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- 8: Ceratophyllaceae. C.M. Wilmot-Dear. 1997. *Bothalia* 27: 125–128.
- 9: Onagraceae. P. Goldblatt & P.H. Raven. 1997. *Bothalia* 27: 149–165.
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- 15: Piperaceae. K.L. Immelman. 2000. *Bothalia* 30: 25–30.
- 16: Sphenocleaceae. W.G. Welman. 2000. *Bothalia* 30: 31–33.
- 17: Casuarinaceae. C.M. Wilmot-Dear. 2000. *Bothalia* 30: 143–146.
- 18: Salicaceae s. str. M. Jordaan. 2005. *Bothalia* 35: 7–20.
- 19: Asteraceae: Anthemideae: *Eumorphia*. N. Swelankomo. 2011. *Bothalia* 41: 277–282.

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Revision of the genus *Sphenostylis* (Fabaceae: Phaseoleae) in South Africa and Swaziland

A.N. MOTEETEE*† and B.-E. VAN WYK*

Keywords: Fabaceae, Leguminosae, *Nesphostylis* Verdc., Phaseoleae, Phaseolinae, southern Africa, *Sphenostylis* E.Mey., *Vigna* Savi

ABSTRACT

A taxonomic revision of the genus *Sphenostylis* E.Mey. (tribe Phaseoleae) in southern Africa is presented. The genus is distinguishable by its characteristic wedge-shaped, dorsiventrally flattened style tip. Of the seven known species in the genus, only two, *S. angustifolia* and *S. marginata*, occur in South Africa and Swaziland; and the former is endemic to these countries. The two species differ in the size, shape, and venation of the leaflets; as well as the length of the petiole, peduncle, and pod. A key to the two species is provided and the correct nomenclature, typification, and known geographical distributions are given.

INTRODUCTION

Sphenostylis E.Mey. belongs to the subtribe Phaseolinae of tribe Phaseoleae (Fabaceae). It is named for the wedge-shaped, dorsiventrally flattened style (from the Greek word *spheno* = wedge). It is a small genus comprising seven species, all occurring in the tropics and southern parts of the African continent (Gillett *et al.* 1971; Potter 1992; Potter & Doyle 1994; Schrire 2005). The Indian species *S. bracteata* (Baker) Gillett, transferred from *Dolichos* L. to *Sphenostylis* by Gillett (1966), was moved to *Nesphostylis* Verdc. by Potter & Doyle (1994) based on a cladistic analysis of morphological data. Three species of *Sphenostylis* are used as food sources in Africa. *Sphenostylis stenocarpa* (Hochst. ex A.Rich.) Harms is known as African yam bean or *girigiri* (Burkhill 1995), and cultivars of this tropical African species are grown for their seeds and tubers in tropical and West Africa. The leaves, flowers, pods, and seeds of *S. schweinfurthii* Harms and *S. erecta* Hutch. ex Baker f. are wild-harvested. The roots of *S. erecta* are also used as fish poison (Potter 1992).

Sphenostylis appears to have a close relationship with *Nesphostylis* (Potter & Doyle 1994) with which it shares the dorsiventrally flattened style tip; but it differs by features of the calyx (Lackey 1981), the standard petals, and the stamens (Potter 1992). In *Nesphostylis*, the inner surface of the calyx is pubescent, standard appendages are present, the base of the vexillary stamen is hooked, and the stamen apices are dilated. None of these characters are present in *Sphenostylis*. Based mainly on the narrow pods, several botanists including Harvey (1862), Bentham (1865) and Taubert (1894), relegated *Sphenostylis* into synonymy with the genus *Vigna* Savi (Gillett 1966). Harms (1899) reinstated the genus and expanded it to include related species previously placed in *Dolichos* and *Vigna*. *Sphenostylis* differs from these two genera by its distinctive style tip. Furthermore, *Vigna* generally has peltate stipules (stipules not peltate in *Sphenostylis*). In addition, a phylogeny based on molecular data shows that *Vigna* and *Sphenostylis* are not

as closely related as previously thought, and that *Sphenostylis* is rather closer to *Dolichos* and *Macrotyloma* (Wight & Arn.) Verdc. (Wojciechowski *et al.* 2004). *Sphenostylis* can be distinguished from *Dolichos*, *Macrotyloma*, and *Vigna* by the absence of appendages on the standard petals (appendages present on the standard petals in the latter three genera).

Sphenostylis is represented in South Africa and Swaziland by two species, namely *S. angustifolia* Sond. and *S. marginata* E.Mey.; the former being endemic to the two countries.

MATERIALS AND METHODS

Plant material was studied mainly from herbarium specimens housed in JRAU, NH, NU, and PRE (acronyms after Holmgren *et al.* 1990); and also in the field. Habit affinities are described according to Mucina & Rutherford (2006).

TAXONOMY

***Sphenostylis* E.Mey.**, *Commentariorum de Plantis Africae Australioris*: 148 (1836); Baker f.: 670 (1929); Burt Davy: 418 (1932); E.Phillips: 427 (1951); Wilczek: 273 (1954); Verdc.: 389 (1970); J.B.Gillett *et al.*: 670 (1971); Compton: 286 (1975); R.A.Dyer: 275 (1975); Potter & Doyle: 389–406 (1994); Germish.: 296 (2000); Verdc. & Døygard: 68 (2001). Type species: *S. marginata* E.Mey.

Prostrate, climbing (twining), or erect shrubs or perennial herbs, arising from a thick, woody rootstock. Leaves pinnately 3-foliolate (Figure 1D); stipules persistent, ovate-lanceolate or ovate-acuminate; leaflets ovate, elliptic or linear, with four linear stipels, one at the base of each lateral leaflet and two at the base of the terminal one (Figure 1E), appressed-pubescent when young but becoming glabrescent with age. *Inflorescence*: flowers in congested heads on long peduncles, peduncles much longer than leaves; bracts linear or oblong-lanceolate, small, falling off at a very early stage or absent; bracteoles 2, ovate-lanceolate or oblong-ovate, caducous or persistent. *Calyx* tube campanulate, bilabiate, the two

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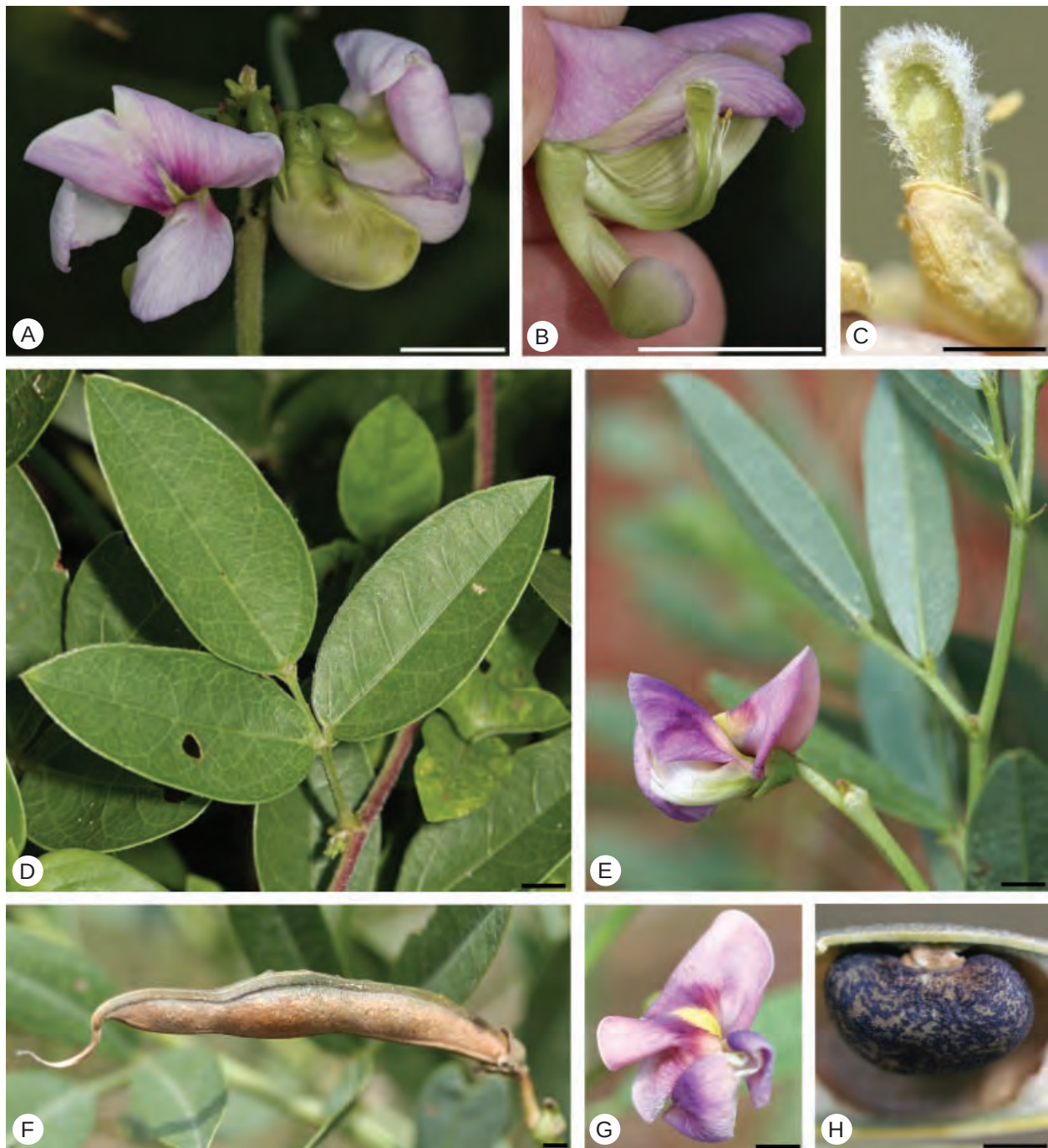


FIGURE 1.—*Sphenostylis marginata* (A, B, D) and *S. angustifolia* (C, E–H): A, flowers showing the twisted standard petals; B, flower showing the cuneate style tip; C, keel tip and cuneate style tip; D, leaf in adaxial view; E, flowering branch (note the stipules and stipels); F, pod; G, flower in front view (note the twisted petals); H, seed. Scale bars: A, 8 mm; B, 12 mm; C, E–G: 5 mm; D, H: 2 mm. Photographs: A, B, D by David Styles; C, E–H by Ben-Erik van Wyk.

lobes of the upper lip partially or entirely connate, lobes very short and blunt. *Corolla* purple, purplish pink, violet, whitish pink, or yellow; standard suborbicular, symmetrical or twisted (Figure 1A & 1G) with 2 inflexed auricles, but without appendages, with well-developed, channelled claw; wings obliquely obovate, eared near base, with short linear claw; keel incurved, $\pm$ concave-convex beaked, with short linear claw. *Androecium* diadelphous (with 9 stamens fused into a tube, vexillary stamen free), 5 basifixed anthers alternating with 5 dorsifixed anthers. *Ovary* narrowly oblong, pubescent, 3–12-ovuled; style penicillate below the stigma; stigma dorsiventrally flattened, ciliate on the margins (Figures

1B & 1C). *Fruit* linear, compressed, twisting after dehiscence, glabrescent to densely silky, with persistent style at tip (Figure 1F), 2–several-seeded, dehiscent. *Seeds* oblong, uniformly black or brown to reddish brown speckled black, minutely papillose (Figure 1H).

Key to species of *Sphenostylis* in South Africa and Swaziland:

- 1a Leaflets 20–45 mm wide; petiole 50–70 mm long; peduncles 220–300 mm long; fruit 95–120 mm long *S. marginata*
- 1b Leaflets 10–19 mm wide; petiole 8–16 mm long; peduncles 75–115 mm long; fruit 55–85 mm long *S. angustifolia*

1. *Sphenostylis angustifolia* Sond. in Linnaea 23: 33 (1850); R.A.Dyer: t 1010 (1947); Burt Davy: 418 (1932); Compton: 287 (1975). *Vigna angustifolia* (Sond.) Benth. ex Harv.: 240 (1862). Type: South Africa, Gauteng, 2528 (Pretoria): Magaliesberg, (–DC), Zeyher 524 (S, specimen on the left, lecto!., here designated; BM!, K!, isolecto.). Syntype: KwaZulu-Natal, 2931 (Stanger): Port Natal [now Durban], (–CC), Gueinzus 624 (S!).

Note: the Zeyher specimen in the Sonder Herbarium in S is chosen as lectotype because this is probably the specimen that Sonder used in his description. The twig on the left is chosen because it bears a flower and some immature fruits. Curiously Potter (in sched.) chose the Zeyher specimen in K as lectotype but this choice was apparently never published.

Erect suffrutex, rarely climbing and twining, much-branched, up to 0.5 m tall, spreading. *Leaflets* oblong or linear-lanceolate, 30–60 × (7–)10–19 mm; petiole 8–16 mm long; stipules ovate-acuminate, 3.5–5.0 × 2–3 mm. *Inflorescences* subumbellate axillary racemes; peduncles (55–)75–115 mm long, with 2–4 flowers; flowers pink or purple, with a whitish or yellowish centre, 12–25 mm long; bracts linear, ± 1.5 mm long, caducous; bracteoles ovate-lanceolate, 2.0–2.5 × ± 1.5 mm, persistent. *Calyx* sparsely pubescent, with ± equal lips, upper lip 6–8 mm long, lower lip 6–8 mm long; lobes rounded, those of the upper lip joined for almost their entire length. *Corolla* pinkish red; standard suborbicular, 15–25 × 15–26 mm,

glabrous; wings obovate, 14–24 × 4–7 mm, without surface sculpturing, apex rounded; keel falcate, 14–24 × 6–10 mm, apex rounded, pocket absent. *Ovary* 9–13 mm long, linear-oblong. *Fruit* linear, 55–85 × 5–6 mm, glabrescent, many-seeded. *Seeds* reniform, ± 7 × ± 4 mm, brown, reddish brown speckled black, or uniformly black (Figure 2). *Flowering time:* Sept.–Feb.

