland”, ♂ fl. & ♀ fr. 1840, *Drège* 4496 (lectotype: K! [K000098902 ♂ fl. buds & ♀ fr.]; isolectotypes B [B_10_0004142 ♂ fl. buds & ♀ fr., B_10_0004143 ♂ fl. buds digital images!]; G [G00018675 ♀ fr. digital image!]; K [K000098900 ♂ fl. buds & ♀ fr.!]; KIEL; OXF! [OXF00004193 ♀ fr.]; P [P00440187 ♀ fr., P00440188 ♂ fl. buds & ♀ fr., P00440189 ♀ fr., P00440191 ♂ fl. buds & ♀ fr.!], TCD ♀ fr.!).

Description. Twining vine to ca 3 m in height, vegetative growth annual from a perennial tuber. Tuber apex only seen, ca 15 cm in diam., convex, dark brown to black, bark-like, bearing one shoot per year at central apex, according to von Teichman und Logischen et al. (1975) lobed and irregular below ground but not branched like that of *D. rupicola*. Indumentum absent. Stems left-twining, to ca 5 mm in diam., terete to shallowly longitudinally ridged and more so when dry, base with dense, firm processes to ca 1 mm long, dark purple-brown, becoming unarmed above and pale green to dull purple-hued. Cataphylls present towards stem base, ovate, acuminate, concolorous with stem to paler. Leaves alternate, blade 15–148 × 8–133 cm, ovate to narrowly or broadly so in outline, deeply to shallowly 3- to 7-lobed, usually lobed at base at least, blade sometimes (sub) entire in especially in leaves on terminal shoots, lobing usually concentrated in basal part of leaf close to point of petiole insertion, texture thinly to thickly chartaceous, primary venation in shallow channels on upper surface in fresh material sometimes bullate between secondary veins, primary and secondary venation prominent below, dark to mid green above, pale below, base cordate to truncate, sinus where present to 31 mm deep, lobes to 42 mm long, apically obtuse to rounded, lobe margins entire to sometimes with weak secondary lobing, apical lobe lanceolate-deltoid to broadly ovate, apex acute to obtuse, bearing a thickened, narrow, caudate forerunner tip to 7 mm long, sometimes subterminal, derived from central 3 veins of blade, pale yellow-green when fresh, brown and with margins curled inwards on upper surface when dry, primary veins 5–9, 3 in apical lobe, usually 1 per basal lobe but sometimes multiple veins per lobe in 3-lobed or entire leaves; petiole 6–54 mm long, ridged and with a narrow channel on upper surface, colour as stem, upper pulvinus sometimes paler than lower; lateral nodal organs absent and nodes not thickened but in vegetative stem leaves petiole base broader where inserted onto stem;



Figure 2. *Dioscorea multiloba* Kunth vegetative and reproductive morphology. **A** Habit of male plant with axillary inflorescences **B** Apical part of male inflorescence showing tepal shape and habit and bud shape habit **C** Lobed leaf showing venation of upper surface and forerunner tip **D** Male flower from above showing filament habit **E** Male flower with 3 tepals and part of torus removed showing torus shape, pistillode and associated concavities in torus surface **F** Female flower with 3 tepals and part of torus removed showing torus shape, staminodia and gynoecium **G** Female inflorescence showing tepal habit and ovaries **H** Infructescence showing some submature capsules with persistent tepals **J** Seed showing wing shape. Scale bar: **A, C** 3 cm; **B** 7 mm; **D, E** 4 mm; **F** 3 mm; **G, H** 2.5 cm; **J** 2 cm. From Ward 3076 (**A, B, D, E**), Medley Wood 329 (**F, G**), *Gueinzus* s.n. (**H, J**) and a photograph (**C**). Drawn by Lucy Smith.

axillary bulbils not present. Inflorescences simple, usually spicate, axes angular, pale green; male inflorescences 1–6 per axil, often 1, sometimes borne on weak axillary shoots with few to no leaves, 10–88 mm long, peduncle 2–8 mm long pendent to spreading, never erect, axis usually straight but sometimes irregularly flexuous, flowers usually solitary or rarely in clusters of 2–3, 1.2–4.6 mm apart, buds patent to axis, pendent at developing inflorescence apex only in very early development; female inflorescences 7–84 mm long, peduncle 4–10 mm long, flowers patent to axis at anthesis but ascending to erect soon thereafter. Flowers (sub)globose in bud, tepals 6, free, inserted on a saucer-shaped torus, spreading at anthesis, whorls scarcely differentiated, yellow-green to pale green, often with a darker apical mark or darker on midrib; male (sub)sessile, floral bract 1.0–1.7 × 0.4–0.6 mm, ovate to lanceolate, acuminate, concolorous with axis, bracteole similar, narrower, usually offset from bract; outer tepals 1.4–2.1 × 0.7–1.5 mm, inner 1.2–2.2 × 0.7–1.3 mm, ovate to narrowly so or deltoid, apex acute to obtuse, slightly thickened and sometimes with upcurved margins but not cucullate, inserted on margin of 1.5–2.3 mm diam. torus, thicker than tepals (but less so than in *D. rupicola*) and concolorous with them, stamens 6, inserted at torus/tepal boundary at tepal base midpoint, filaments 0.35–0.7 mm long, erect but markedly incurved such that anthers are held over concave surface of torus with apices sometimes almost touching, anthers 0.3–0.5 × 0.2–0.45 mm, oblong to oblong-elliptic, basifixed, pale yellow, pistillode 0.1–0.7 mm long, variable in shape but formed by 3 centrally fused triangular ridges at 120° to each other, with a 0.35–0.6 mm diam. bowl-shaped, concave, circular to ovoid in outline, possibly nectariferous depression between each lobe demarcated by a membrane and with a denser texture than torus, pistillode apex either acute or bearing short recurved lobes; female flowers sessile, floral bract 0.9–1.6 mm long, appressed to ovary base, otherwise bract and bracteole as male; ovary 3.0–6.1 mm long, 3-angled, lorate to very narrowly elliptic in outline, pale green, apex constricted, tepals 1.5–2.5 × 0.8–1.5 mm, shape, apex and colour as male, torus 1.7–2.4 mm in diam., Tepals and torus accrescent as ovary enlarges when flowers persist and tepals sometimes becoming ascending but not erect, staminodia 6, ca 0.1 mm long, inserted at torus/tepal boundary at tepal base midpoint, style ca 1.0 mm long, erect, stout, 3-angled, broadest at base, stigmas 3, ca 0.4 × 0.9 mm, spreading, bifid, lobes broadly ovate in outline. Capsule 16–28 × 15–20(–22) mm, pedicel reflexed and thus ascending to erect at dehiscence, oblong to obovate in outline, thick-chartaceous, base obtuse to truncate, apex truncate to rounded, dry and withered flowers persistent until relatively late in development on a ca 1.0–1.7 mm long stipe, pale brown with darker coppery-brown speckling, dehiscing apically at least at first. Seed 4.6–5.0 × 3.7–5.0 mm excluding wing, lenticular, dark brown, wing 11–14 × 6.5–9.3 mm, oblong to irregularly elliptic, all round margin though with elongated towards rounded to obtuse base and apex, pale brown, translucent with fine paler speckling.

Distribution. Endemic to South Africa (Eastern Cape to Mpumalanga) and Swaziland.

Vernacular name(s). The only vernacular name known is wild yam.

Ecology. *Dioscorea multiloba* occurs in a range of habitats but is principally associated with forest and bush margins and associated grasslands on a range of sandy and loamy substrates. In the northern part of its range it often appears to occur in swampy



Figure 3. *Dioscorea multiloba* and *Dioscorea rupicola* colour photographs. **A** Upside down shoot of *D. multiloba* with male flowers **B** Female plant of *D. multiloba* with female flowers and immature capsules **C** Leaf and erect male inflorescence of *D. rupicola* showing habit of flowers. **D** Immature capsule of *D. rupicola* with persistent, erect, cucullate tepals at its apex. Photo **A, B**: Tony Abbott; **C, D**: Neil Crouch.

habitat. It is found at altitudes from close to sea level to 800 m in KwaZulu Natal. At the edges of its range the specimen from Swaziland (*Compton* 26691) was collected at ca 4000' (1200 m) and *Flanagan* 2717 from the Eastern Cape 4500' (1400 m).

Conservation. *Dioscorea multiloba* is widespread in lowland KwaZulu Natal, and its distribution extends into the Eastern Cape, Mpumalanga and Swaziland. Thus its EOO and AOO will greatly exceed the threshold for threatened IUCN categories (20, 000 km²/2000 km²) (IUCN 2001) and its provisional status is LC. This status is also given by the SANBI red list programme (under *D. diversifolia* Griseb.)

Uses. None known. Data on the steroid content of this species is desirable. Codd (1960) states that only three South African species contain diosgenin but the data on which this is based are not presented.

Notes. Kunth cites male and female syntypes as follows “Drège, Herb. Cap. no. 4495. ex parte. v.s. in Herb. Luc. and Drège, Herb. Cap. No 4496. ex parte. v.s in Herb. Luc.” Herb. Luc. appears to be an abbreviation for Herbarium Lucae, which formed part of the KIEL herbarium. Kunth specified that 4495 was male and 4496 female. However, there is both male and female material at K under 4496. In contrast, a single sheet in B (B_10_0004142) has fragments of both male and female plants under both collection numbers. P has female material under 4495 (P00440190) and male material under 4496 (P00440188) among 5 duplicates of both numbers. Given this confusion and the number of duplicates in European herbaria it was decided to lectotypify the species using K000098902, the most complete and representative specimen available.