Diagnostic characters: Based on Potter & Doyle's cladistic analysis (1994), *Sphenostylis angustifolia* appears to have close affinities with *S. zimbabweensis* R.Mithen, which is restricted to the Highlands of Zimbabwe. The two species share the deciduous bracts and the persistent bracteoles. *Sphenostylis zimbabweensis* is, however, differentiated by the more prostrate growth form (as opposed to the erect growth form of *S. angustifolia*), and the broader, ovate to elliptic leaflets (leaflets narrower and oblong to linear-lanceolate in *S. angustifolia*). *Sphenostylis angustifolia* can be distinguished from *S. marginata* by the narrower leaflets and the much shorter petioles, peduncles, and pods (dimensions are given in the key).

Distribution and habitat: *Sphenostylis angustifolia* occurs in South Africa (Limpopo, North-West, Gauteng, Mpumalanga and KwaZulu-Natal Provinces) and Swaziland (Figure 3). It grows scattered in Zeerust Thornveld (SVcb 3), Central Sandy Bushveld (SVcb 12), Soutpansberg Mountain Bushveld (SVcb 21), Polokwane Plateau Bushveld (SVcb 23), Granite Lowveld (SVI 3), Tza-

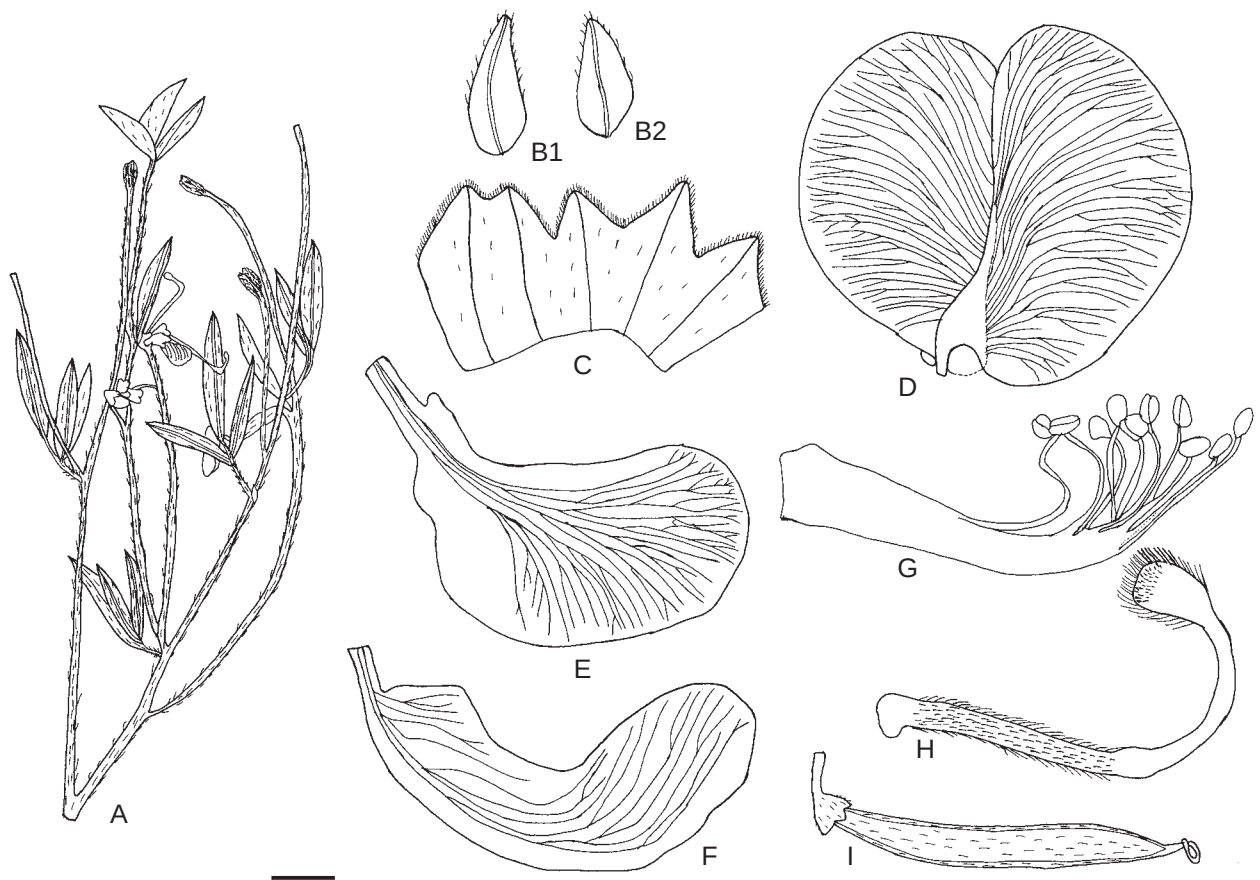


FIGURE 2.—Vegetative and reproductive morphology of *Sphenostylis angustifolia*: A, flowering branch; B1 & B2, abaxial view of bracteoles; C, calyx opened out with upper lobes to left; D, standard petal; E, wing petal; F, keel petal; G, stamens; H, pistil; I, lateral view of pod. Vouchers: A from A.O.D. Mogg 35461 (JRAU); B–I from B-E. van Wyk 1438 (JRAU). Scale bar: A, 30 mm; B, 1 mm; C–F, H, 3 mm; G, 2 mm; I, 10 mm.

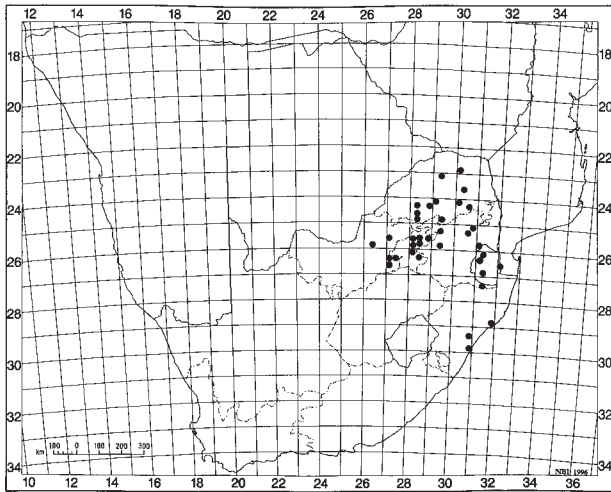


FIGURE 3.—Distribution of *Sphenostylis angustifolia*.

neen Sour Bushveld (SVI 8), Legogote Sour Bushveld (SVI 9), Swaziland Sour Bushveld (SVI 14), Southern Lebombo Bushveld (SVI 16), Carletonville Dolomite Grassland (Gh 15), Soweto Highveld Grassland (Gm 8), Rand Highveld Grassland (Gm 11), KaNgwane Montane Grassland (Gm 16), Maputaland Coastal Belt (CB 1), KwaZulu-Natal Coastal Belt (CB 3).

Additional specimens examined

LIMPOPO.—2230 (Messina): Soutpansberg, Entabeni Forestry Station at Muchindudi Fall, (–CC), 27 Jan. 1954, *L.E. Codd* 8392 (PRE). 2329 (Polokwane): Polokwane, Farm Eersteling, on slope of mtn, (–AB), 1 Jan. 1992, *G.J. du Toit* 2238 (NH). 2330 (Tzaneen): Modjadji Reserve near Duiwelskloof, (–CB), 24 May 1938, *J.D. Krige* 164 (PRE). 2428 (Nylstroom): Waterberg, (–AD), 6 Nov. 1978, *G. Germishuizen* 909 (PRE); Naboomfontein, (–BD), 13 Dec. 1934, *E.E. Galpin* 133130 (PRE); between Warmbaths and Pietersburg [Polokwane], (–CB), 4 Nov. 1985, *B.J. Pienaar* 636 (PRE); 18 km from Nylstroom on road to Warmbaths near Groot Nyl turn-off, (–CD), 4 Nov. 1985, *G. Germishuizen* 3347 (PRE). 2429 (Zebediela): near Daggakraal 50 m NE of Potgietersrus, (–AA), 3 Jan. 1954, *B. Maguire* 2569 (PRE); Arabie, Camp 1, (–CD), 7 Jan. 2007, *W. Ellery* 357 (PRE). 2430 (Pilgrim's Rest): Lekgalameetse Nature Reserve, The Downs, SE of Makwens, (–AA), 16 Oct. 1985, *M. Stalmans* 718 (PRE).

NORTH-WEST.—2526 (Zeerust): Marico Distr., ± 10 km NE of Wondergat, (–CD), 6 Feb. 1983, *C. Reid* 676 (PRE). 2527 (Rustenburg): Rustenburg Nature Reserve, (–CA), 27 Feb. 1970, *N. Jacobsen* 845 (PRE). 2627 (Potchefstroom): on road from Frederikstad to Rysmierbult, (–AC), 31 Oct. 1978, *B. Ubbink* 733 (PRE); Ventersdorp, Goedgedacht, (–CA), 29 Dec. 1930, *J.D. Sutton* 511 (PRE).

GAUTENG.—2528 (Pretoria): La Montagne Rand, N of Chamberd W/S, (–CA), 30 Sept. 1978, *A.E. van Wyk* 2405 (PRE); 28 miles [45 km] from the National Herbarium on road to Boekenshoutsloof, (–CB), 15 Apr. 1971, *L.A. Coetzer* 73 (PRE); Fountains Valley, (–CC), 3 Oct. 1948, *J.M. Watt* 4565 (PRE); Doornkloof, Smutskoppie, (–CD); 24 Nov. 1985, *B-E. van Wyk* 1438 (JRAU); Renosterkop, NE of Bronkhorstspuit, (–DB); 6 Dec. 1987, *B-E. van Wyk* 2730 (JRAU). 2628 (Johannesburg): Melville Koppies Nature Reserve, (–AA), 4 Feb. 1987, *B-E. van Wyk* 2600–2604 (JRAU); Heidelberg, (–AD), Nov. 1927, *A. Thode* A1311 (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): Drie Rondavels lookout, (–BC), 2 Feb. 1982, *A.E. van Wyk*, *R. Dahlgren* & *P.D.F. Kok* 5487 (PRE). 2529 (Witbank): Loskopdam Game Reserve, (–AD), 13 Dec. 1966, *G.K. Theron* 728 (JRAU, PRE); between Witbank and Middelburg along N4 highway, (–CD), 20 Feb. 1991, *P. Herman* 1338 (PRE). 2530 (Lydenburg): 7 km S of Sabie, (–BB), 29 Sept. 2005, *J.J. Meyer* 4530 (PRE); Wonderkloof Nature Reserve, (–BC), 17 Nov. 1978, *J.P. Kluge* 1408 (PRE). 2531 (Komatipoort): KaNgwane, Songimvelo Game Reserve, (–CC), 8 Dec. 1992, *N.L. Meyer* 29 (PRE).

SWAZILAND.—2631 (Mbabane): Hhohho Dist., Nyokane, 15 km from Piggs Peak-Mbabane turnoff on road to Maphalaleni, (–AB), 23 Oct. 1963, *R.H. Compton* 31707 (PRE); Dabriach, (–AC), 18 Oct. 1958, *R.H. Compton* 28097 (PRE); Hlatikulu, (–CD), Oct. 1910, *M. Steward* 10081 (PRE). 2632 (Bela Vista): Lebombo Mountains, near fence separating Swaziland and Mozambique, (–CA), 22 Nov. 2002, *M.K. Maserumule* 74 (PRE).

KWAZULU-NATAL.—2930 (Pietermaritzburg): Beacon Hill, off Panorama Terrace, Wyebank, (–DD), 10 Jan. 2005, *D. Styles* 2180 (NH).

2. *Sphenostylis marginata* E.Mey., *Commentarium de Plantis Africae Australioris*: 148 (Feb. 1836); Baker f.: 148 (1929); Wilczek 6: 274 (1954); Verdoorn: t. 1521 (1968); J.B. Gillett et al.: 671 (1971); Compton: 287 (1975); Lock: 438 (1989); Potter & Doyle: 403 (1994); Verdc. & Døygard.: 71 (2001). *Vigna marginata* (E.Mey.) Benth. ex Harv.: 240 (1862); De Wild.: 98 (1921). Type: KwaZulu-Natal, 3030 (Port Shepstone): 'in graminosis ad ostia fluvii Omsamculo' [mouth of Umzimkulu River], (–CB), *Drège* s.n. (K!, lecto., designated by Potter & Doyle (1994) [as 'holo.'], G!, MO!, P!, isolecto.)

Note: although the P specimen which bears an original *Drège* label with locality details corresponding exactly to those given in the prognosis as well as Meyer's handwriting ('*mihi*') would have been more appropriately selected as lectotype, Potter & Doyle's (1994) designation of the K specimen as the holotype constitutes effective lectotypification (Art. 9.8).

Prostrate suffrutex with twining stems up to 1.5 m long, arising from a woody rootstock. *Leaflets* ovate, elliptic or oblong, 45–110(–125) × 20–40(–45) mm; petiole (15–)50–70 mm long; stipules oblong-lanceolate or ovate, 3–7 × 2–4 mm. *Inflorescence* pseudo-umbellate, axillary raceme, long-stalked; peduncles 220–300 mm long, few-flowered; flowers mauve, 14–16 mm long; bracts oblong-lanceolate, ± 1.5 mm long, caducous, bracteoles ovate-lanceolate, 2–3 × 1.5–2.0 mm, persistent. *Calyx* pubescent, lobes rounded, with equal lips, upper and lower lips 5–6 mm long, lobes of upper lip joined for almost their entire length. *Corolla* pinkish red; standard broadly obovate, 13–17 × 14–23 mm, glabrous; wings obovate, deep purplish pink 10–17 × 4–6 mm, without surface sculpturing, apex rounded; keel ± equal to wings, 12–18 × 4–6 mm, paler or white, apex rounded, pocket absent. *Ovary* 10–15 mm long, linear-oblong. *Fruit* linear, 95–120 × 4–8 mm, glabrescent, 5–8-seeded. *Seeds* reniform, ± 5.0 × ± 3.5 mm, brown or reddish brown speckled black (Figure 4). *Flowering time:* Nov.–Feb.

Diagnostic characters: *Sphenostylis marginata* differs from *S. angustifolia* in having broader leaflets and longer petioles, peduncles, and pods (see key for dimensions).

Verdcourt (1970) divided what he called the *Sphenostylis marginata* complex, which included the two central and East African species *S. erecta* (Baker f.) Baker f. and *S. obtusifolia* Harms, into three subspecies, namely subsp. *marginata* (occurring only in South Africa and Swaziland), subsp. *obtusifolia* (Harms) Verdc., and subsp. *erecta* (Baker f.) Verdc. However, based on morphological and DNA data, Potter & Doyle (1994) pro-

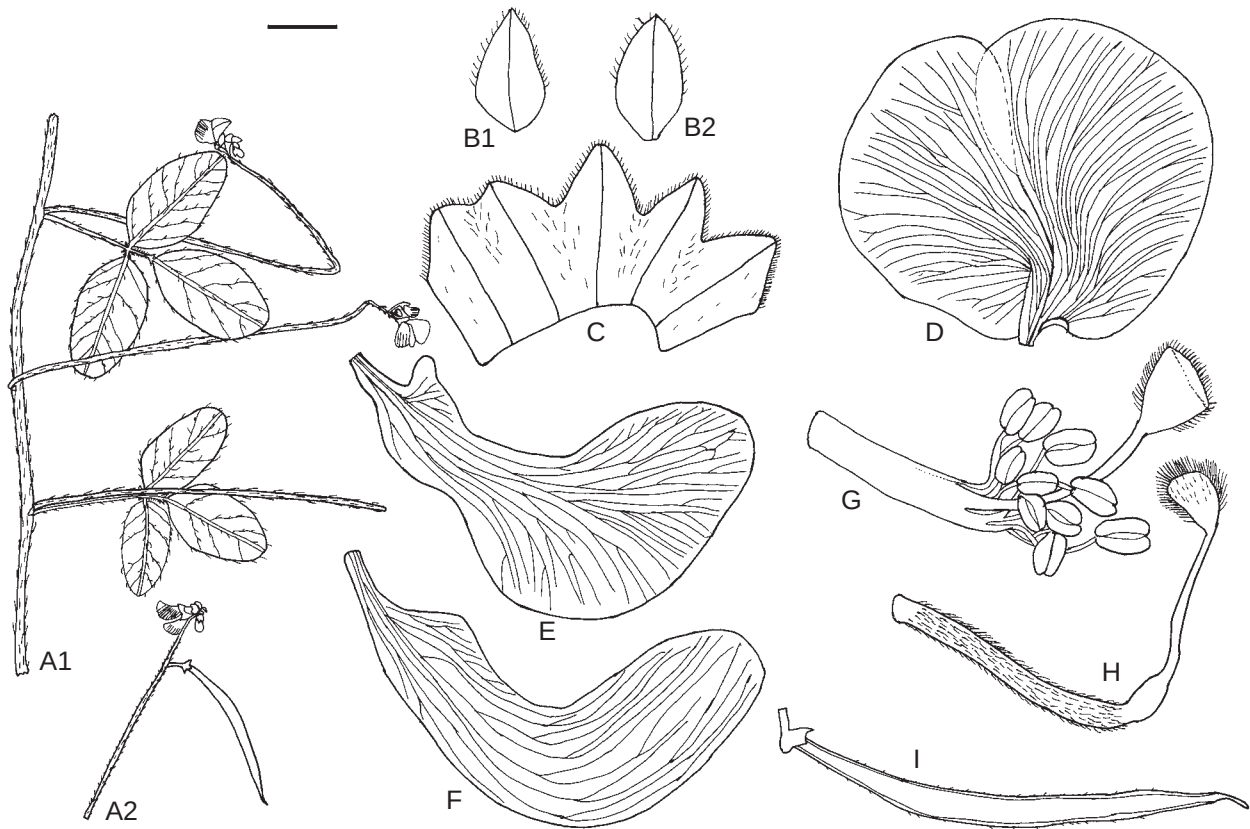


FIGURE 4.—Vegetative and reproductive morphology of *Sphenostylis marginata*: A1, flowering branch; A2, inflorescence; B1 & B2, abaxial view of bracteoles; C, calyx opened out with upper lobes to left; D, standard petal; E, wing petal; F, keel petal; G, stamens; H, pistil; I, lateral view of pod. Vouchers: A from *N. Grobbelaar* 1648 (PRE); B–F from *Commis* 855 (PRE); H from *Acocks* 20928 (PRE); I from *N. Grobbelaar* 1648 (PRE). Scale bar: A1, A2, 30 mm; B, 1 mm; C, 2 mm; D–F, H, 3 mm; G, 4 mm; I, 15 mm.

posed a narrow view of *S. marginata* by limiting the species concept to subsp. *marginata* (the other two subspecies were excluded). *Sphenostylis marginata* subsp. *erecta* was restored to species level and subspecies *obtusifolia* was transferred to *S. erecta* (as subspecies).

Distribution and habitat: *Sphenostylis marginata* occurs in South Africa (Limpopo, Mpumalanga, KwaZulu-Natal and Eastern Cape Provinces), and Swaziland (Figure 5). It grows in Central Sandy Bushveld (SVcb 12), Ohrigstad Mountain Bushveld (SVcb 26), Gran-

ite Lowveld (SVI 3), Legogote Sour Bushveld (SVI 9), Zululand Lowveld (SVI 23), PaulPietersburg Moist Grassland (Gm 15), KaNgwane Montane Grassland (Gm 16), Income Sandy Grassland (Gs 7), Ngongoni Veld (SVs 4), Eastern Valley Bushveld (SVs 6), Maputaland Coastal Belt (CB 1), and KwaZulu-Natal Coastal Belt (CB 3).

Additional specimens examined

LIMPOPO.—2428 (Nylstroom): 13 km NE of Warmbaths [Bela-Bela] on road to Nylstroom, (–CD), 18 Nov. 1981, *C. Reid* 439 (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): foothills SE of Magalieskop, Mariepskop Dist., (–DB), 27 Jan. 1990, *H.P. van der Schijf* 5878 (PRE). 2531 (Komatipoort): 25 km from H.P. River to Hazyview, near White Waters Forest Station, (–AA), 3 Jan. 1984, *M. Jordaan* 298 (PRE); Kruger National Park, Lower Sabie dam, (–BB), 26 Nov. 1990, *V.R. Bredenkamp* 468 (PRE); Eerste Geluk no. 16, Uitkyk, (–CA), 26 Mar. 1975, *C.H. Stirton* 1729 (PRE).

SWAZILAND.—2631 (Mbabane): Hhohho Dist., Masilela area, on Maphalaleni Rd., (–AB), 27 Jan. 1994, *G. Germishuizen* 7152 (PRE); Little Usutu River, (–AC), 27 Oct. 1956, *R.H. Compton* 26163 (NH, PRE); Stegi, (–BD), 22 Dec. 1960, *R.H. Compton* 30388 (NH, PRE); S of Mankai-ana, (–CA), 6 Nov. 1949, *J.L. Sidey* 1933 (PRE). 2731 (Louwsburg): at camp on hilltop before reaching Hluti, (–BA), 8 1931, *I.B. Pole-Evans* 3364 (PRE).

KWAZULU-NATAL.—2730 (Vryheid): 0.9 km towards Vryheid from Natal Spa, Freddie Coetzee's farm, (–BD), 2 Dec. 1988, *P.D.F. Kok & B.J. Pienaar* 1282 (PRE). 2731 (Louwsburg): Nongoma, (–DC), 20 Nov. 1960, *M.J. Wells* 2060 (PRE). 2830 (Dundee): hill near Glencoe, (–AA), 22 Feb. 1993, *J. Medley-Wood* 4823 (PRE); Dundee Dist., on banks of Buffalo River, 1 km S of P.O. Vantsdrift, (–AB), 22 Dec. 1946, *L.E. Codd* 2377 (PRE); Elandslaagte, Blanerne Farm,

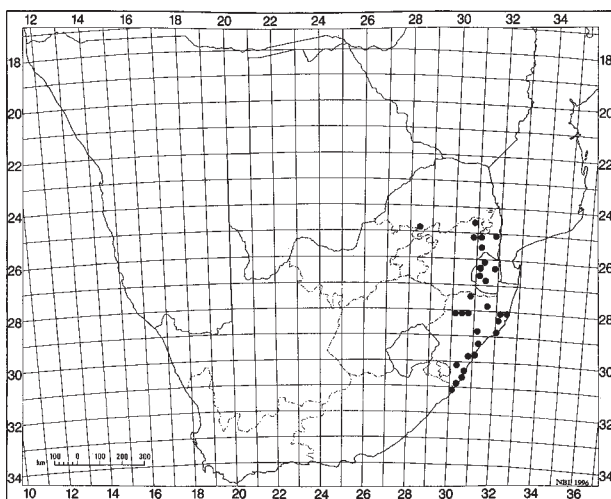


FIGURE 5.—Distribution of *Sphenostylis marginata*.

32 km from Ladysmith on road to Newcastle, (–BA), 15 Nov. 1994, A.M. Ngwenya 1295 (PRE). 2831 (Nkandla): Babanango Dist., valley N of Izulu Hill, (–CC), 16 Jan. 1946, J.P.H. Acocks 12317 (PRE). 2832 (Mtubatuba): Masundwini, Hluhluwe Game Reserve, (–AA), 7 Nov. 1971, P.M. Hitchins 635 (NU, PRE); Palm Ridge Farm, (–AC), 3 Oct. 1967, E.R. Harrison 128 (PRE). 2931 (Stanger): Twinstreams Farm, Mtunzini, (–DC), 12 Oct. 1984, I. Garland s.n., & G. Nichols 805 (PRE). 3030 (Port Shepstone): St Michaels-on-Sea, (–AB), 1 Feb. 1985, B.J. Pienaar 587 (PRE); Port Shepstone (–CD), 24 Mar. 1967, R.G. Strey 7420 (PRE); Hibberdene, (–DA), 09 Mar. 1970, R.G. Strey 9701 (NU).

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Anatomy of myxospermic diaspores of selected species in the Succulent Karoo, Namaqualand, South Africa

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Keywords: arid regions, diaspores, dispersal, myxospermy, Namaqualand, scanning electron microscopy, Succulent Karoo

ABSTRACT

Environmental conditions encountered in arid ecosystems differ vastly from those in more mesic ecosystems. Dispersal strategies in arid environments reflect these differences and many mechanisms have evolved that restrict or hinder dispersal. Myxospermy is a trait developed by plant species from arid regions to restrict diaspore dispersal by means of an anchorage mechanism. Several of the abundant plant species in Namaqualand, within the arid Succulent Karoo Biome, display myxospermy. Diaspores of these species produce copious amounts of mucilage when they are moistened and are anchored to the soil once the mucilage dries out again. This study investigated the origin of the mucilaginous layer of 12 species anatomically, using both light and scanning electron microscopy. The mucilage production of the species investigated could best be grouped into three types: 1, epidermal and sub-epidermal cells of seeds and achenes; 2, specialized tissue in wings or the pappus of achenes; and 3, mucilage excreting hairs. Previous systems for classifying the different types of mucilage production did not recognize the mucilaginous nature of wings or a pappus. A short note on the composition of the mucilage is included.

INTRODUCTION

Plants have developed many functional traits that allow them to adapt and survive in different environments. Seed dispersal is an important functional trait that influences the population structure and the spatial and temporal turnover of species within a plant community. Myxospermy is the phenomenon where the epidermis of the diaspore (seed/fruit) contains mucilaginous cells, which swell and become sticky when in contact with water (Gutterman & Shem-Tov 1997; Van Rheede van Oudtshoorn & Van Rooyen 1999). Myxospermy is classified as an antitelechoric dispersal mechanism and is encountered more often in arid than in mesic environments. The original explanation for the prevalence of antitelechory in desert environments was that these mechanisms were adaptive responses to the particularly high mortality of dispersed seeds in deserts and that they had evolved as mechanisms to reclaim the mother site (Murbeck 1919; Zohary 1937; Stopp 1958; Ellner & Shmida 1981; Van Rooyen *et al.* 1990). Ellner & Shmida (1981) however, argued that antitelechory was a side effect of characters whose adaptive value was not directly related to dispersal. Among the benefits derived from antitelechory are the spreading of germination over time and the provision of suitable conditions for germination and subsequent seedling establishment.