The only specimen cited in the protologue of *Dioscorea diversifolia* Kunth, a later homonym of *D. diversifolia* Griseb., was Drège 4497. The material under this number at TCD appears to represent two different male plants of *D. multiloba*, with the left and bottom fragments possessing flexuous inflorescences and the right a straight inflorescence. The K and OXF material is different, with entire leaves, male flowers in bud and the previous season’s fruit. K has 2 very similar sheets from both Hooker and Bentham’s herbaria.

Specimens examined. SOUTH AFRICA. Eastern Cape: Komga, near Kei Mouth, ♂ fl. Jan 1890, *Flanagan* 442 (K!, PRE); Engcoba (Ngcobo) Mountain, ♀ immature fr. Jan 1896, *Flanagan* 2717 (PRE!); Mquanduli, Coffee Bay, ♂ fl. 4 Mar 1953, *Theron* 1505 (PRE!); Pondoland, between Umtentu River and Umzinkulu River, ♂ fl. buds & old fr. Feb unknown year, Drège 4497 (K!, OXF!, TCD!). **KwaZulu Natal:** Port Shepstone, Mgayi, 30°25'S, 30°30'E, ♂ fl. 27 Jan 1968, *Ward* 6339 (NU [NU0028305], UDW); Port Shepstone, Mgayi, “30°25'S, 30°25'E”, ♀ immature fr. 27 Jan 1968, *Ward* 6340 (K!, NU [NU0028304 digital image!], PRE, UDW digital image!); Inanda, ♀ fl. & immature fr. Jan ?1879, *Medley Wood* 329 (K, 2 sheets!); Port Shepstone, Umtamvuna Nature Reserve, Beacon Hill, 31°00'33"S, 30°10'55"E, ♀ fl. & immature fr. 9 Dec 2010, *Abbott* 9287 (PCE!, PRU!); Port Shepstone, Umtamvuna Nature Reserve, Beacon Hill, 31°00'33"S, 30°10'55"E, ♂ fl. 9 Dec 2010, *Abbott* 9288 (PCE!, PRU!); Inanda, ♂ fl. Jan. ?1880, *Medley Wood* 825 (K!); Inanda, Groenberg, ♂ fl. Mar ?1880, *Medley Wood* 892 (K!); Lions River District, collected at Karkloof 11 July 1952 and cultivated at Irene, ♀ immature fr. 20 Dec 1954, *Pole-Evans* 4862 (K!, PRE); Durban, Umbilo Waterfall, ♂ fl. received Feb 1883 *Rehmann* 8155 (K!); Port Natal, ♂ fl. & ♀ fr. without date, *Gueinzius* s.n. (K!, TCD!); Port Natal, ?Umgenana, ♂ fl. without date, *Gerrard & McKen* 1920 (TCD!); Fort Bowker, ♂ fl. & ♀ fr. without date, *Bowker* 575 (TCD!); Kaffraria, Tsomo (?), ♂ fl. without date, *Bowker* 861 (TCD!); Fort Bowker ♂ fl. without date, *Bowker* 627 (TCD!); Natal, no further data, ♂ fl. without date, *Gerrard & McKen* 36 (TCD!); Port Natal, ♂ fl. without date, *Sanderson* 5 (TCD!); Durban District, Umbogintwini, above lagoon, st. 10 May 1964,

Ward 4976 (NU [NU0028355 digital image!]); Pietermaritzburg District, Isipingo Flats, 29°59'S, 30°56'E ♂ fl. 1 May 1971, *Ward* 6992 (NU [NU0028390 digital image!], UDW digital image!); Lower Umfolozi District, Hluhluwe Game Reserve, ♂ fl. 24 Jan 1949, *Ward* 665 (NU [NU0028255, 0028351 digital image!]); Hlabisa District, Hluhluwe Game Reserve, ♂ fl. 16 Jan 1954, *Ward* 2073 (K!, NU [NU0028352 digital image!], PRE); Hlabisa District, Hluhluwe Game Reserve, ♂ fl. 6 Mar 1957, *Ward* 3076 (K!, (NU [NU0028353, 0028354 digital images!], PRE); Mtubatuba District, Hlabisa, Park Ridge Farm, ♀ fr. 11 May 1968, *Harrison* 498 (PRE!); Maputaland, Kosi Bay area near Catholic Mission, sterile 20 Mar 1965, *Vahrmeijer* 482 (K!, PRE); Maputaland, 3 miles from Maputa on road to Olibotini, ♂ fl. 23 Mar 1965, *Vahrmeijer* 540 (K!, PRE); KZN, No further data, ♂ fl. received Jul 1965, *Gerrard* 772 (K!); ♂ fl. received Jul 1965 & Mar 1872, *Gerrard* 1920 (K!); KZN, Locality illegible, ♂ fl. 1862, *Cooper* 3244 (K!). **Mpumalanga:** Pilgrims Rest District, collected at Mac Mac 19 Aug 1952 and cultivated at Irene, ♂ fl. 20 Dec 1954, *Pole-Evans* 4846 (K!, 2 sheets, PRE); Pilgrims Rest District, collected at Mac Mac and cultivated at Irene, ♂ fl. 14 Apr 1955, *Pole-Evans* 4861 (K!, 2 sheets, PRE). **Swaziland:** Mankaina District, ♂ fl. 3 Feb 1958, *Compton* 27492 (K!, PRE); Mbabane District, Ukutula, ♂ fl. 21 Feb 1957, *Compton* 26691 (K!, PRE).

Dioscorea rupicola Kunth

Figure 3C, D

Dioscorea rupicola Kunth, Enum. Pl. 5: 378 (1850).

Type. SOUTH AFRICA. No further data, plant obtained by Ecklon possibly from the Winterberg mountains cultivated in Berlin s.n., ♂ fl. 27 Jul 1836 (holotype: B†; isotype K! [K000098907!]).

Description. Twining vine to not more than 5 m in height. Vegetative growth annual from a perennial tuber. Mature tuber apex to 4 × 4 cm, buried to 15 cm below soil surface, irregularly ridged longitudinally, corky, with an apical depression bearing shoot(s, usually 1 per year) and hard, brown, deltoid cataphylls to 15 mm long; base of tuber bearing 1–3 branches to 30 × 1–3 cm long, corky and fissured externally and bearing wiry roots, parenchyma white, brittle (*vide* Archibald 1968). Indumentum absent. Stems to 4 mm in diam., left-twining, terete but longitudinally ridged, unarmed, pale green, sometimes pink, purple or brown-hued, branched above, cataphylls present towards base, to 6 × 3 mm, deltoid, apex caudate, recurved (*vide* Archibald 1968). Leaves alternate, blade 20–104 × 15–85 mm, ovate to narrowly so or lanceolate in outline, weakly to strongly 3- to 7-lobed around point of petiole insertion, rarely entire, juvenile plants with wholly entire leaves, usually broadly ovate to orbicular, texture chartaceous (thinner in juveniles), primary venation in shallow channels on upper surface in fresh material and lamina between secondary veins weakly bullate, shiny mid green above, paler below, drying olive green below, browner above; margins weakly undulate in fresh

material, base cordate, sinus (1–)3–33 mm deep, lobes to 36 mm long, apically obtuse to rounded, apical lobe lanceolate to lanceolate-deltoid or lanceolate oblong, apex broadly acuminate with a 0.5–5 mm long narrow, caudate, thickened forerunner tip that appears channelled above, brown, veins usually 7, 3 in apical lobe with 2 per side running into basal lobe(s), sometimes a smaller vein close to the basal sinus, primary and secondary venation prominent below; petiole 10–67 mm long, ridged and with a narrow channel on upper surface, colour as stem, basal pulvinus flattened and broadly deltoid towards point of insertion onto node, especially in larger leaves, lateral nodal organs absent but in largest stems nodes swollen with a blunt projection on either side of petiole insertion onto node; axillary bulbils not present. Inflorescences 1 per axil, simple, axes angular, pale green, flowers campanulate; male inflorescences 20–86 mm long, peduncle 5–14 mm long, ca 1 mm in diam. at base, racemose, erect and bearing flowers ca 2–8 mm apart, buds oriented towards apex in very early development but at least patent to axis and usually recurved towards its base at anthesis, female inflorescences 9–82 mm long, peduncle 9–24 mm long, spicate, pendent, flowers oriented towards apex in very early development but usually patent to axis to ascending at anthesis. Flowers with 6 tepals, buds turbinate, apex acute-conical, at anthesis pedicel, tepals and torus exterior pale green to yellow-green, torus inner surface light pink to purple, possessing a light, sweet fragrance (*vide* Moll 1400, Archibald 1968); male flowers borne on 0.6–1.5 mm long curved, stout, obconic pedicels, floral bract 1 per flower, at pedicel base 1.0–1.7 × 0.4–0.7 mm long, ovate to narrowly so, acuminate, concolorous with pedicel and flower when fresh, paler brown than flower when dry; bracteole 1 per flower, similar, usually narrower and slightly shorter; tepal whorls virtually undifferentiated, inner slightly broader, tepals free, outer whorl 2.0–2.8 × 0.6–1.3 mm, inner whorl 2.0–3.7 × 0.8–1.5 erect to ascending, lanceolate to deltoid-lanceolate, apex acute but cucullate and appearing blunt, tepals inserted on the margin of a 1.0–2.1 mm diam. fleshy torus, when fresh externally broadly convex, internally with 3 swollen lobes forming an annulus with a central depression in flower centre, shape lost in drying but darker than tepals; stamens 3; filaments 0.35–0.7 mm long, inserted at base of each torus lobe on outer edge adjacent to outer whorl tepals, erect, weakly incurved, pale green, anthers 0.25–0.35 × 0.25–0.35 mm, very broadly oblong-orbicular, introrse, basifixed, pale yellow; pistillode ca 0.1 mm long, conical; female flowers overall shape as male, sessile, floral bract 1.0–2.0 × 0.6–1.2 mm, ovate to broadly so, acuminate, concolorous with inflorescence axis, bracteole narrower and thinner, both erect and appressed to ovary base; ovary 3.8–9.1 mm long, 3-angled, lorate to very narrowly elliptic in outline, pale green, sometimes purple-hued, apex weakly constricted, tepals 2.3–3.1 × 0.7–1.7 mm, shape and habit as male, inserted on the margin of a 1.8–2.5 mm diam. fleshy torus, when fresh forming an annulus in centre of flower bearing 3 0.1–0.7 mm long staminodia opposite outer tepals; style inserted in central depression, 0.9–1.2 mm long, styles 3, spreading, bifid, gynoeceium concolorous with tepals. Capsule (18–)20–30 × 13–20 mm, pedicel reflexed and thus more or less erect at dehiscence, oblong-elliptic to obovate in outline, thick-chartaceous, base obtuse, apex rounded to truncate, dry and withered flowers persistent until relatively late in development (early April) on a

ca 1.5–2 mm long stipe, pale brown with darker coppery-brown speckling, dehiscing apically at least at first. Seed 4.6–6.5 × 5.0–6.5 mm excluding wing, irregularly lenticular, dark brown, wing 10.5–18.8 × 6.7–8.3 mm, oblong to oblong-elliptic, winged all round margin though with elongated towards rounded to obtuse base and apex, pale brown, translucent with fine paler speckling.