There are many divergent ideas about the ecological importance of myxospermy, and it probably fulfils various functions. When wet, myxospermic diaspores adhere to the soil; and after drying out, remain glued to soil particles and thus resist being carried to unfavourable locations by wind. However, wet diaspores can also adhere to the feet or fur of animals and be dispersed zoochorically. The good contact between the mucilage layer and the soil surface increases water absorption for germination,

and as a result, myxospermic species germinate more successfully on the surface of the soil than non-myxospermic species (Bregman & Graven 1997; Zaady *et al.* 1997; Van Rheede van Oudtshoorn & Van Rooyen 1999). The water held by the mucilage could also serve as a water reservoir for seedling establishment (Gutterman *et al.* 1967; Gutterman 1993, 1996), although this function of the mucilage has been challenged (Murbeck 1919; Grubert 1974). Furthermore, the adherence of the seed to the soil by the mucilage prevents massive collection by seed predators (Gutterman 1993), and the repeated wetting of mucilaginous seeds during many nights with dew may affect the repair mechanisms of the DNA, cell membranes, and organelles; thereby enhancing seed viability for many years (Osborne *et al.* 1980/1981; Leprince *et al.* 1993; Huang *et al.* 2008). The mucilage has also been reported to have a stimulatory action on germination (Gat-Tilman 1995) or it may control the germination process by excluding the passage of oxygen when there is excess moisture (Gutterman *et al.* 1967, 1973; Gutterman 1996; Tamara *et al.* 2000).

Although several studies have drawn the attention to the ecological importance of myxospermy in the flora of Namaqualand (Rösch 1977; Van Rooyen *et al.* 1990; Van Rheede van Oudtshoorn & Van Rooyen 1999), the germination behaviour of myxospermic species (Fotouo Makouate 2008) and the response of myxospermic species to grazing pressure (Fotouo Makouate 2008), little attention has thus far been given to the origin and chemical composition of the mucilage of these myxospermic diaspores. The objectives of this study were to investigate the origin and the chemical composition of the mucilage of a representative sample of myxospermic species in Namaqualand, South Africa.

STUDY AREA AND SPECIES

Diaspores of the species investigated in this study were all collected in the Namaqualand Hardeveld Bioregion of the Succulent Karoo (Mucina & Rutherford

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2006). The Succulent Karoo is an arid winter rainfall region stretching along the West Coast of South Africa and Namibia; and is recognized by the IUCN as one of only two entirely arid global hotspots of biodiversity (Conservation International 2009). Many of the biologically unique features of this biome have been attributed to its climate, *i.e.* the effective and relatively predictable seasonal rainfall, and the relatively moderate winter temperatures (Mucina & Rutherford 2006). A prominent feature of the Namaqualand Hardeveld Bioregion is the extravagant spring floral display of winter-growing annuals (Van Rooyen 1999).

Representative species of four families were investigated: within the Lamiaceae, the perennial shrub *Salvia dentata*; within the Acanthaceae, two dwarf perennial shrubs *Acanthopsis horrida* and *Blepharis furcata*; within the Brassicaceae, the annual *Heliophila thunbergii* var. *thunbergii*; and within the Asteraceae, the perennial shrubs *Pentzia incana* and *Othonna cylindrica* as well as the annual species *Cotula barbata*, *Monoculus (Tripteris) hyoseroides*, *Senecio arenarius*, *Ursinia cakilefolia*, *Oncosiphon grandiflorum* and *Foveolina dichotoma*.

MATERIALS AND METHODS

Scanning electron microscopy (SEM)

Dry seeds/achenes were mounted on a stub and made conductive with RuO₄ vapour (Van der Merwe & Peacock 1999). For wet samples, seeds/achenes of each species were soaked in water for 24 hours before fixation. Seeds/achenes were then fixed in 2.5% glutaraldehyde in 0.075 M phosphate buffer, pH 7.4, for one hour, and rinsed three times (five minutes per rinse) in 0.075 M phosphate buffer and dehydrated in an ethanol series with the respective concentrations of 30%, 50%, 70%, 90%, and 100%. This was followed by critical point drying in liquid CO₂, whereafter the seeds/achenes were mounted on a stub and made conductive with RuO₄ vapour. Samples were viewed with the use of a JSM 840 scanning electron microscope (SEM) (JEOL, Tokyo, Japan), and photographs were taken with the computer program Orion 6.60.4.

Light microscopy

Further studies were done on diaspores where the origin of the mucilage could not be clearly established with the aid of an SEM. Dry samples were fixed in 4% (v/v) formaldehyde in 50% (v/v) ethanol (FAA) to prevent mucilage release. The wet samples were immersed in water for 24 hours. Wet samples were fixed in 2.5% glutaraldehyde in 0.075 M phosphate buffer, pH 7.4, for one hour, and rinsed three times (five minutes per rinse) in 0.075 M phosphate buffer, and dehydrated in an ethanol series with the respective concentrations of 30%, 50%, 70%, 90% and 100%. Samples were subsequently infiltrated over two days with pure LR-White resin and polymerized at 65°C for 24 to 36 hours. Sections were cut with a Reichert Ultracut E microtome. Each section was stained, mounted in immersion oil, and viewed with a Nikon Optiphot light microscope (LM) (Tokyo, Japan). Photographs were taken with a Nikon Digital

camera DXM 1 200 (Tokyo, Japan) and the computer program Nikon ACT-1 (Tokyo, Japan).

Diaspore staining was done according to various manuals of microscopic staining (McClellan & Ivimey Cook 1941; O'Brien & McCully 1981; Lawton & Ettridge 1986). Seven different stains were used to test for the presence of various compounds, the details of which are given in Table 1.

TABLE 1.—Stains used for various compounds and expected results

Stain	Compound	Expected results
Aniline blue	Callose	Blue
Biuret solution	Protein	Violet
Methylene blue	Cellulose	Blue
Phloroglucinol	Lignin	Pink
Ruthenium red	Pectic substances	Red
Sudan 4	Lipids	Yellow
Toluidine blue	Polysaccharides	Pink-purple

RESULTS AND DISCUSSION

Anatomical investigation

On the basis of the anatomical origin of the mucilage, Zohary (1937) distinguished seven different types. Grubert (1974) recognized many more types, but his three main categories were based on whether the origin was 1, restricted to epidermal structures, *e.g.* epidermis or hairs; 2, from epidermal and sub-epidermal layers; or 3, restricted to sub-epidermal layers.

Neither the classification systems of Zohary (1937) or Grubert (1974) accommodate diaspores where the mucilage production occurs on wings of achenes, as was reported in the present study. In general, diaspores of most myxospermic species are smooth-coated and do not contain obvious appendages to advance telechory. Contrary to the belief that none of the myxospermic Asteraceae possess a pappus (Grubert 1974), many myxospermic species from Namaqualand are winged or possess a winged pappus. The presence of wings would allow anemochoric dispersal during phase I dispersal (Chambers & MacMahon 1994), but further anemochoric dispersal would be prevented once the achenes were moistened and remained attached to soil particles.

The mucilage production of the species investigated in the present study could best be grouped into three main types:

- 1 Epidermal and sub-epidermal cells of seeds and achenes:
 - 1.1 Cells of seeds bursting only in the centre
 - 1.2 Cells of achenes bursting across the entire surface
- 2 Specialized tissue in wings or pappus of achenes
- 3 Hairs:
 - 3.1 On achenes
 - 3.2 On seeds

Epidermal mucilage

Heliophila thunbergii var. *thunbergii* (Brassicaceae)

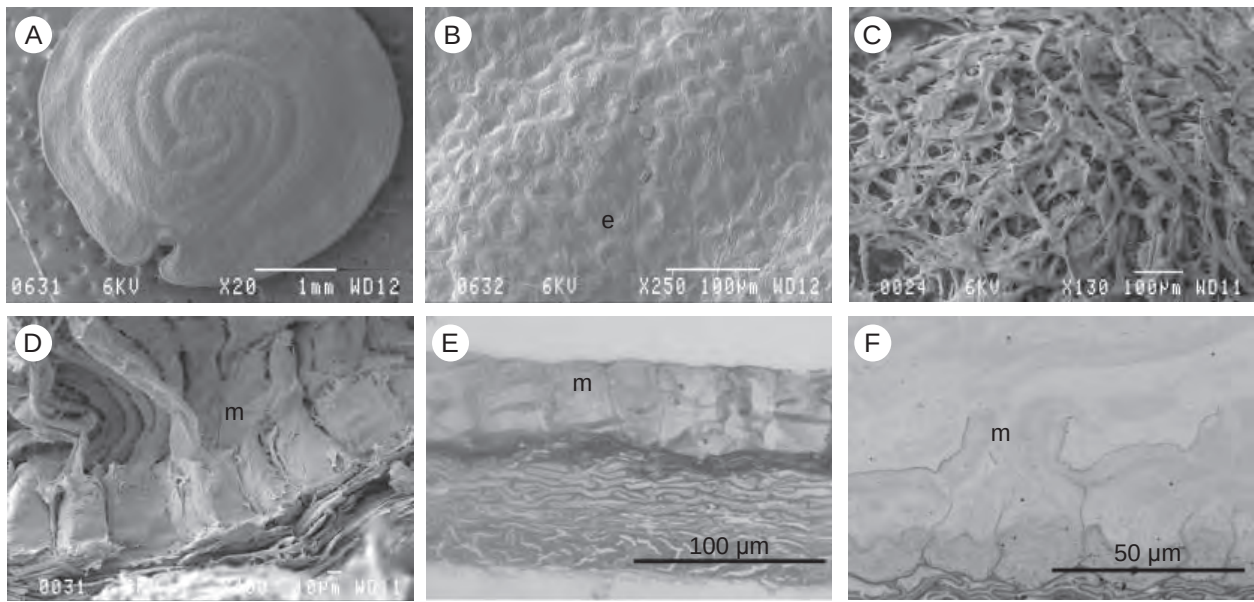


FIGURE 1.—*Heliophila thunbergii* var. *thunbergii*, seeds. A–D, SEM: A, entire dry seed; B, high magnification of dry epidermis; C, high magnification of wet seed surface; D, section of wet seed. E, F, LM: E, section of the dry seed; F, cross section of wet epidermis. e, epidermal layer, m, mucilage.

The scanning electron micrograph of dry seeds of *H. thunbergii* var. *thunbergii* reveals a circular seed (Figure 1A). The epidermal layer (e) consists of circular cells with a raised margin and a cavity in the centre (Figure 1B). Upon wetting, the mucilage swells and the epidermal cells become incapable of containing the excess mucilage and therefore rupture. Once wet, the seed is covered by a gelatinous film (Figure 1C), similar to the mucilaginous seed coat of two species of the Brassicaceae described by Gutterman & Shem-Tov (1997). The thin section of the dry seed also reveals the epidermal cells filled with mucilage (m) (Figure 1E). The section of the wet seed reveals the epidermis with ruptured

cells from which filaments of mucilage (m) emerge (Figure 1D, F).

Salvia lanceolata (Lamiaceae)

A similar pattern was observed for the seeds of *S. lanceolata* (Lamiaceae). Once in contact with water, the outer layer of the epidermis absorbs water quickly, the epidermis cells swell, the cuticle ruptures and the contents are excreted as long, continuous threads. Hedge (1970) reported that the contents of the epidermis cells of some Lamiaceae are secreted in the shape of long, continuous, helically coiled threads.

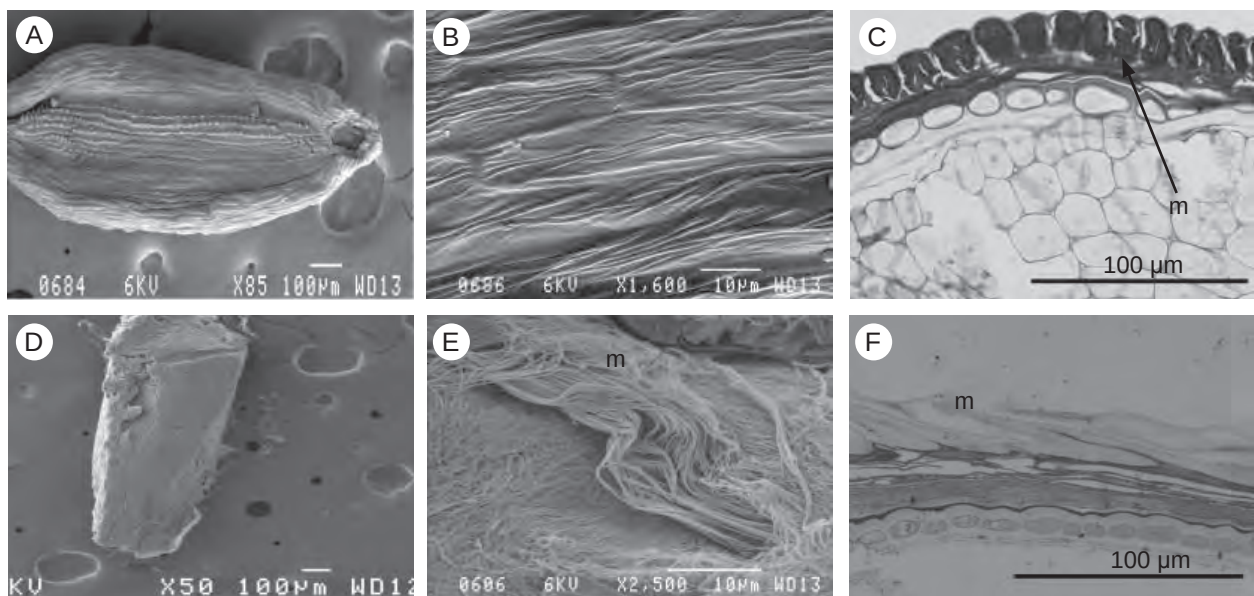


FIGURE 2.—*Cotula barbata*, achenes. A, B, D, E, SEM: A, entire dry achene; B, high magnification of the epidermis; D, entire wet achene; E, high magnification of wet epidermis covered with thick layer of mucilage. C, F, LM: C, cross section of dry achene coat, with mucilage (arrow) retained in epidermal layer; F, cross section of wet epidermis of which outer layer has burst, releasing mucilage from epidermal cells. m, mucilage.

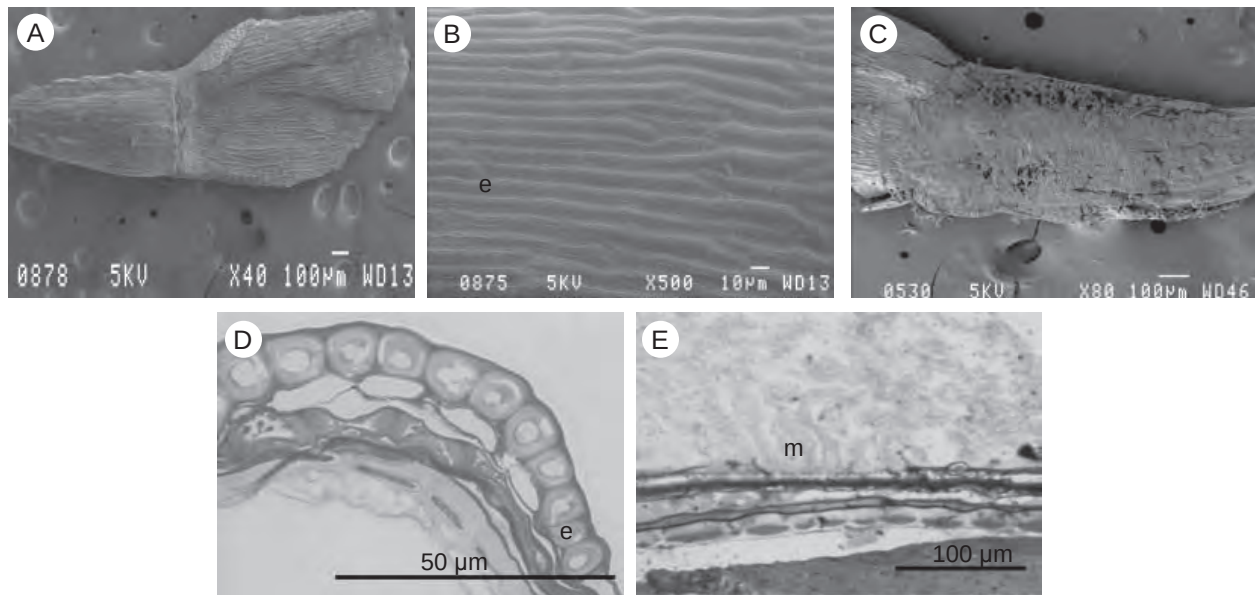


FIGURE 3.—*Foveolina dichotoma*, achenes. A–C, SEM: A, entire achene of *F. dichotoma*; B, high magnification of the epidermis of *F. dichotoma*; C, wet achene. *Oncosiphon grandiflorum*, achenes: D, E, LM: D, thin cross section of dry epidermis; E, thin cross section of wet epidermis with broken epidermal cells that liberate mucilage. e, epidermal layer, m, mucilage.

Cotula barbata (Asteraceae)

In the dry state, the one side of the achene of *C. barbata* is undulated (Figure 2A), whereas the other side of the achene is smooth (Figure 2B). The mucilage structure observed in *C. barbata* is similar to that of *H. thunbergii* var. *thunbergii* with the mucilage contained in the epidermal layer (Figure 2C). When *C. barbata* achenes come into contact with water (Figure 2D), the epidermal cells burst across the entire outer surface (Figure 2E, F) and not only the centre of the cell as in the case of *H. thunbergii* var. *thunbergii*.

Foveolina dichotoma, *Oncosiphon grandiflorum* and *Pentzia incana* (Asteraceae)

These three species are taxonomically closely related, and it appears that they have the same way of producing mucilage. The SEMs show that the epidermis of the dry achenes of *F. dichotoma* consists of parallel longitudinal cells (Figure 3A, B), as was also found for *O. grandiflorum* and *P. incana*. Following wetting, fixation, and critical point drying, the achenes are covered with a gelatinous film but the pappus remains unchanged (Figure 3C). Light microscope sections of the dry achene of *O. grandiflorum* show that the epidermal cells are filled

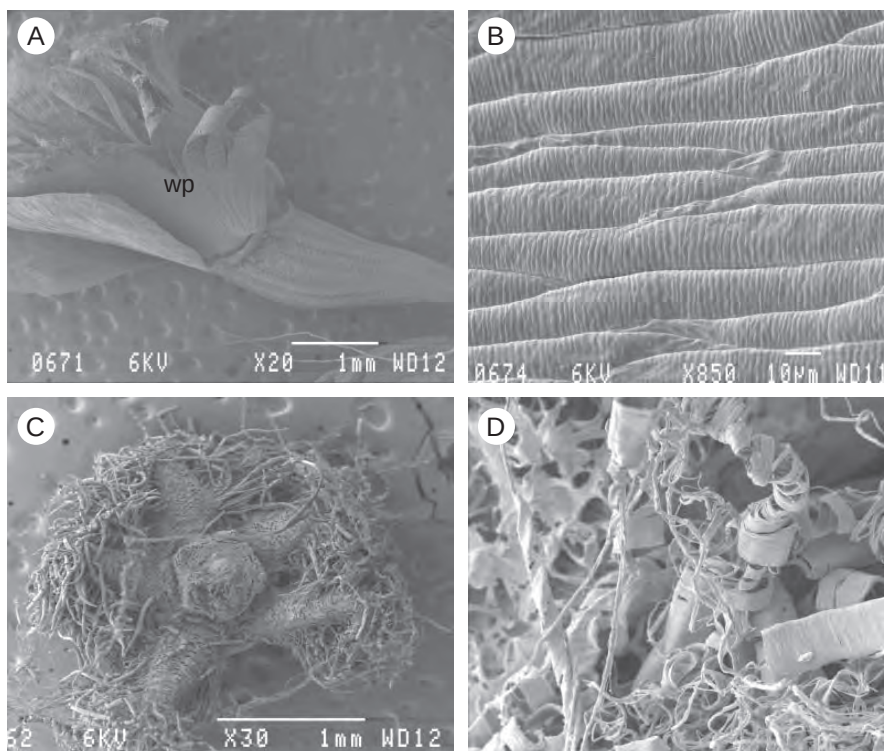


FIGURE 4.—*Ursinia cakilefolia*, SEM of achenes: A, entire dry achene with winged pappus; B, high magnification of dry winged pappus consisting of radially elongated cells; C, entire wet achene with uncoiled winged pappus; D, high magnification of wet winged pappus showing long strands of uncoiled mucilage. wp, winged pappus.

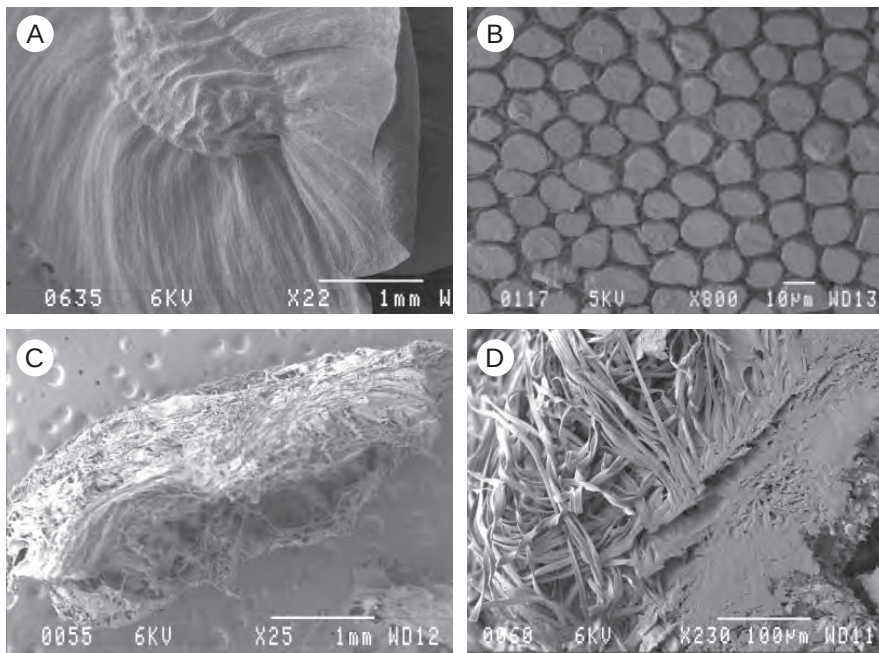


FIGURE 5.—*Monoculus hyoseroides*, SEM of achenes: A, entire dry achene; B, high magnification of a section of the wing; C, entire wet achene with disintegrated wing; D, high magnification of long strands of mucilage.

with mucilage (Figure 3D), which is released when the cells burst open upon swelling in contact with water (Figure 3E).

Mucilaginous wings

Ursinia cakilefolia (Asteraceae)

Dry achenes of *U. cakilefolia* have a winged pappus (wp) (Figure 4A), consisting of a single layer of radially elongated cells with helically thickened cell walls (Figure 4B). When the pappus comes into contact with water, the cells separate at the middle lamellae and the helical thickenings uncoil to form long strands of mucilage (Figure 4C). The different steps through which the pappus uncoils are clearly visible under the SEM (Figure 4D). The same process was observed in *U. nana* subsp. *nana* (Rösch 1977).

Monoculus hyoseroides (Asteraceae)

Achenes of *M. hyoseroides* are three-winged. The epidermis of the seed-bearing part of the achene is undulate and does not become mucilaginous (Figure 5A). The section through the wings shows hexagonally shaped cells completely filled with mucilage and separated by thick cell walls (Figure 5B). Upon wetting, the cells separate and the wings become completely mucilagi-

nous (Figure 5C) and the long mucilage strands remain attached to the achene (Figure 5D).

Mucilaginous hairs

Senecio arenarius (Asteraceae)

In the dry condition, the shiny white hairs (h) have a finger-like shape and lie against the achene surface (Figure 6A, B). The interior of the hair seems to be filled with a coiled thread as seen at high magnification (Figure 6B). In the wet condition, the hairs spread $\pm$ at right angles to the seed. Apparently, when the mucilaginous hairs absorb water the threads uncoil and become thin and long (Figure 6C). The same phenomenon was observed for *Othonna cylindrica*, as well as for *O. floribunda* (Rösch 1977).

Acanthopsis horrida and *Blepharis furcata* (Acanthaceae)

In the dry condition, the hairs on the seed surface of *A. horrida* (Figure 7A, B) and *B. furcata* are tightly appressed to the seed coat and are covered with a thick deposit (Figure 7C). At high magnification it can be seen that these hairs contain coiled spirals (Figure 7B). Once in contact with water the thick deposit expands, the hairs become swollen and spread $\pm$ at right angles to the seed

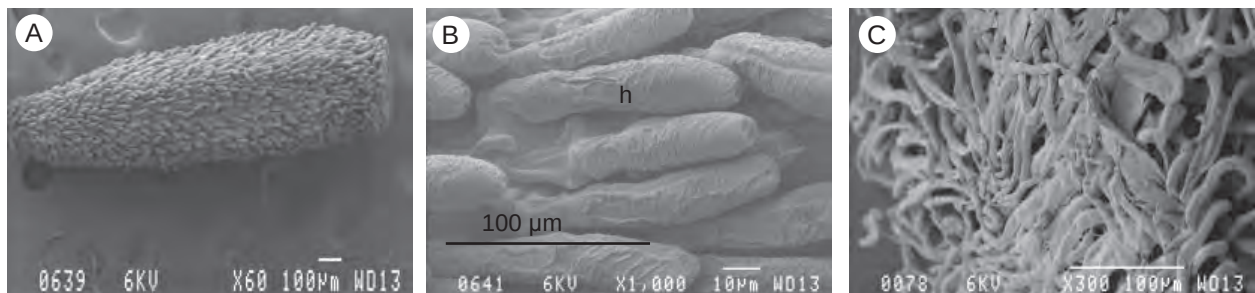


FIGURE 6.—*Senecio arenarius*, SEM of achenes: A, entire dry achene; B, high magnification of dry achene with hair lying against it; C, high magnification of wet hairs. h, hair.