Distribution. South Africa, endemic to the Eastern Cape (as far west as the Winterberg) and KwaZulu Natal.

Vernacular name(s). *Cunningham* 2486, a sterile specimen grown from a root bought at Umlazi Muthi market appears to be *D. rupicola* and has the name iMpinyampinya. The name inKwa may also be associated with this species.

Ecology. *D. rupicola* grows in the margins of and clearings in forests and bush (including *Leucosidea sericea* woodland) and is often associated with watercourses and rocky kloofs. Archibald (1968) stated that it occurs on shady eastern and southern slopes on moist black doleritic soils in association with *Podocarpus falcatus* and *Olea capensis* in the Eastern Cape and that it is associated with and dolerite boulders. It is usually encountered from 1200 to 2100 m, but has been collected at lower altitudes in Alexandra District (*Rudatis* 1269, 600 m) and Umzinto District (*Strey* 7052, ca 580 m) in KwaZulu Natal.

Conservation. *D. rupicola* is found widely in higher elevation sites in the Eastern Cape and KwaZulu Natal. Its EOO and AOO will greatly exceed the threshold for threatened IUCN categories (20, 000 km²/2000 km²) (IUCN 2001) and its provisional status is LC.

Uses. None known. Like *D. multiloba*, data on the steroid content of this species is desirable.

Notes. The specimens bearing labels Dioscor. 3, *Ecklon & Zeyher* 21.12 at TCD (♂ fl.) and LE (seen by Prain in 1916 according to a note on the Kew isotype) appear likely to have made from the plant material that was taken to Berlin and cultivated to yield the type. Alternatively it is possible that they were collected from other plants with that seed or tuber in late 1831 or early 1832. The locality 21.12 suggests that the collection was made in the Winterberg mountains in the Eastern Cape (Glen and Germishuisen 2010). Thus these specimens are likely to represent clonotype or paratype material.

Unpublished sequence data shows that *D. rupicola* forms a clade with the other two species covered here. Thus the shift in androecium morphology is likely to be a recent, pollinator-driven event correlated with the erect inflorescences bearing recurved flowers with erect to ascending tepals (Fig. 3C, D).

Specimens examined. **SOUTH AFRICA. Eastern Cape:** Winterberg Mountains, ♂ fl. late 1831 or early 1832, *Ecklon & Zeyher* s.n. (TCD!, LE) (see Notes above); Collected at Mt. Kemp, Keiskamma Hoek and cultivated at Irene, ♀ fl. 20 Dec 1954, *Pole-Evans* 4847 (K!, PRE); Fort Beaufort District, Hogsback, big dolerite cliff near top of pass facing South, ♂ & ♀ fl. 10 Dec 1961, *Archibald* 7557 (K!); same locality, ♂ fl. (post anthesis) & ♀ fr. 27 Apr 1962, *Archibald* 7560 (K!); same locality, ♂ fl. 15 Nov 1961, *Archibald* 7537 (PRE!); Victoria East, on pass Port Elizabeth aspect, ♂ fl. 15 Nov 1961, *Archibald* 7551 (K!); Victoria East, about ¼ way up pass, sterile 15 Nov 1961, *Archibald*

7552 (K!); Victoria East, about ¼ way up pass, ♀ fl. 10 Dec 1961, *Archibald* 7558 (K!); Hogsback, ♂ fl. 27 Dec 1944, *Acocks* 11019 (K!); Victoria East, Hogsback Natural Forest Reserve, above Swallowtail Falls, sterile 17 Apr 1955, *Johnson* 1273 (K!, PRE); King William's Town District, no further data, ♂ fl. 26 Jan 1956, *Comins* 1425 (K!, PRE); Mountains near Ntsizwa (in umbros. Mont. Jnsiowa), ♂ fl. 28 Jan 1895, *Schlechter* 6443 (K!, PRE!, Z digital images!); Insizwa Forest Reserve, sterile 23 Feb 1958, *Wilson & Buchner* 163 (K!); Insizwa Forest Reserve, sterile seedling 23 Feb 1958, *Wilson & Buchner* 164 (K!); Insizwa Forest Reserve, sterile seedling 23 Feb 1958, *Wilson & Buchner* 165 (K!); Insizwa Forest Reserve, sterile seedling 23 Feb 1958, *Wilson & Buchner* 166 (K!); Insizwa Forest Reserve, sterile seedling 23 Feb 1958, *Wilson & Buchner* 167 (K!); Insizwa Forest Reserve, sterile 23 Feb 1958, *Wilson & Buchner* 16 (K!); Kokstad, Tabankulu Forest, ♂ fl. Jan 1925, *Dist. Forest Officer* 558 (PRE!); Prentjiesberg, Ugie "Forest Reserve", sterile 12 Nov 2000 *Potgieter* 392 (NU [NU0028393, 4]). (2 sterile sheets, possibly *D. rupicola* (28393) and *D. multiloba* (28394).) **KwaZulu Natal:** Alfred District, Weza, Ingeli (Ngeli) slopes, 1 Jan 1966, *Strey* 6284 (K! ♀ fl., (NU [NU0028252 digital image ♂ fl.]), PRE, UDW digital image ♂ fl. !); Alfred District, Ngeli Mountain, ♂ fl. & ♀ fl. 2 Jan 1969, *Hilliard & Burtt* 5758 (E, K!, NU [NU0028253 digital image!]); Weza State Forest, South boundary of Farm Diabolo, ♂ fl. 3 Dec 1989, *Abbott* 4583 (NH, PCE!, PRU); Griqualand East, Mount Currie, ♂ fl. Feb- Apr 1883, *Tyson* 468 (K!, Z digital image!); Griqualand East, Mount Currie, ♀ fr. Feb- Apr 1883, *Tyson* 1433 (K! Z digital image!); Kokstad, Mt. Currie slopes, ♂ fl. without date, *Dist. Forest Officer* 636/F.D. Herb 7215 (K!, PRE!); Polela District, Farm "Glengariff", ♂ fl. late Jan 1981, *Rennie* s.n. (NU [NU0028254 digital image!]); Polela District Ndunduina Bush, Glengariff, 5 Jan 1974, *Rennie* 510 (NU [NU0028391 digital image!]); Sunset Farm, 2929DC, ♂ fl. buds 17 Jan 2000, *Rennie* 2526 (NU [NU0028259 digital image!]); Umzinto District, Ellesmere, ♂ fl. 18 Dec 1966, *Strey* 7052 (K!, NU [NU0028356 digital image!], UDW, possibly also at PCE (Ellesmere, ? Dumisa, 19 Dec 1966)); Alexandra District, Ellesmere, ♂ fl. 20 Feb 1910, *Rudatis* 1269 (K!); Eastern Frontier C.B.S, Botha's Hill, ♀ fl. without date, *Macowan* 537 (TCD!) Weenen, old bush above 'Lulwers', ♂ fl. Dec 1923 *Rogers* 28163 (Z digital image!); York-Rietvlei road, ca 1 km South of Karkloof turnoff, ♂ fl. 17 Jan 1987, *Goldblatt & Manning* 8362 (MO, NU [NU0028236 digital image!], PRE!); On Road Bulwer to Underberg-SA Paper Pulp Forest, ♀ fl. & immature fr. 22 Feb 1958, *Wilson & Buchner* 156 (K!, 4 sheets); On Road Bulwer to Drakensberg Garden, ♂ fl. 22 Feb 1958, *Wilson & Buchner* 159 (K!, 3 sheets); Drakensberg, upper Umkomaas, ♂ fl. 15 Dec 1958, *Werdermann & Oberdieck* 1395 (B, K!); Underberg District, Cobham State Forest, Emerald Vale, ♀ fl. & immature fr. 4 Mar 1985, *Hilliard & Burtt* 18309 (E, NU [NU282256 digital image!]); Underberg District, Cobham State Forest, Emerald Vale, ♂ fl. 14 Jan 1985, *Hilliard & Burtt* 18061 (E, NU [NU282257 digital image!], PRE); Underberg District, Sunset, Upper Lurane, ♀ fl. & immature fr. 12 Jan 1980, *Rennie* 1095 (NU [NU0028389 digital image!]); Underberg District, Sunset, Upper Lurane Valley, ♂ fl. 12 Jan 1980, *Rennie* 1094 (NU [NU0028392 digital image!]); Mpendhle District, Loteni Nature Reserve, Ngondwini valley, ♂ fl. 25 Dec 1978, *Hilliard & Burtt* 11828 (K!, NU [NU0028386 digital image!]); Impendhle Dis-

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Acknowledgements

Thanks are due to Benny Bytebier, Snowy Baijnath and Ashley Nicholas, Martin Nickol, John Parnell, Yashica Singh, Terry Trinder-Smith, Braam van Wyk, John Wood and curators of other herbaria listed for help with access to specimens and images. Living plant images were obtained from Neil Crouch, Johan Hurter and the late Tony Abbott. Fieldwork help from John and Sandie Burrows, the late Tony Abbott and Graham Grieve was very important in facilitating this research. Particular thanks to Lucy Smith for the fantastic line drawings in Figs 1 and 2. Lauren Raz and Charlotte Sletten Bjora made significant improvements to this paper through their thoughtful reviews. Thanks to Sandy Knapp for her editorial work.