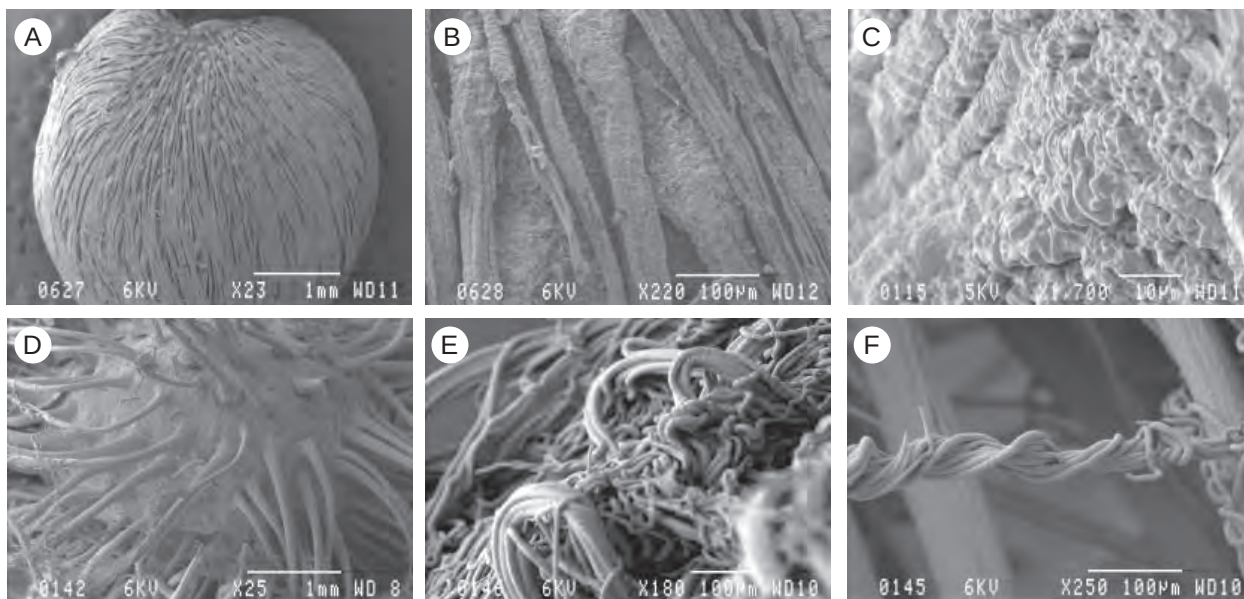


FIGURE 7.—*Acanthopsis horrida*, SEM of seeds: A, entire dry seed; B, hairs; C, dry epidermis covered with thick deposit; D, wet seed; E, swollen hairs; F, uncoiled strands of mucilage.

coat (Figure 7D). The tips of the hairs break open and release a multitude of strands of mucilage (Figure 7E, F).

Chemical composition

Three stains reacted positively with the mucilage of all species: methylene blue, ruthenium red, and toluidine blue; thus confirming the presence of polysaccharides such as cellulose and pectic substances. On the basis of the intensity of the reaction, the epidermal mucilage seemed to contain less cellulose than the mucilaginous wings and mucilaginous hairs. In some species, a slight reaction was also observed with aniline blue, indicating the presence of callose in the mucilage.

Cellulose is the most abundant plant polysaccharide found in the form of microfibrils in cell walls and mucilage. Dry amorphous and fibrous cellulose can absorb considerable amounts of water and becomes soft, flexible, and viscous. Pectin is a heterogeneous grouping of acidic structural polysaccharides with the main molecules being the D-galacturonic acid residues. They do not possess exact structures and are complex. As for cellulose, pectin is a water binder, is highly viscous, and can form a firm gel when in contact with water. In all cases, the mucilage of the diaspores investigated contained both cellulose and pectic substances. This could be due to the presence of microfibrils of cellulose embedded in the pectin compounds forming a complex matrix. Both pectic substances and cellulose were also reported in the seed mucilage of *Arabidopsis thaliana* (Brassicaceae) (Windsor *et al.* 2000; Willats *et al.* 2001; Macquet *et al.* 2007). In a detailed chemical and macromolecular study of the composition of *A. thaliana* seed mucilage (Brassicaceae), Macquet *et al.* (2007) found that the mucilage was made up of two layers: a water-soluble layer that could be separated from the seed and an inner layer that remained firmly attached to the seed. The inner layer was itself constituted of two domains,

the internal one of which contained cellulose. The major pectin of both the water-soluble and adherent seed mucilage was rhamnogalacturonan I.

This study has only provided a rough indication of the composition of the mucilage of the diaspores investigated. The chemistry of mucilage is complex and needs a more detailed study to determine the exact type of polysaccharide-forming mucilage in each diaspore.

CONCLUSIONS

The mucilaginous layer of the diaspores of 12 species from Namaqualand was investigated anatomically using both light and scanning electron microscopy. The structural origin of the mucilage produced by the diaspores was diverse. Diaspores of myxospermic plant species might produce mucilage in different ways; but in general, this function resides in the epidermal cells and other external appendages such as hairs and wings. Previous systems to classify the different types of mucilage production did not recognize the mucilaginous nature of wings or pappus. Despite the diversity of the origin and structure of the mucilage, it performs more-or-less the same ecological functions.

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Recircumscription and distribution of elements of the ‘*Ceterach cordatum*’ complex (*Asplenium*: Aspleniaceae) in southern Africa

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Keywords: Aspleniaceae, *Asplenium*, *Ceterach*, ferns, pteridophytes, southern Africa, xerophytes

ABSTRACT

Ceterachoid aspleniums in southern Africa have long been treated as a single widespread and variable taxon, *Asplenium cordatum* (Thunb.) Sw. (= *Ceterach cordatum* Thunb.). In addition to *A. cordatum*, a further two ceterachoid taxa are now recognized as occurring in the *Flora of southern Africa* (FSA) region, namely *A. capense* (Kunze) Bir, Fraser-Jenk. & Lovis and *A. phillipsianum* (Kümmerle) Bir, Fraser-Jenk. & Lovis. We provide full descriptions and distributions of these three taxa.

INTRODUCTION

Pteridophyte treatments for the *Flora of southern Africa* (FSA) (Roux 1986; Schelpe & Anthony 1986; Burrows 1990) and *Flora zambesiaca* (FZ) (Schelpe 1970) regions, have considered a single xerophytic rock fern, *Ceterach cordatum* Thunb., to occur widely throughout the region and to show great morphological variability. *Ceterach* is currently treated as a subgenus of *Asplenium* L. (Crabbe *et al.* 1975; Bir *et al.* 1985; Roux 2001). Subgenus *Ceterach* is distinguished from subgenus *Asplenium* in our region by its lack of indusia and the presence of densely-set scales (paleae) on the abaxial lamina surface, versus indusiate sori and sparsely-set scales in subgenus *Asplenium* (Roux 2001). Moore (1857) early recognized that the strictly African ceterachoid species were anatomically and morphologically distinct from the Eurasian-Macronesian elements, and therefore excluded them from *Asplenium* subgen. *Ceterach*. More recent molecular analyses have demonstrated the polyphyly of subgenus *Ceterach*, implicating homoplasy in the dense scale cover and in pinnatisect laminae of these asplenoid ferns (Pinter *et al.* 2002; Van den Heede *et al.* 2003). The taxonomic implications are that southern African taxa referred earlier to subgenus *Ceterach* should either be accommodated in a new subgenus, or that distinction at a subgeneric level (*sensu* Roux 2001) should be abandoned altogether (Van den Heede *et al.* 2003).

The multiple origins in *Asplenium* of redundant indusia and dense abaxial scales have been attributed to independent adaptation to rocky xeroseres across its range (Van den Heede *et al.* 2003). We further postulate that the pinnatisect fronds common to both groups is a poikilohydric modification that allows for frond integrity to be maintained in the inrolled, desiccated state (Figure 1), and for even restoration following rehydration. Ceterachoid taxa in southern Africa are extremely

desiccation-tolerant; a member of this group has been shown by Gaff (1977) to tolerate relative humidities in the 0–5% range for at least six months, with an initial water potential (ψ) of 18%, expressed in terms of the relative humidity at 28°C.

We concur with Roux (2009a) in his reinstatement of *Asplenium capense* (Kunze) Bir, Fraser-Jenk. & Lovis as distinct from *A. cordatum* (Thunb.) Sw., but we also identify *A. phillipsianum* (Kümmerle) Bir, Fraser-Jenk. & Lovis as occurring in the FSA region (Table 1). This taxon extends from the island of Socotra off Somalia through East and Central Africa to the northern provinces of South Africa, as far south as the northern regions of Mpumalanga, Gauteng, and North West Province. Pappe & Rawson (1858) recognized the widespread European and North African taxon *Asplenium ceterach* L. (= *Ceterach officinarum* Lam. & DC) as South African, based on a Krebs collection made on the Baviaans River. This species is not currently considered to occur south of the Sahara, and has been taken as a misidentification (Roux 1986, 2009a).

We provide the recircumscription and distribution of the three ceterachoid elements of *Asplenium* currently known from southern Africa.



FIGURE 1.—Inrolled pinnatisect leaves of a desiccated plant of *Asplenium cordatum*, Nieu Bethesda, Eastern Cape Province. Photo: N. Crouch.

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TABLE 1.—Characters distinguishing ceterachoid members of *Asplenium* occurring in the FSA region.

Character/taxon	<i>A. cordatum</i>	<i>A. capense</i>	<i>A. phillipsianum</i>
Frond division	shallowly to very deeply 2-pinnatifid, sometimes 2-pinnate	pinnatisect to pinnate, sometimes shallowly 2-pinnatifid	pinnatisect to very shallowly 2-pinnatifid
Frond apex division	to near apex	to some way below apex	to some way below apex
Pinnae width	narrower at base	broader at base	broader at base
Pinnae shape	narrowly oblong to oblong-lanceolate, apex bluntly acute; petiolulate throughout; base flared to somewhat auriculate-cordate	ovate-oblong, apex obtuse; apical pinnae adnate with base decurrent; basal 1–2 pinnae pairs becoming petiolulate with base somewhat flared to auriculate-cordate	narrowly ovate-oblong, apex obtuse; base adnate and decurrent throughout
Scale density on abaxial surface	very dense	very sparse	sparse
Scale shape	deltate, attenuate	deltate to lanceolate, attenuate	lanceolate
Scale margins	serrate	finely serrate	finely serrate
Scale composition	cells short roundish to oval	cells narrowly oblong	cells oblong
Scale colour on stipe	not darker towards apex	darker towards apex	darker towards apex
Rhachis robustness	strong, rigid	strong, fairly rigid	weaker, flexible
Sori size	small, up to 2 mm, not confluent	very large, 3–6 mm, later confluent	large, 2–3 mm, later confluent
Gemmae	absent	absent	sometimes present near apex
Stipe length	17–40 mm	15–35 mm	5–20 mm

MATERIALS AND METHODS

All ceterachoid *Asplenium* material held in the following herbaria (totalling almost 600 specimens) were studied: Geo-Potts Herbarium (BLFU), University of the Free State, Bloemfontein; Buffelskloof Nature Reserve Herbarium (BNRH), Lydenburg; Bolus Herbarium (BOL), University of Cape Town, Cape Town; Selmar Schönland Herbarium (GRA), Albany Museum, Grahamstown; the Herbarium at the Royal Botanic Gardens, Kew (K), London, United Kingdom; Mpumalanga Parks Board Herbarium (LYD), Lydenburg; Compton Herbarium (NBG), SANBI, Cape Town; KwaZulu-Natal Herbarium (NH), SANBI, Durban; National Museum Herbarium (NMB), Bloemfontein; Bews Herbarium (NU), University of KwaZulu-Natal, Pietermaritzburg; National Herbarium (PRE), SANBI, Pretoria; H.G.W.J. Schweickerdt Herbarium (PRU), University of Pretoria, Pretoria; A.P. Goossens Herbarium (PUC), North West University, Potchefstroom; and the South African Museum Herbarium (SAM), SANBI, Cape Town.

The JSTOR Plant Science website (<http://plants.jstor.org>) was consulted for type material held in other herbaria. Images of type specimens were directly obtained from The Museum of Evolution Herbarium (UPS), Uppsala University, Uppsala, Sweden. Types seen electronically are cited as e!

Herbarium acronyms follow Holmgren *et al.* (1990). Author citations used follow the standardized author abbreviations provided by the International Plant Names Index (<http://www.ipni.org>).

TAXONOMY

Three taxa are recognized in southern Africa, all chasmodontophytic saxicoles (Jacobsen 1983):

Key to the species

- 1a. Fronds always pinnate, with stronger, rigid rachis; pinnae free from rachis (petiolulate), with flared to somewhat auriculate/cordate base, abaxially very densely covered with overlapping, broadly deltate scales; sori small, discrete 1. *A. cordatum*
- 1b. Fronds pinnatisect to pinnate, with weaker, flexible rachis; pinnae adnate to rachis, with broader decurrent base (at least in distal half of frond), abaxially sparsely covered with ovate lanceolate scales; sori large and confluent:
 - 2a. Pinnae adnate to rachis and decurrent apically, becoming free from rachis (petiolulate) with ± flared to auriculate/cordate base basiscopically; rachis winged apically 2. *A. capense*
 - 2b. Pinnae adnate to rachis and decurrent throughout; rachis almost winged throughout 3. *A. phillipsianum*

1. ***Asplenium cordatum* (Thunb.) Sw.** in Journal für die Botanik 1800,2: 54 (1801). *Acrostichum cordatum* Thunb.: 171 (1800). *Grammitis cordata* (Thunb.) Sw.: 23, 217 (1806). *Cincinalis cordata* (Thunb.) Desv. (1811). *Notholaena cordata* (Thunb.) Desv.: 92 (1813). *Gymnogramma cordata* (Thunb.) Schltdl.: 16 (1825). *Ceterach cordatum* (Thunb.) Desv.: 223 (1827). Type: South Africa, 'e Cap bonae Spei', Thunberg *s.n.* (UPS-Thunb 24439, holo. e!).

Ceterach crenata Kaulf.: 85, 86 (1824), nom. illegit. superfl. Type: as for *Acrostichum cordatum* Thunb. [McNeill *et al.* (2006) Art. 7.5].

Gymnogramma namaquensis Pappe & Rawson: 42 (1858). *Gymnogramma cordata* var. *namaquensis* (Pappe & Rawson) Sim: 212 (1892). *Ceterach cordatum* var. *namaquensis* (Pappe & Rawson) Sim: 176 (1915). Type: South Africa, Namaqualand, between rocks near Modderfontein, 1856, Whitehead *s.n.* (K, holo.!).

Grammitis cordata [var. and] subvar. *nudiuscula* Hook.: t.7 (1860), nom. illegit. superfl. Type: as for *Gymnogramma namaquensis* Pappe & Rawson [see Roux (2009a)].

Grammitis cordata var. *pinnato-pinnatifida* Hook.: t.7 (1860), nom. inval. [McNeill *et al.* (2006) Art. 26.2].

Gymnogramma cordata var. *subbipinnata* Hook.: t.7 (1860). *Ceterach cordatum* var. *subbipinnata* (Hook.) Kümmerle: 289 (1909). Type: South Africa, 'elevated mountain of Macaliesberg', *Ecklon & Burke s.n.* [missing, see Schelpe & Anthony (1986: 206) and Roux (2009: 83)].

Gymnogramma cordata var. *bipinnata* Sim: 212 (1892). Type: South Africa, Namaqualand, without precise locality, *Holland s.n.* [NBG, lecto.!, designated by Schelpe & Anthony (1986: 206)].

Notholaena inaequalis Kunze γ *eckloniana* (Kunze) Kuntze var. *rawsonii* (Pappe) Kuntze forma *minor* Kuntze: 379 (1898). Type: South Africa, [Eastern Cape], 'Capland', Cradock, 940 m, 12 Feb. 1894, *Kuntze s.n.* [NY, lecto., designated by Roux (2009b: 228)].

Rhizome to 3–6 mm diam., erect or procumbent; scales sessile, clathrate, very narrowly lanceolate, 2–3 $\times$ 0.5–0.6 mm, acuminate, frequently with a hair point, irregularly serrate, bicolorous, chestnut-brown distally, brown proximally, with paler margin throughout, with narrowly oblong to ovate cells. **Fronde** tufted, suberect to erect; **stipe** (10–)17–40(–60) mm long, dark chestnut-brown, densely scaled when young, becoming subglabrous with age, scales sessile, lanceolate, 3.0–3.5 $\times$ 0.7–0.9 mm, acuminate, irregularly serrate, glossy, sometimes bicolorous, chestnut-brown, sometimes with narrow paler margin, with oblong to ovate cells; **lamina** subcoriaceous, involute and inrolled when dry, elliptic or narrowly elliptic to oblanceolate in outline, shallowly to very deeply 2-pinnatifid, sometimes 2-pinnate, (20–)50–120(–150) $\times$ (10–)15–40(–50) mm, basal pinnae gradually decrescent; **rachis** not winged between pinnae, scales as for stipe but lanceolate, 3.0 $\times$ 0.9 mm; **pinnae** (4–)6–19(–30) $\times$ (2–)3–7(–13) mm, free from rachis (petiolulate), with flared to $\pm$ auriculate-cordate base, narrowly oblong to oblong-lanceolate, bluntly acute, margin irregularly scalloped to incised, glabrous above at maturity, abaxially very densely scaled, scales sessile, deltate, $\pm$ 2.0 $\times$ 1.5 mm, attenuate, serrate, glossy, light reddish brown, with short roundish to oval cells; **sori** linear along (obscure) veins, up to 2 mm long, exindusiate, almost totally obscured by scales. Figure 2A–D.

Etymology: *cordatum* = heart-shaped, referring to the basally lobed pinnae.

Distribution and ecology: *Asplenium cordatum* is widespread in South Africa, Lesotho, Swaziland, Namibia, Botswana, and Zimbabwe (Figure 3); also in Angola, Tanzania, Kenya, Uganda, and Ethiopia.

It occurs in rocky crevasses in exposed, hot, and dry habitats, often at the base of boulders, well away from water. A dense scale cover on the abaxial surface of the fronds serves to protect the sori of this xerophytic species.

Asplenium cordatum is very variable in size, with the largest specimens originating from the dry areas of the north-western parts of the Western and Northern Cape

provinces. This immense variability is reflected in the long list of synonyms for this taxon. Burrows (1990) noted that northwards of the Limpopo River it becomes progressively rarer, reaching the extreme of its range in Ethiopia.

Although purported to occur in Madagascar (Roux 2009a), where a ceterachoid element has been reported from a single locality on Mount Morahahiva (Tardieu-Blot 1957), this collection best matches *Asplenium philipsianum* (Tardieu-Blot 1958: Fig. XVII).

Vouchers: *H.H. Burrows* 3294 (GRA); *E. Esterhuysen* 25624 (BOL); *D. Galpin* 4782a (BLFU); *H.H.W. Pearson* 8557 (BOL, K, NBG); *L.E. Taylor* 2913 (NBG).

2. *Asplenium capense* (Kunze) Bir, Fraser-Jenk. & Lovis in *Fern Gazette* 13,1: 61 (1985). *Ceterach capense* Kunze: 496 (1836). *Grammitis capensis* (Kunze) T.Moore: 1xiii (1857). Type: South Africa, 'Port Natal et Afrique meridionalea', *Drège s.n.* [G, lecto.!, isolecto., designated by Roux (1986: 352)]; 'Ceded territory, bergwaldungen an den Quellen des Katriver, Oberhalb Philipstown', *Ecklon & Zeyher s.n.* (UPS, syn. e!).

Gymnogramma capensis Spreng. ex Kaulf.: 183 (1831), nom. nud. *Ceterach cordatum* var. *capense* (Spreng. ex Kaulf.) Hieron. ex Kümmerle: 287 (1909). Type: South Africa, 'Cap. Bon spei: in einer Felsenritze am Löwenberg', *Zeyher s.n.* Fl. Cap. No. 273 (HAL, holo. e!; BOL, iso.!).

Grammitis cordata var. *pinnata* Hook.: t.7 (1860), Type: as for *Ceterach capense* Kunze [see Roux (2009a)].

Rhizome to 4 mm diam., erect or procumbent; scales sessile, clathrate, lanceolate, 3–5 $\times$ 1.0–1.5 mm, acuminate, frequently with a hair point, irregularly serrate, bicolorous, with dark brown central region and paler margins, with narrowly oblong cells. **Fronde** tufted, erect to suberect; **stipe** 15–35(–60) mm long, chestnut-brown to dark chestnut-brown, densely scaled, scales sessile, narrowly triangular, 3–5 $\times$ 0.5–1.0 mm, acuminate, irregularly finely serrate, glossy, sometimes bicolorous, with narrow rust coloured central region and broad straw coloured margin, with oblong to ovate cells; **lamina** herbaceous, involute and inrolled when dry, elliptic to narrowly obovate in outline, pinnatisect to pinnate, sometimes shallowly 2-pinnatifid, (80–)90–120(–190) $\times$ (20–)30–45(–52) mm, basal pinnae gradually decrescent; **rachis** somewhat winged apically, not winged between widely spaced pinnae basally, scales as for stipe but 2–4 $\times$ 0.7–1.0 mm; **pinnae** (10–)15–25(–28) $\times$ (4–)5–10(–11) mm, adnate to rachis with decurrent base apically, becoming free from rachis (petiolulate) with somewhat flared to auriculate-cordate base basiscopically, ovate-oblong, obtuse, margin sinuate to scalloped, glabrous above at maturity, abaxially very sparsely scaled, scales sessile, deltate to lanceolate, 1.5–2.5 $\times$ 0.4–0.7 mm, attenuate, finely serrate, glossy, bicolorous, with narrow rust coloured central region and broad straw coloured margin, with narrowly oblong cells; **sori** linear along (obscure) veins, 3–6 mm long, becoming confluent at maturity, exindusiate, not obscured by scales. Figure 2E–H.

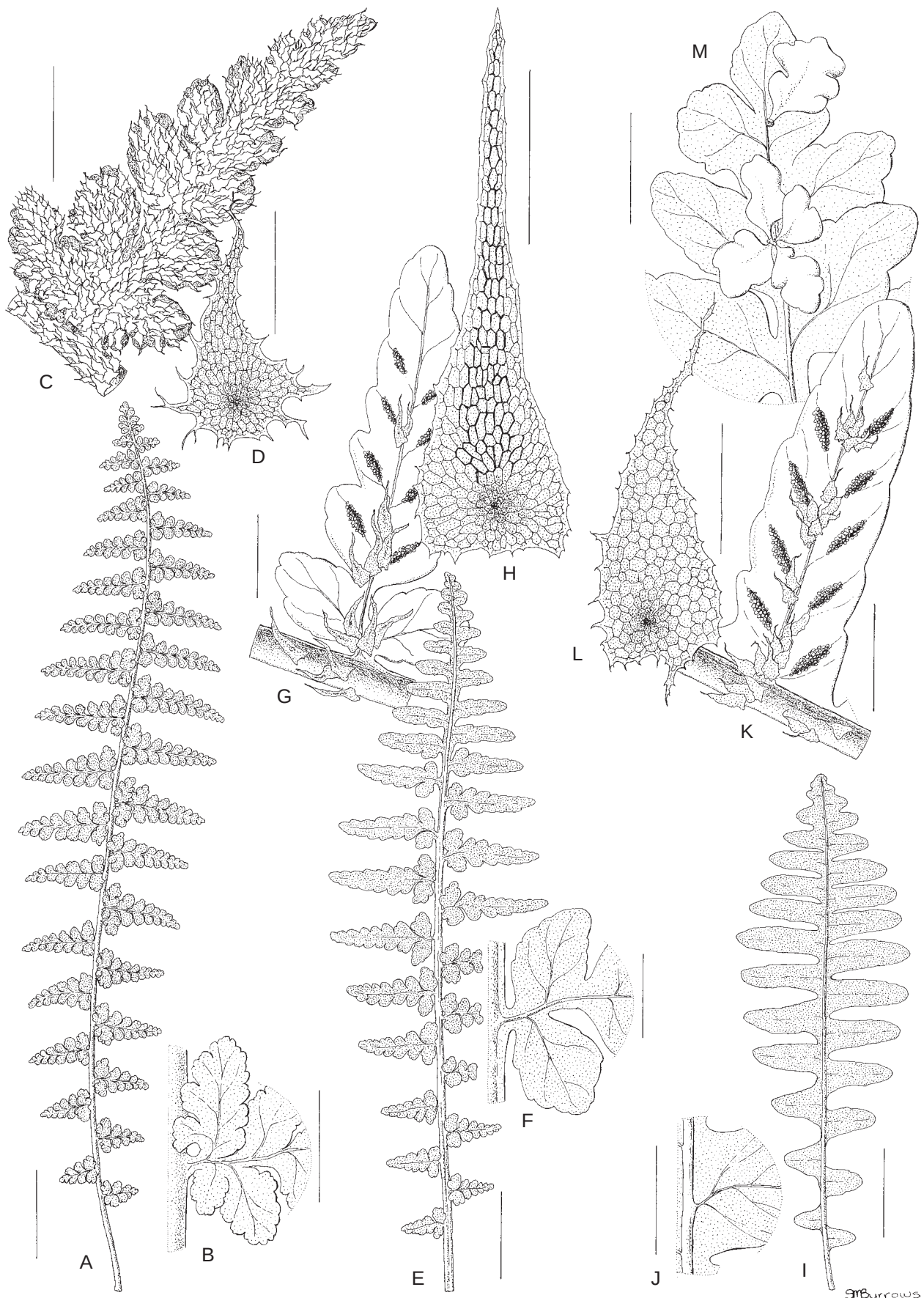
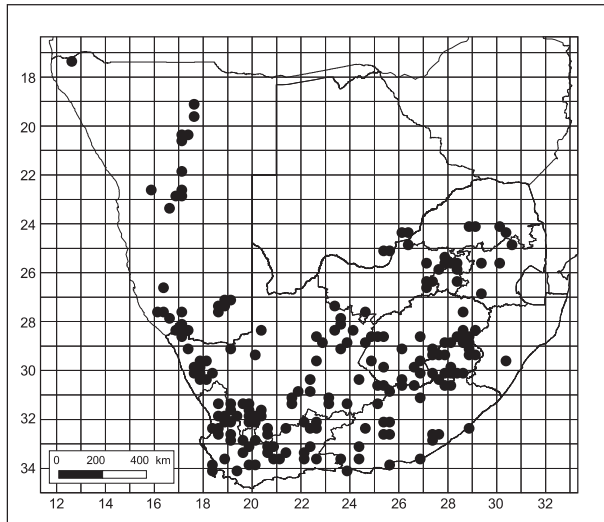


FIGURE 2.—A–D, *Asplenium cordatum*, J.E. Burrows 1110 (BNRH): A, complete frond; B, cordate pinna base; C, abaxial surface of pinna with dense scales; D, lamina scale. E–H, *Asplenium capense*, H.H. Burrows 2891 (BNRH): E, complete frond; F, pinna base; G, abaxial surface of pinna with sparse scales; H, lamina scale. I–M, *Asplenium phillipsianum*, J.E. Burrows & S.M. Burrows s.n. (BNRH): I, complete frond; J, adnate pinna base; K, abaxial surface of pinna with sparse scales; L, lamina scale; M, gemmae at frond apex. Scale bar: A, E, I, 20 mm; B, C, F, G, J, K, M, 5 mm; D, H, L, 1 mm. Artist: Sandra Burrows.

FIGURE 3.—Distribution of *Asplenium cordatum* in the FSA region.