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Grassroots e-floras in the Poaceae: growing GrassBase and GrassWorld

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Academic editor: *S. Knapp* | Received 29 January 2014 | Accepted 6 March 2015 | Published 15 April 2015

Citation: Vorontsova MS, Clayton D, Simon BK (2015) Grassroots e-floras in the Poaceae: growing GrassBase and GrassWorld. *PhytoKeys* 48: 73–84. doi: 10.3897/phytokeys.48.7159

Abstract

GrassBase and GrassWorld are the largest structured descriptive datasets in plants, publishing descriptions of 11,290 species in the DELTA format. Twenty nine years of data compilation and maintenance have created a dataset which now underpins much of the Poaceae bioinformatics. GrassBase and GrassWorld can continue to grow productively if the proliferation of alternative classifications and datasets can be brought together into a consensus system. If the datasets are reconciled instead of diverging further apart a long term cumulative process can bring knowledge together for great future utility. This paper presents the Poaceae as the first and largest model system for e-taxonomy and the study of classification development in plants. The origin, development, and content of both datasets is described and key contributors are noted. The challenges of alternative classifications, data divergence, collaborative contribution mechanisms, and software are outlined.

Keywords

Classification, DELTA, grasses, e-taxonomy, Scratchpads

Dedication to Bryan Simon

The authors would like to dedicate this article to Bryan Simon who has passed away on 3 January 2015. Bryan has studied grasses for 46 years, in the National Herbarium of Rhodesia and then in the Queensland Herbarium as Principal Botanist. He was active in the international network of agrostologists, readily shared his knowledge and his data, and believed in the importance of taxonomic information delivery online. Many years of dedicated work have gone into the production of electronic resources AusGrass, AusGrass2, and GrassWorld, the biggest Scratchpad to date. We would like to say thank you for this contribution to global grass taxonomy and informatics.

Grasses as the first plant e-taxonomy model system

Grasses and floristic knowledge. Grasses (Poaceae) are undisputedly the most economically important family of flowering plants (www.fao.org), including wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), maize (*Zea mays* L.), sugar cane (*Saccharum officinarum* L.), bamboos, forage grasses, and lawn grasses. As a group so fundamental to the human civilisation the grasses have always been well studied and the cumulative body of knowledge on the circa 12,000 species (Clayton et al. 2014, Simon et al. 2014) is considerably greater than that available for any other group of plants. The global biodiversity inventory of the grasses at the species-level is advanced compared to other families and Flora treatments are available for Europe (Tutin et al. 1980), Central America (Davidse et al. 1994), North America (Barkworth et al. 2003, 2007), West Africa (Hutchinson and Dalziel 1972), East Africa (Clayton 1970, Clayton et al. 1974, Clayton and Renvoize 1982), and Zambia to Mozambique (Launert 1971, Clayton 1989, Cope 1999, 2002), with completed and ongoing Flora-writing projects in many other parts of the world (for a list see World Grass Floras in Simon et al. 2014). Plant morphology and spikelet structure are largely uniform across the family lending themselves well to structured descriptions. Grasses are a natural model system for the development of bioinformatics and e-taxonomy in plants because of the large body of data available, a real need for organised and accessible data, and a broad community of specialists across the world.

DELTA as a standardization tool for descriptions. The idea of storing standardised species descriptions as a database which could be automatically converted to text was first developed by Mike Dallwitz for insects (Dallwitz 1974) and was implemented using a set of standard data formats and programs called the DDescription Language for Taxonomy (DELTA, Dallwitz 1993 onwards). Grasses were chosen as the first model system in application of the new DELTA system to plants, in collaboration with Leslie Watson at the Australian National University (Watson and Dallwitz 1981). The DELTA Grass Genera of the World dataset (Watson and Dallwitz 1992, 1994) was developed concurrently with the DELTA software and with the implementation of DELTA in numerous plant and animal groups (for a list of references see Dallwitz 1993 onwards).

GrassBase: baseline data compilation

How GrassBase grew. Poaceae Flora treatments written at the Kew Herbarium provided the starting material for Derek Clayton to compile the family generic conspectus *Genera Graminum* (Clayton and Renvoize 1986), changing numerous generic and tribal concepts. The DELTA software platform was chosen to expand *Genera Graminum* to a species-level taxonomic treatment in a database format to create an infinitely updatable flora with a useful life span far beyond that of a static publication: GrassBase was born. A summary of the aims of GrassBase is presented in Appendix 1. A new DELTA character set independent from Watson and Dallwitz's work was developed with a particular emphasis on smooth natural language wording of the descriptions, working with Mike Lazarides at CSIRO Canberra supported by a CSIRO grant in 1985. Species descriptions from Floras, monographs, and taxonomic revisions were translated into the new DELTA character set and species names were arranged in line with the *Genera Graminum* classification. Nomenclature, synonymy, type, and species distribution data were managed in a separate SYNON Access database. It is estimated that between 1985 and 2014 Derek Clayton spent approximately fifteen hours a week on data entry and management. As GrassBase grew to become the largest DELTA dataset it became too cumbersome for manual editing and additional scripts were written to automate more of the data management tasks. A set of Visual Basic programs called GrassUtils were written by Derek to create automatic links between the DELTA dataset and the Access database; scripts were created by Kehan Harman to produce a single web page description for every species and every genus of the Poaceae (Harman 2007; Harman and Clayton 2007; Clayton et al. 2014). Custom scripts continue to be adjusted for the efficient production of web pages by Nick Black at RBG Kew.

GrassBase content. The March 2014 release of GrassBase includes 64,213 Poaceae names published at species rank or below, descriptions of 11,313 accepted species, and 713 genera (Clayton et al. 2014). Nomenclature, synonymy, type, and species distribution data are available for download as part of the SYNON Access database. The SYNON database includes a range of macros, queries and list making tools to aid floristic work, such as a query to generate a list of regional endemic species for any TDWG region. Error checking queries to ensure congruency between data tables are included. A description of every accepted species is available as text automatically translated from the DELTA code on a separate webpage with a stable URL (species descriptions vary in the level of detail depending on how much information was available in the source publication). Generic descriptions are obtained by combining the species descriptions using the DELTA 'gesumm' program and the description of every accepted genus is also available as text on a separate webpage. The species-level dataset is available in the format for the interactive key and data querying program INTKEY (Dallwitz 1993 onwards). The generic level dataset is not available in INTKEY format as this was not judged to be a reliable means of specimen identification to genus. The DELTA ITEMS dataset is available on request following acceptance of a data supply agreement.

GrassBase maintenance. New Poaceae names recorded by the International Plant Names Index (IPNI 2014) are downloaded every six months and added to the SYN-ON database. Descriptions of accepted species are translated into the DELTA format using the 1,090 character set. User-contributed amendments and additions are accumulated in the working copies of both name and description datasets, which may include changes to the character set. The two data sets are reconciled every six months using custom scripts, a new Access database is published, new INTKEY files are made, and a fresh set of web pages is generated, a process which takes circa two working days. More detail on the system specification is available in Harman (2007), Harman and Clayton (2007), and on the website.

Holes in GrassBase. The original compilation of GrassBase was an ambitious pioneering project aiming to demonstrate the feasibility and usefulness of an electronic flora in comparison to a printed book. Timely project completion was a priority and much was inevitably omitted from the database design. Descriptions lack source attributions and no references are provided for the synonymy. Hybrids are not included. The original set of names in GrassBase was taken from IPNI which did not list infraspecific taxa prior to 1970; the focus of GrassBase remains on the species-level so numerous subspecies and varieties are not included except as synonyms of their species. When a new species is published in a genus not accepted by GrassBase it is moved to the GrassBase genus under a provisional unpublished new combination to maintain the consistency of generic concepts across the database, a process which has created approximately 150 accepted species names which do not correspond to current usage and have not been validly published. There are no plans to publish these names and they have been omitted from all derivative data sets. Every new name recorded by IPNI is reviewed by Derek Clayton before incorporation into GrassBase, but publications with changes to synonymy which do not publish a nomenclatural novelty are unfortunately not always noted. The consistency of the dataset on the global scale reflects the available knowledge and literature which is far from uniform, both in terms of the information provided by individual descriptions and the coverage and age of treatments for different parts of the world.

GrassWorld: growing beyond the baseline

Grasses in many languages, reclassified, with pictures. The GrassWorld project was started by Bryan K. Simon in 2003 to build on GrassBase and gather together all information on the world's grasses within the DELTA system, to enable the user to query any data type via INTKEY (Simon 2007). The DELTA dataset was built by Bryan Simon with Daniel Healy and Yucely Alfonso, following on from their popular taxonomic resources for the grasses of Australia: AusGrass (Sharp and Simon 2002) and AusGrass2 (Simon and Alfonso 2014). An average of three days per week has been dedicated to the project by the three people since 2006. A decision was taken to follow phylogenetically circumscribed genera to link modern research data to historic literature. Some-

what narrower species concepts were also used, increasing the number of accepted species from 11,313 in GrassBase to 12,100 in GrassWorld. All basionyms and some recent synonyms were added to DELTA. The GrassWorld system now provides species distribution maps, phylogenetic trees, references to published illustrations, and images. The literature section presents an extensive ENDNOTE database. A section dedicated to agrostologists includes CVs, links, and copies of obituaries. The DELTA character set has been translated into three languages following similar work by Watson and Dallwitz: German (by Philip Sharpe, Queensland herbarium, and Hildemar Scholz, B), French (by Philippe Morat, P) and Spanish (by Gilberto Ocampo, CAS) with descriptions available for download in pdf format.

Grasses in a Scratchpad. The development of the collaborative platform Scratchpads (Smith et al. 2009) provided an opportunity to present GrassWorld data online (Simon et al. 2014). On 1 January 2014, the GrassWorld Scratchpad was ranked third among the Scratchpads viewed globally (925,608 views) and AusGrass2 was fourth (685,095 views); they were also the first and second most viewed plant Scratchpads. The transfer of GrassWorld data to the Scratchpad environment was carried out through the assistance of Kehan Harman and Irina Brake (Natural History Museum), with data work by Daniel Healy and Yucely Alfonso. Transfer of data to Scratchpads 2 is being carried with the assistance of Dimitris Koureas (Natural History Museum) and Isa Vandeveldel (Natural Sciences Museum, Belgium).

GrassWorld development. GrassWorld continues to grow as new data is imported from GrassBase and published literature and online resources are added. GrassWorld and part of AusGrass2 have been supported by Bryan Simon in the absence of project funding and unfortunately the development of GrassWorld in its present form will not continue beyond ca 2020. A future merger of the GrassBase and GrassWorld data may be the best option for preserving data.

Growing apart: the divergence of classifications and datasets

Divergence of grass classifications. The purpose of GrassBase was originally defined as a “practical catalogue of identifiable taxa, stable and conservative, a flora which the database seeks to emulate”, in contrast to “a phylogeny according to the latest theory; volatile and not always practical”. The GrassBase classification follows Genera Graminum (1986) with minor amendments and the Poaceae herbarium sequence at RBG Kew reflects GrassBase via a curation policy known as “curation based taxonomy”. GrassBase is the only currently used Poaceae classification which does not follow the now well established sequence of subfamilies and tribes published by the Grass Phylogeny Working Group system (Grass Phylogeny Working Group 2001, Grass Phylogeny Working Group II 2012). In contrast GrassWorld reflects research data broadly in agreement with the two modern generic level reference treatments: the Catalogue of New World Grasses (Soreng et al. 2014) and Kellogg (in press). The generic level reference treatment published by the Catalogue of New World Grasses presents a phy-

logenetetic classification independently compiled from literature and research data by Robert Soreng at the Smithsonian Institution. The first phylogenetic monograph of the family is currently in press; it documents a sequence of all known clades and their synapomorphies, descriptions of genera and clades of generic rank with an emphasis on synapomorphies, keys to all genera, and a synthesis of multidisciplinary research results relevant to the Poaceae evolution (Kellogg in press).

How far have GrassBase and GrassWorld diverged? An estimated 10% of species in GrassBase have generic placements different from those in GrassWorld, Catalogue of New World Grasses and the forthcoming Kellogg (in press) treatment. The rearrangement of the classification system according to phylogenetic research results has led to 10% of the species names being reassigned to a different genus, a figure which could rise to 20% when species sampling for molecular studies approaches completeness (Vorontsova and Simon 2012).

Divergence of other name databases. Edited versions of GrassBase data contribute to the complexity of taxonomic datasets in the grasses. A copy of the GrassBase SYNON Access database name data made in 2006 has provided the Poaceae data for the World Checklist of Selected Plant Families (WCSP 2014). The edited WCSP Poaceae dataset is now used by The Plant List (2013) and by eMonocot (2014); these are broadly congruent with GrassBase although not identical. It should be noted that the overall global online dataset divergence is considerably more complex than described here when a plethora of other datasets are taken into consideration, e.g. Euro+Med (2006-) which uses more narrow species concepts for European Poaceae.

Challenges and opportunities

Can divergent datasets become a consensus classification? The curator of each database decides which names are accepted. With some 12,000 species the Poaceae are too large for one person to hold in-depth knowledge across the family: in GrassBase a considerable part of the decision making is carried out by data curators who are not taxonomic group specialists. The work of scanning new publications and making decisions on the accepted names is carried out by a different person for each database, sometimes producing a confusing diversity of taxonomic opinions. Considerable resources are spent by users trying to decide which classification to adopt and which names are correct. Developing a process of working towards a single consensus opinion could bring benefits: direct changes to the classification by taxon specialists, as well as time saving for data curators and for users. Database maintenance and the translation of new species descriptions into DELTA format are time consuming tasks which could be distributed between different people.

How do we collaborate towards a consensus? Compilers of any dataset cannot fail to introduce unintentional biases reflecting their areas of expertise. Regional floristic specialists are commonly in disagreement with taxonomic group specialists regarding species delimitation. Taxonomists in biodiversity-rich countries can lack adequate in-

ternet connections to view the outputs of e-taxonomy, let alone participate. Engaging the full range of people who can provide useful information for species-level descriptions is challenging. Considerable resources are needed to incorporate published information into an electronic dataset. Data contributors should be fully acknowledged and have ownership of their contributions, while data quality and consistency still needs to be maintained across the dataset. The area of collaborative e-taxonomy is still in development.

Lack of consensus at species-level? The global community is now broadly in agreement regarding subfamilies and tribes of the Poaceae (Grass Phylogeny Working Group II 2012, Soreng et al. 2014, Kellogg in press). It is possible that a consensus generic classification will emerge once the species-level sampling in phylogenetic studies is more complete. The variation in species concepts is such, however, that a species-level consensus may never be reached. Simultaneous alternative interpretations and concepts are currently not accommodated by any existing taxonomic data system although it is possible that this could be developed.

Grass Genera of the World: data incompatibility challenge. While alternative classifications are a frequent focus of debate, divergent and incompatible datasets are arguably a greater concern when viewed in the context of long term information accrual. The Grass Genera of the World DELTA dataset (Watson and Dallwitz 1992, 1994) was designed as a compendium of information on grasses to aid and inspire research and includes a broad range of information not addressed by GrassBase or GrassWorld: anatomical characters, photosynthetic pathways, pathogen specificity, and economic uses. The dataset was compiled from literature as well as derived from original specimen observations and associated research projects (e.g. Macfarlane 1979, Webster 1987, van den Borre and Watson 1997) and grew to be an influential body of reference material on the grasses. Grass Genera of the World data is recorded for every genus while many of the generic concepts have changed: integrating this information with species-level flora descriptions collected by GrassBase would be challenging. A range of other DELTA datasets in the grasses (listed by Dallwitz 1993 onwards) hold valuable information that could be integrated: species-level data developed by Les Watson in Australia in collaboration with taxonomic specialists, including the Paniceae, Chloridoideae, Pooideae, *Enneapogon*, *Digitaria*, *Sporobolus*, and *Aristida*; grasses of southern Africa (Gibbs Russell et al. 1990); New World Paniceae datasets developed by Webster (e.g. Webster and Valdés Reyna 1988; Webster et al. 1989).

Bamboos in GrassBase. The GrassBase character set was designed with specimen identification as a primary consideration, and some morphological terminology specific to the bamboos was altered for compatibility with non-bamboo grasses, with advice from Christopher M. A. Stapleton. This has enabled the use of INTKEY to distinguish between bamboos and other grasses, but has created discrepancies between terminology in GrassBase and that used in bamboo specialist literature (e.g. Clark 2014). The implementation of technically correct terminology would improve the usefulness of GrassBase to bamboo specialists but would also create an incompatible subset of bamboo descriptions within the dataset.

e-Infrastructure for grasses

The software challenge. The DELTA software suite has been in development for over 30 years and lacks full functionality under 64-bit Windows (Baird 2010). Alternatives to the original software are now becoming available from the Atlas of Living Australia DELTA written in Java (Open Delta 2014) and Free DELTA (2014) although neither of these have been able to fully replace DELTA to date. Open Delta software accommodates most data entry tasks and manipulation of ITEMS files; Open Delta CHECK successfully identifies erroneous character states but fails to identify errors in character dependency. A full update to GrassBase using Open Delta may be possible following further development although testing in early 2014 has demonstrated this is not possible at the time of writing. GrassUtils and other custom scripts will need considerable redevelopment. An alternative strategy could look at novel descriptive data formats outside the DELTA system.

The web integration challenge. Multiple contributor e-taxonomy websites, where multiple users in different countries are able to edit the same website simultaneously, publish descriptions as plain text. DELTA datasets are translated into text prior to web publication and the reverse process of obtaining DELTA code from text descriptions is currently not possible. The DELTA system lacks multiplatform interoperability while LUCID (2014) lacks the full functionality of the DELTA software suite. A future multi-contributor web based data system could not integrate with DELTA datasets online without further software development.

Growing an e-flora into a multipurpose e-infrastructure platform. The original name for GrassBase was “World Grass Flora” to reflect its design as a database equivalent of a traditional flora: a species inventory and an identification guide. GrassWorld has started to expand the range of information available. If these resources are to integrate with the modern eBiosphere online and contribute effectively to the World Flora Online (Global Strategy for Plant Conservation, <http://www.plants2020.net>) a radical modernisation of web presentation will be necessary, including links to observation data, plant ontogenies, and provision of machine readable data output.

Conclusions

This paper argues that a collaborative approach and careful thought across the Poaceae taxonomic community are needed to take grass e-taxonomy forwards. Failure to plan and collaborate could lead to an increasing proliferation of contradictory classifications. Unique datasets of great value could be rendered obsolete if software development and database maintenance does not keep pace with technology platforms. Investment in community database integration and infrastructure could unlock untapped research and data mining potential of many historic datasets. The rich data and the long history of database compilation in the grasses present an unprecedented opportunity to study the development of classifications and to develop e-taxonomic models. The authors would like to invite potential collaborators to discuss dataset improvements and future plans.

Acknowledgements

Mike Lazarides (CSIRO) initiated and supported the start of GrassBase. We would like to thank Dave Simpson (Kew) for project steering, Helen Williamson for early work on GrassBase, Kehan Harman for software development on both GrassBase and GrassWorld, and Nick Black and Michael Bradford (Kew) for software support. Many thanks to Daniel Healy and Yucely Alfonso for the data work on GrassWorld, Irina Brake for Scratchpad work, Dimitris Koureas and Isa Vandevelde for work with Scratchpads 2, and Philip Sharpe, Hildemar Scholz, Philippe Morat, and Gilberto Ocampo for translations. Also many thanks to Mary Barkworth (Intermountain Herbarium), Terry MacFarlane (Western Australian Herbarium), Rob Soreng (Smithsonian Institution), Lynn Clark (Iowa State), and Elizabeth Kellogg (Donald Danforth Plant Science Center) for discussion and support, and to Fernando Zuloaga and Donat Agosti for reviewing the manuscript. Many thanks also to everyone who has contributed corrections to GrassBase: please continue sending them in.

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Appendix I

Aims of GrassBase as summarised by Derek Clayton in 2012.

Grassbase is a natural extension of Genera Graminum and the big Regional Floras produced at Kew, expanding them to a global treatment at species-level, and exploring the concept of a continuously updated e-Flora for a family of some 11000 species. Its design is based, firstly, on defining its intended applications; secondly on identifying all the retrieval and exploratory tasks commonly undertaken in the course of these applications, then building the database to service these tasks. Applications and tasks are outlined below:

- 1 As a public Flora. Floras are the essential reference manuals underpinning all plant science. Grassbase emulates their traditional content, embracing nomenclature, description, identification and distribution.
Tasks. Display the classification currently adopted at Kew. Identify specimens. Clarify nomenclature. Investigate plant geography.
- 2 As a source for expediting the production of local Floras or Field Keys for public use.
Tasks. List the local flora. Deliver chunks of text for pasting and editing on an external file. Write keys.
- 3 As a workspace and toolkit for research on the family's morphological classification from species to tribal level. It involves detection and resolution of inconsistencies in nomenclature, identity or relationships, and reconciliation with external datasets such as DNA.
Tasks. Enable the user to rummage for relevant information throughout the system seeking solutions to problems. Assist comprehension of the overall classification. Support the hatching and testing of innovative ideas.

A refined concept of the *Critoniopsis bogotana* species group in Colombia with two new species (Vernonieae, Asteraceae)

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Academic editor: P. de Lange | Received 23 October 2014 | Accepted 10 March 2015 | Published 15 April 2015

Citation: Robinson H, Keeley SC (2015) A refined concept of the *Critoniopsis bogotana* species group in Colombia with two new species (Vernonieae, Asteraceae). PhytoKeys 48: 85–95. doi: 10.3897/phytokeys.48.8810

Abstract

Critoniopsis bogotana is more precisely delimited, and two related Colombian species are described as new. The form of trichomes on the abaxial surfaces of the leaves is found to be of major importance. A short key to the *C. bogotana* group is provided.

Keywords

Critoniopsis, Colombia, new species, trichomes

Introduction

Collections of *Critoniopsis* Sch.-Bip. (1863) made during field work by the second author in 1984 have proven that the group of mostly 5-flowered species including *Vernonia bogotana* Cuatrec. (1956) is more complex than previously believed. The two new species described here are based on the collections of the second author in 1984 and material collected by Ramirez and Cuayal in 1991. Both the collections of Keeley, and Ramirez and Cuayal had presented some problems when first studied, mostly because features of leaf shape, seemed unreliable, the prominence of the veins on abaxial surface of the leaves differed but was rather subtle, and geography alone showed a near continuum. In at least one Ecuadorian species, *Critoniopsis floribunda*

(Kunth in HBK) H. Rob., even the number of florets in the heads had proved unreliable (Haro-Carrión and Robinson 2008). The question arose as to what characteristics could be trusted, or whether there was only one highly variable species.

The most important treatment of *Critoniopsis* in the northern Andes was by Cuatrecasas (1956) at which time the group was treated as a Section of *Vernonia* Schreb. It was in the Cuatrecasas treatment that many of the Colombian species were described as new, including *V. bogotana* and *V. killippii* Cuatrec. Since then, *Critoniopsis* has been restored to separate generic status (Robinson 1980) and has been recognized as a closer relative of the genus *Piptocarpha* R. Br. (Robinson, Bohlmann and King 1980, Keeley et al. 2007; Robinson 2007; Keeley and Robinson 2009). The most recent treatment of species of *Critoniopsis* with a key was that of Haro-Carrión and Robinson (2008) dealing with genus in Ecuador.

The present study arose from an attempt to finally resolve the identity of the series of collections made by the second author which had been put aside because they seemed closely related to *Critoniopsis bogotana* but did not exactly fit that concept in the appearance of the leaf undersurfaces. This extensive set of Keeley collections from Cundinamarca in Colombia seemed to lack the prominent abaxial tertiary and quaternary leaf venation that is characteristic of *C. bogotana*. More careful study of the group has shown some major variation in leaf shape within the group as well as some close approximations of venation patterns in a few of the specimens in both typical *C. bogotana* and the Keeley collections. In the process, additional Keeley collections initially determined as *C. bogotana* from Cauca and Caldas were studied along with a few puzzling collections by Rameriz and Cuayal from Nariño that had been previously left unidentified. At the same time, it has seemed appropriate to restate the differences between *C. bogotana* and *C. killippii*, the latter often incorrectly distinguished from *C. bogotana*.

Methods

Materials studied were all deposited in the U.S. National Herbarium, Department of Botany, National Museum of Natural History or in Bogota (COL) or Pasto (PSO). Examination included study with a light microscope and the USNM Leica 440, Scanning Electron Microscope (SEM), equipped with a lanthanum hexaboride (LaB) electron source.

Conclusions

Two species are recognized that have some differences in appearance of the abaxial leaf surfaces, but which are most reliably distinguished by the form of the trichomes on those leaf surfaces. Other features such as length of the outer pappus series, shape of the involucre bracts, broadenings of the tips of the inner segments of the pappus, and leaf shape are found unreliable.

In contrast to the confusion derived from other characteristics, the differences in the trichomes are striking. The trichomes in *C. bogotana* are elongate and sparsely irregularly branched, the trichomes of the new Cundinamarca species are strictly stellate with stiffly spreading arms, and the trichomes of the Nariño species are flattened and thin-walled. The species of the *C. bogotana* group can be distinguished by the following key based on features of the leaf bases and abaxial surfaces.

Key to the species of the *Critoniopsis bogotana* Group

- 1a Base of leaf blade narrowly decurrent on petiole *Critoniopsis killipii*
 1b Base of leaf blade not decurrent on petiole, abruptly acute or obtuse 2
 2a Abaxial surface of leaf mostly with prominulous tertiary veins and obscure quaternary veins; trichomes stellate with stiffly spreading arms (Fig. 3C, D).
 *Critoniopsis tausae*
 2b Abaxial surface of leaf with distinct network of tertiary and quaternary veins; trichomes not stellate with stiffly spreading arms 3
 3a Abaxial surface of leaf with mealy appearance; trichomes elongate, sparsely branched, thick-walled, not flattened (Fig. 3A, B)..... *Critoniopsis bogotana*
 3b Abaxial surface of leaf with veinlets dark and areoles filled with pale pubescence; the pale trichomes spreading, densely branched, thin-walled and flattened (Fig. 3E)..... *Critoniopsis narinoensis*

Species treatments

Critoniopsis bogotana (Cuatrec.) H. Rob., *Phytologia* 46: 439. 1980.

Vernonia bogotana Cuatrec., *Bot. Jahrb. Syst.* 77: 65. 1956.

Specimens examined. COLOMBIA: Cundinamarca: Nacizo de Bogotá, Quebrada del Rozal, Arbol 7 metros; corolla blanca o ligeramento violácea; alt. 3000 m, 29 VI 1939, *Cuatrecasas* 5696 (holotype US); 11 km from La Calera on road to Chiaci, just before desvío to La Esperanza, along edges of pastures, tree 6-8 m tall; stout. Most in bud, 1 in flower; 3000 m, 29 Dec. 1984, *S.C. Keeley with J.E. Keeley & S Diaz* P 4538. 4540 (US). **Caldas:** road from Bogotá to Manizales, 4.4 km W of turnoff to Los Neva dos N.P. Roadside quebradas, at edge of steep embankment previously cut back, large tree, 5–6 m tall, 19 July 1983, *S.C. Keeley with J.E. Keeley* 4228 (US). Cauca: Coconuco to Paletara, near Parque Paracé, in cut over *Chusquea* dominated remnant cleared forest; Small tree, 3 m tall, in bud; elev. 3045 m. 17 July 1983, *S.C. Keeley with J.E. Keeley* 4220, 4221 (US). **Nariño:** Pasto; a 3 km E de la población de Dolores, alt. 3000 m, 3 Aug 1991, *B. Ramirez & J. Cuayal* 3964 (COL). **COLOMBIA:** s. loc.. s. d., *Triana* 1122 (US).

The species ranges from near Bogotá southwestward to Nariño near the border of Ecuador.

At one time *Vernonia calerana* Cuatrec. was treated as a synonym of this species, (Robinson 1993) but differs by the much more numerous florets in the heads.

The much overused name *V. pycnantha* Benth [*C. pycnantha* (Benth.) H. Rob.] has been applied to this species in the past, but the Bentham species is restricted to southern Ecuador and northern Peru (Haro Carrión & Robinson 2008). Careful examination of a photograph of the type of *C. pycnantha* at Kew shows a tendency for ultimate branches of the inflorescence to be scorpioid- or seriate-cymose, a trait seen only in members of the genus *Critoniopsis* from southern Ecuador and southward.

***Critoniopsis killipii* (Cuatrec.) H. Rob., *Phytologia* 46: 440. 1980.**

Vernonia killipii Cuatrec., Bot. Jahrb. Syst. 77: 71. 1956.

Vernonia bogotana var. *santandarensis* Cuatrec., Bot. Jahrb. Syst. 77: 66. 1956.

Specimens examined. COLOMBIA: Norte de Santander: Road from Pamplona to Toledo, crossing the divide between Río La Teja (Maracaibo drainage) and Río Mesme (Orinoco drainage), thickets along stream, alt. 2500–2800 m, 28 Feb 1927, *E.P. Killip & A.C. Smith* 19886 (holotype US). **Santander:** vicinity of California, shrub 10–12 ft., pappus greenish-white, open hillside, alt. 3000 m, 11–27 Jan 1927, *E.P. Killip & A.C. Smith* 16941 (holotype of *V. bogotana* var. *santandarensis*, US); vicinity of La Baja, shrub 10–12 ft, pappus yellowish-white, dense forest, alt. 3000 m, 14–31 Jan 1927, *E.P. Killip & A.C. Smith* 18332 (US); 65 km NNW of Duitama on road to Charaló, about 1 km below La Palmera, growing in *sphagnum*-covered bog, saturated, over limestone rock. Trees 3.5–4 m tall (others 8–10 m tall), with slender trunk and spreading crown to 5 m across, with clusters of light lavender-white flowers; style long exerted, anthers inside corolla, short, pappus pale white, apparently deciduous, locally common, elev. 1900 m, 23 July 1983, *S.C. Keeley with J.E. Keeley* 4290–4 (US). **Venezuela: Tachira:** selva .nublada húmeda, faldas del Páramo de Tamá, cerca de la frontera Colombo-Venezolana, arriba de Betania y Tamá, cerca de la Quebrada Buena Vista, tree 10 m, leaves subcoriaceous, deep green above, white below, alt. 2300–2450 m, 22–24 May 1967, *J.A. Steyermark & G.C.K & E. Dunsterville* 98656 (US).

The placement of the variety *santandarensis* in the species *bogotana* indicates the confusion that has existed between *C. bogotana* and *C. killipii* from the time of their description. This is surprising since *C. killipii* is distinct in both its leaf base and its geography. The base of the leaf blade has a strongly recurved margin and an abrupt decurrence ca. 1 cm long on the petiole. The specimens seen are from Depto Santander and Norte de Santander in Colombia and adjacent Tachira in Venezuela, both areas distinctly to the northeast of any known collections of *C. bogotana*.

Leaf bases similar to those of *C. killipii*, led to the misidentification of a series of Keeley collections of *C. glandulata* (Cuatrec) H. Rob. as *C. killipii*. On closer

examination, *Critoniopsis glandulata* is strikingly distinct in its more thyriform inflorescence branches, apiculate involucre bracts, and stalked T-shaped trichomes. *Critoniopsis glandulata* was originally described from Norte de Santander in Colombia. The 1983 Keeley collections, 4464, 4465, 4466, 4467, 4468 extend the range into Tachira in Venezuela.

***Critoniopsis tausae* H. Rob. & S.C. Keeley, sp. nov.**

urn:lsid:ipni.org:names:77146548-1

Type. COLOMBIA: Cundinamarca: Mun. de Tausa, 8.4 km from fork in road to San Cayetano and Los Pached. On road to San Cayetano, about 2 km above Boca de Monte, 12 km below summit of Paramo Leguma Sec. Elev. 3150 m, 30 Dec, 1984, S.C. Keeley with J.E. Keeley 4543 (holotype US, isotypes COL, K).

Description. Shrubs or small trees up to 6 meters tall. Stems terete, dark brown, covered with grayish indument of short irregularly-shaped trichomes; internodes 0.5–1.0 cm long. Leaves alternate; petioles mostly 1.0–1.5 cm long; blades subcoriaceous, elliptical to broadly ovate-elliptical, 7–11 cm long, 2.7–4.3(–6.5) cm broad, base usually acute, without decurrence onto petiole, broad-leaved specimen (*Keeley 4544*) with obtuse to rounded base, margins mostly entire or with few teeth distally, broad-leaved specimen with margins distinctly serrate distally, apex acute, with little or no acumination, adaxial surface essentially glabrous, veinlets variously slightly incised to slightly prominulous, abaxial surface with prominent primary and secondary veins, tertiary veins prominulous and quaternary veinlets obscure to slightly prominulous, secondary veins ca. 8 on each half, mostly spreading at ca. 45°, arching, lower secondary veins more widely spreading in broad-leaved specimen (*Keeley 4544*), surface covered with dense appressed grayish pubescence, individual trichomes with short stem and stiff spreading stellate arms. Inflorescence terminal on leafy branches, densely pyramidally paniculate with corymbiform branches, mostly 9–12 cm high and wide. Branches grooved, covered with dense whitish tomentum, heads sessile or on short peduncles 1–3 mm long. Heads cylindrical, at anthesis ca. 12 mm long and 4 mm wide, with ca. 35 involucre bracts in ca. 7 series, ca. 4 rows of basal bracts densely imbricated, broadly ovate, ca. 0.5–3.5 mm long, 1.5–2.5 mm wide, with scarious lateral margins, persistent and widely spreading with age; inner bracts in ca. 3 series, oblong, 5–7 mm long, 1.5–2.2 mm wide, with narrowly recurved lower margins, with flattened rounded, dark and membranous tips, highly deciduous with age, all but basalmost bracts glabrous on outer surface; receptacle glabrous, flat. Florets 5 in a head; corollas white, funnellform, ca. 8 mm long, basal tube ca. 4 mm long, throat ca. 1.5 mm long, lobes ca. 2.6 mm long, linear-lanceolate; outer surface of upper tube, lower throat and lobes with minute monoseriate trichomes, a few glandular dots at tips of lobes; anther thecae purple, ca. 2.5 mm long, bases with short obtuse sterile margin, apical appendages ca. 0.5 mm long, oblong-ovate; style base broadened, shortly conical. Achenes light brown, ca. 4 mm long, without evident glands or setulae on surface, with longitudinal



Figure 1. Holotype of *Critoniopsis tausae* H. Rob. & S.C. Keeley (US).

striae; Pappus white, ca. 5 mm long, inner pappus of ca. 40 capillary bristles, flattened beyond middle and slightly broadened at tips, outer pappus a series of lanceolate squamae 0.5–1.7 mm long.

Additional specimens examined. COLOMBIA: Cundimamarca: Prov. Ubaté; Mun. Tausa, 8.4 km from fork in road to San Cayetano and Los Pachos, on road to San Cayetano, about 2 km above Boca de Monte, 12 km below summit of Paramo Legune Sec. Elev. 3150 m. Plants 6 m tall, 7–10 flower heads, revolute corolla lobes white with purple anthers; 30 Dec. 1984; *S.C. Keeley with J.E. Keeley 4544* (US); Mun. de Tausa, 10.9 km from fork in road to San Cayetano; Elev. 3000 m, 20 Dec. 1984; *S.C. Keeley with J.E. Keeley 4545, 4546, 4547, 4548, 4549* (US); individuals about 6 m tall' population seen about 10–12 individuals. Tausa is at 5°11'47"N; 73°53'15"W.

The specimens of the species were initially left unidentified because of the comparative lack of prominence of the tertiary and quaternary veins and the comparatively even surface of the pubescence on the abaxial surfaces of the leaves. In *C. bogotana*, the venation of the abaxial leaf surfaces is distinctly reticulated, and the tomentum is mealy in appearance. Examination of the trichomes under the light microscope is sufficient to show the profound difference in the trichome shape, shown here in SEM photos. The stellate form is consistent in every specimen sampled from what are evidently members of at least two separate populations.

A problem that seemed of importance when the specimens were first studied, was the striking difference in the leaf shape of one of the collections (*Keeley 4544*). This broad-leaved form had more obtuse to rounded bases of the leaf blades, more broadly ovate blades, and distinctly multiple serrate distal margins on the leaves. This is seen here as a difference within the species. It is reminiscent of the leaves that often arise on sprouts or sucker shoots from stumps of felled trees, and is not regarded here as worthy of any taxonomic distinction.

***Critoniopsis narinoensis* H. Rob. & S.C. Keeley, sp. nov.**

urn:lsid:ipni.org:names:77146549-1

Type. COLOMBIA: Nariño: Mun. Pasto, parte alta del bosque de Daza, kilómetro 12 via Pasto-Buesaco, 3000 m, 8 Aug 1991, *B.R. Ramírez & Cuayal 4033* (holotype PSO; isotype frag. US).

Description. Large shrub or small tree. Stem terete, brownish, with appressed pubescence; internodes scarcely deflected, ca. 0.7 cm long. Leaves alternate; petioles 2.0–2.5 cm long; blades narrowly ovate-elliptic, 10–14.5 cm long, 3.5–6.3 cm wide, base obtuse to rounded, ending abruptly at petiole, margins entire, apex scarcely acuminate, with 9 or 10 secondary veins on each half, spreading at ca. 60° at base, somewhat arching, upper surface glabrous, slightly roughened with scarcely prominulous veinlets, abaxial surface with prominent primary and secondary veins, with obvious reticulum of prominulous brownish pubescent tertiary and quaternary veins, areoles filled with minute, pale, thin-walled, flattened trichomes (Fig. 3E). Inflorescence terminal on



Figure 2. Isotype fragments and photocopy of part of holotype of *Critoniopsis narinoensis* H. Rob. & S.C. Keeley (US).

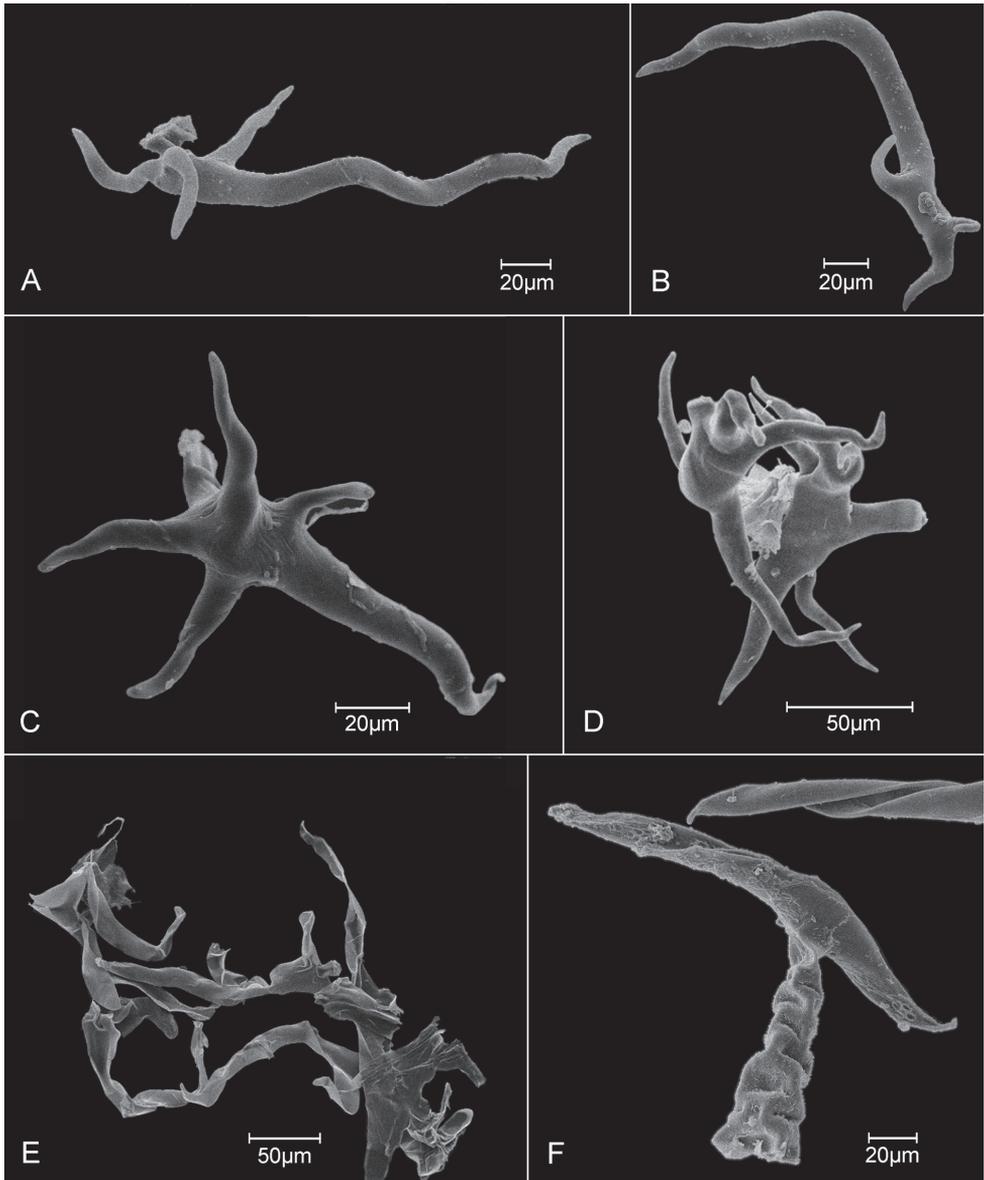


Figure 3. SEM images of trichomes of *Critoniopsis*. **A, B** *C. bogotana* (Cuatrec.) H. Rob., unicellular trichomes showing elongate branch and short spur-like branches near base **C, D** *C. tausae* H. Rob. & S.C. Keeley, showing unicellular stellate form with short arms, one arm slightly longer than the other four **D** Two trichomes entangled with each other showing lack of elongate arms **E** *C. narinoensis* H. Rob. & S.C. Keeley, showing highly ramified and flattened form **F** *C. glandulata* (Cuatrec.) H. Rob., showing T-shaped trichome with multicellular stalk and transversely mounted cap-cell, also showing part of cap-cell of second trichome, cap-cells with thinner-walled distal surface caved-in as result of drying.

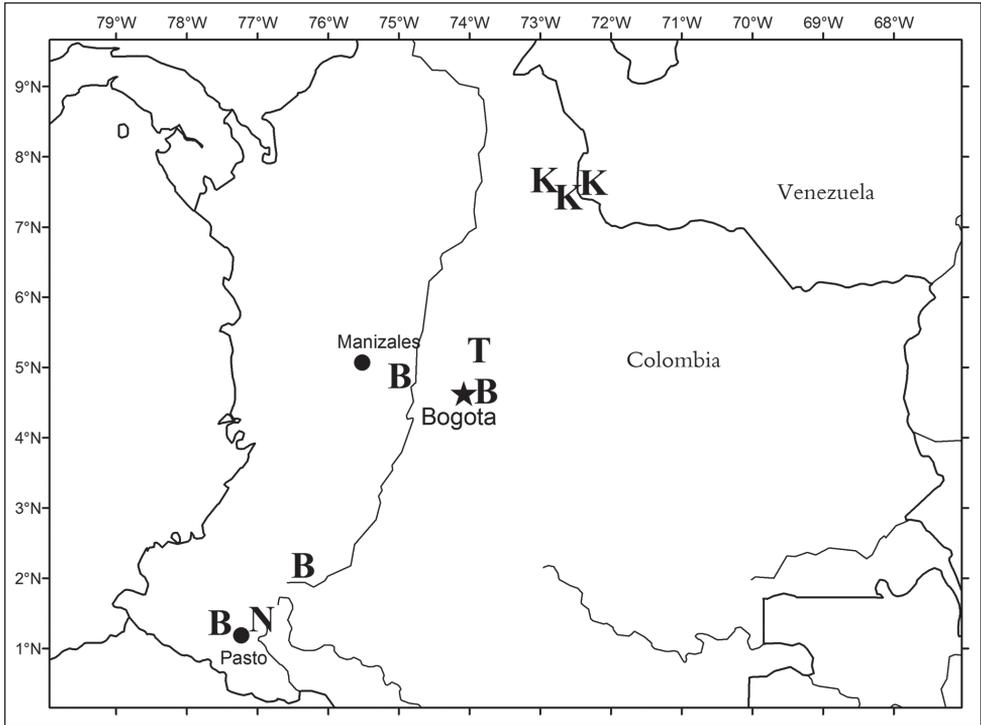


Figure 4. Map of Colombia and adjacent Venezuela showing distributions of *Critoniopsis bogotana* (**B**) *C. killipii* (**K**) *C. narinoensis* (**N**) and *C. tausae* (**T**).

leafy branches, rounded to somewhat pyramidal, with loosely corymbiform branches; heads clustered on short branchlets and ultimately sessile in clusters of 3 or 4. Heads short-cylindrical, ca. 9 mm long, 3–4 mm wide; involucre bracts ca. 35 in ca. 7 series, basal bracts ca. 16, in 3–4 rows, persistent, weakly spreading in fruit, broadly ovate to ovate-oblong, 1.5–3.9 mm long, 1.0–1.7 mm wide, with scarious lateral margins, inner bracts mostly fallen in specimen, estimated in 3 series, 4–8 mm long, ca. 1.2 mm wide, oblong to oblanceolate, narrowed to base, with narrowly recurved basal margins, apices darkened, rounded, outer surfaces mostly glabrous; receptacle slightly convex, glabrous. Florets ca. 5 in a head; corolla color not stated, probably white, funnelform, 6.5 mm long basal tube ca. 3.5 mm long, throat ca. 0.7 mm long, lobes ca. 1.8 mm long, lanceolate, traces of few minute monoseriate hairs seen on outer surfaces of upper tube, throat and lobes; anther thecae ca. 1.3 mm long, bases with acute hyaline edge; apical appendages ca. 0.3 mm long; style not observed. Achene body brownish, 3.5–4.0 mm long, with 3 or 4 angles, mostly glabrous with some small glandular dots near base; pappus white, ca. 5 mm long, with ca. 40 inner capillary bristles not or scarcely broadened at tips, outer series of short narrow squamae ca. 0.5 mm long.

The species is known only from the type collection.

Vegetatively the specimen is in excellent condition, and fortunately species of the genus *Critoniopsis* can usually be distinguished by leaves and number of florets in the

head. The present new species might have been placed in either *C. lindenii* Sch.Bip. or *C. popayanensis* (Cuatrec.) H. Rob. on superficial examination, but the former differs obviously by the smoother abaxial surface of the leaves covered with goblet-shaped trichomes. The latter differs by the decurrence of the leaf blade onto the upper petiole.

Acknowledgements

We wish to thank Carol Kelloff who operated the USNM SEM, and Scott Whittaker, supervisor of the USNM SEM laboratory. Dr. Mauricio Diazgranados, now Director of Science at Bogota Botanical Garden, Bogota Colombia, is to be thanked for tracking down the complete collection data and place of deposit of the specimen that is here made the holotype of *Critoniopsis narinoensis*. Ingrid Lin is thanked for scans of the types, Alice Tangerini, staff illustrator, assembled the plate of Scanning Electron micrographs of trichomes. Sara Alexander is thanked for preparing the map.

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