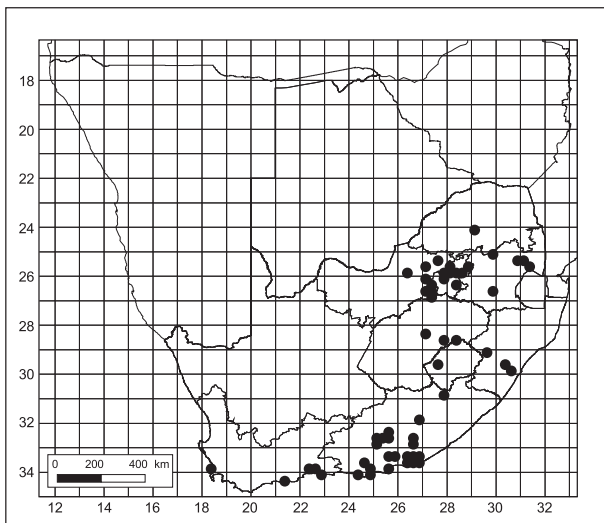
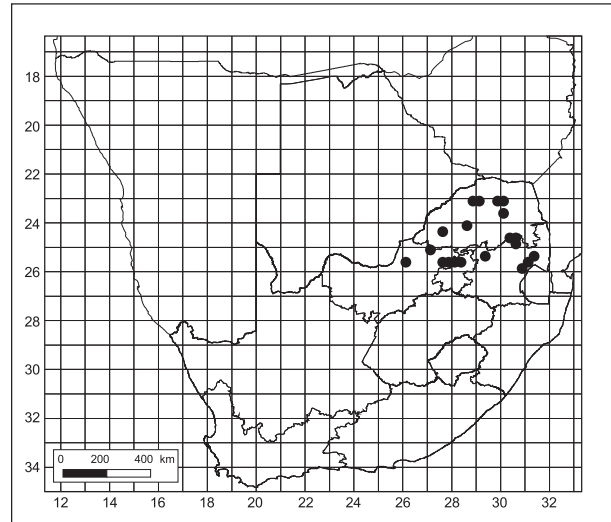
Etymology: *capense* = pertaining to the Cape.

Distribution and ecology: *Asplenium capense* occurs from the Cape Peninsula through the Western and Eastern Cape, KwaZulu-Natal, the Free State and northern provinces of South Africa (Figure 4), extending sporadically to central and tropical East Africa.

This species typically grows in sandy soil on forest floors, as well as under coastal dune scrub, often fairly close to streams and under trees on steep damp earth banks. It is usually associated with riparian or open forest, most often in lightly rather than deeply shaded conditions.

Vouchers: Th.C.E. Fries, T. Norlich & H. Weimark 30-8 (BOL, K); D.B. Müller 890 (NMB; PRE); R. Schlechter 2703 (GRA, K); E.M. van Zinderen Bakker 1135 (BLFU, PRE); C.J. Ward 12400 (NH, NU, PRE).

3. *Asplenium phillipsianum* (Kümmerle) Bir, Fraser-Jenk. & Lovis in Fern Gazette 13,1: 62 (1985).

FIGURE 4.—Distribution of *Asplenium capense* in the FSA region.FIGURE 5.—Distribution of *Asplenium phillipsianum* in the FSA region.

Ceterach phillipsianum Kümmerle: 287 (1909). Type: Somalia, 'Ferns from deep shade Wagga Mountain, anno 1897', Phillips s.n. (BM, holo.; K, iso.!).

Rhizome to 4 mm diam., erect or procumbent; scales sessile, clathrate, lanceolate, 3–4 × 0.6–1.0 mm, acuminate, frequently with a hair point, irregularly serrate, sometimes bicolorous, with dark chestnut-brown central region, sometimes with darker apex, with paler margins throughout, with narrowly oblong to ovate cells. **Fron**ds tufted, suberect to spreading; **stipe** 5–20(–30) mm long, dark chestnut-brown, densely scaled, scales sessile, lanceolate, 3–4 × 0.7–1.0 mm, acuminate, irregularly serrate, glossy, bicolorous, distally dark brown and proximally chestnut-brown with paler margins throughout, with narrowly oblong to ovate cells; **lamina** herbaceous, involute and inrolled when dry, elliptic to obovate in outline, pinnatisect to very shallowly 2-pinnatifid, (5–)70–100(–130) × (16–)24–33(–50) mm, lower pinnae gradually decrescent, occasionally produces 1–3 gemmae situated adaxially in the sinus of the distal pinnules; **rachis** almost winged throughout, scales as for stipe but 2.5–3.0 × 0.6–1.0 mm, concolorous reddish brown, sometimes chestnut-brown towards apex; **pinnae** (6–)10–20(–25) × (3–)4–6(–9) mm, adnate to rachis with decurrent base throughout, narrowly ovate-oblong, obtuse, margin entire to weakly sinuate, glabrous above at maturity, abaxially sparsely scaled, scales sessile, lanceolate, 1.7–2.4 × 0.6–0.8 mm, attenuate, finely serrate, glossy, brown, with oblong cells; **sori** linear along (obscure) veins, 2–3 mm long, becoming confluent at maturity, exindusiate, not totally obscured by scales. Figure 2I–M.

Etymology: *phillipsianum* = commemorates the English explorer Ethelbert Lort-Phillips (1857–1944) who in 1897 collected the type specimen in Somalia.

Distribution and ecology: *Asplenium phillipsianum* occurs from the northern provinces of South Africa (Limpopo, North West, Gauteng, and Mpumalanga) (Figure 5), through central and tropical Africa as far north as Socotra; also known from Réunion and Madagascar.

This species is typically found close to streams, shaded under trees on steep damp earth banks.

Of the three regional ceterachoid species, *A. phillipsianum* is the only member noted to be gemmiferous (J. Nel, pers. comm.) (Figure 2M).

Vouchers: J.E. Burrows & S.M. Burrows s.n. (BNRH); M.F. Glen PRE62127 (PRE); E. Retief & S.E. Strauss 2154 (PRE); J.P. Roux 3195 (NBG); A. Winterboer s.n. (PRU).

Excluded name

Ceterach cordatum var. *pinnatifida* Sim: 177 (1915). The syntypes cited by Sim (1915) include representatives of both *A. capense* and *A. phillipsianum*.

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Dr Hugh Glen, KwaZulu-Natal Herbarium, SANBI, Durban, is thanked for translating Latin texts and for providing nomenclatural advice; Prof. John McNeill, Royal Botanic Gardens, Edinburgh, for providing nomenclatural advice; Ms Hester Steyn, National Herbarium, SANBI, Pretoria, for producing updated distribution maps. The Curators of BLFU, BNRH, BOL, GRA, K, LYD, NBG, NH, NMB, NU, PRE, PRU, PUC and SAM kindly facilitated access to their collections.

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A revision of Tecophilaeaceae subfam. Tecophilaeoideae in Africa

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Keywords: Africa, *Cyanella* Royen ex L., *Eremiolirion* J.C.Manning & F.Forest, new species, systematics, Tecophilaeaceae, *Walleria* J.Kirk

ABSTRACT

Family Tecophilaeaceae subfam. Tecophilaeoideae is revised for the *Flora of southern Africa* region, with the inclusion of the tropical *Walleria mackenzii* J.Kirk for completeness. The genera *Cyanella* Royen ex L. (9 spp.), *Eremiolirion* J.C.Manning & F.Forest (1 sp.) and *Walleria* J.Kirk (3 spp.) are treated, with keys to the genera, species and subspecies; and full descriptions and distribution maps. A formal infrageneric classification is proposed for *Cyanella*, in which sect. *Trigella* (Salisb.) Pax & K.Hoffm. is revived for the species with a 3 + 3 arrangement of stamens. The new species, *C. marlothii* J.C.Manning & Goldblatt, is described from the Richtersveld; and *C. pentheri* Zahlbr. is resuscitated from the synonymy of *C. hyacinthoides* Royen ex L. Pink-flowered plants of normally yellow-flowered *C. lutea* have a separate geographical distribution and are recognized as subsp. **rosea** (Eckl. ex Baker) J.C.Manning & Goldblatt.

INTRODUCTION

Tecophilaeaceae is a small family of seven or eight genera and $\pm$ 25 species from California, Chile, and southern and tropical mainland Africa (Simpson & Rudall 1998). The reported occurrence of the family in Madagascar (Simpson & Rudall 1998) is based on *Walleria paniculata* Fritsch, a synonym of *Dianella ensifolia* (L.) DC. (Hemerocallidaceae). The family is best represented in Africa, where almost two thirds of the species are found. *Cynastrum* Oliv. (3 spp.) and *Kabuyea* Brummitt (1 sp.) are strictly tropical, but *Walleria* J.Kirk (3 spp.), *Eremiolirion* J.C.Manning & F.Forest (1 sp.), and *Cyanella* Royen ex L. (9 spp.), are primarily distributed in subtropical and temperate southern Africa. Members of the family are perennial herbs with a cormous, usually tunicated rootstock, basal (rarely cauline) leaves, and long-lasting flowers, typically in racemose or paniculate, cymose inflorescences; but sometimes solitary and axillary. The flowers are actinomorphic or zygomorphic, with 3 + 3 petaloid tepals fused into a short tube adnate to the ovary, and six stamens, all fertile or some reduced to staminodes, with $\pm$ porose dehiscence. The ovary is inferior or semi-inferior and 3-carpellate, and matures into a loculicidal capsule (Simpson & Rudall 1998; Heywood *et al.* 2007).

The two tropical African genera, *Cynastrum* and *Kabuyea*, have been the subject of a detailed review (Brummitt *et al.* 1998), in which they were segregated as subfam. Cynastroideae, with the remaining genera of the family retained in subfam. Tecophilaeoideae. The taxonomy of the southern African species is relatively well understood, and both *Cyanella* and *Walleria* were revised fairly recently (Carter 1962; Scott 1991; Cowley & Brummitt 2001), including historical and morphological details. Since then, however, the genus *Eremiolirion* has been established to accommodate *Cyanella amboensis* Schinz, which was excluded from *Cyanella*

by Scott (1991), but unplaced. We have also published additional observations on the distribution and morphology of *Walleria gracilis* (Salisb.) S.Carter (Manning *et al.* 2001). It is now clear that there is more variation in some species of *Cyanella* than was recognized by Scott (1991), and three subspecies have since been described in *C. alba* L.f. (Manning *et al.* 2005). Field study and examination of herbarium material of *C. hyacinthoides* Royen ex L. suggest that this species is currently too broadly circumscribed, and that *C. pentheri* Zahlbr. should be resuscitated from synonymy. In addition, the clear geographical segregation between the typical yellow-flowered and the pink-flowered forms of *C. lutea* L.f. is appropriately reflected by the recognition of distinct subspecies for them. A collection from the Richtersveld, until now identified as *C. orchidiformis* Jacq., differs from that species and from all others in the genus in having all six filaments connate into a staminal tube. It evidently represents an unnamed species that we describe here.

Currently, therefore, there is no comprehensive treatment for the family in southern Africa and the available treatment of *Cyanella* is inadequate and incomplete in some respects. We provide here a complete review of the genera and species occurring in the *Flora of southern Africa* region, including also the tropical African *Walleria mackenzii* J.Kirk for completeness. We also propose a new infrageneric classification for *Cyanella* that associates morphologically similar species in two sections, with the larger of the two, sect. *Cyanella*, subdivided into two series.

MATERIALS AND METHODS

Type specimens or digital images of types from the relevant herbaria were examined for all names, as well as all available herbarium specimens in BOL, NBG, PRE, and SAM (herbarium acronyms after Holmgren *et al.* 1990). Particular use was made of high-resolution digital images on the Aluka website (www.aluka.org), and of the Herbarium of the Linnean Society of London (www.linnean-online.org).

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TAXONOMY

Key to genera

- 1a Corm not tunicated; leaves cauline; flowers solitary in leaf axils; seeds verrucose or papillate, with tufts of trichomes, brown *Walleria*
- 1b Corm with fibrous tunics; leaves basal; flowers in racemose or paniculate cymes; seeds rugose, glabrous, black:
- 2a Foliage leaves 2; inflorescence a divaricate panicle; pedicels without a bracteole; flowers actinomorphic; stamens monomorphic, central, and symmetrical *Eremiolirion*
- 2b Foliage leaves 3–12; inflorescence a raceme, usually branched, rarely condensed and flowers apparently solitary; pedicels bracteolate; flowers zygomorphic; stamens dimorphic, in two groups of 3 + 3 or 5 + 1 *Cyanella*

Walleria J.Kirk in Transactions of the Linnean Society 24: 497 (1864). Type species: *Walleria nutans* J.Kirk [lecto., designated by E.P.Phillips: 207 (1951)].

Androsyne Salisb: 61 (1866). Type species: *A. gracilis* Salisb. = *Walleria gracilis* (Salisb.) S.Carter.

Deciduous geophytes with deep-seated, non-tunicated corm; subterranean portion of stem developing paired adventitious roots at each node, aerial portion of stem erect or straggling, smooth, scabrid or armed with recurved prickles. *Cataphylls* numerous, scattered along subterranean portion of stem, small, tubular, membranous. *Foliage leaves* numerous, all cauline, alternate, sessile or amplexicaul, linear to ovate, acute or cirrhose and tendrilliferous, midrib sometimes armed with recurved prickles beneath. *Inflorescence* of solitary, axillary flowers, or rarely bracteole subtending a second flower; pedicels erect or cernuous, smooth or prickly, with solitary bracteole inserted $\pm$ midway. *Flowers* actinomorphic, erect or nodding, rotate, white to blue; tepals connate below into short tube, $\pm$ similar. *Stamens* 6, monomorphic, erect-symmetrical, inserted at mouth of tube; filaments short; anthers basifixed, erect, free, or connivent around style, narrowly lanceolate, dehiscent by apical pores, outer surface scabridulous in basal $\pm$ 1/2. *Ovary* $\pm$ superior, with several ovules per locule; style terete, erect, filiform. *Capsules* ovoid to subglobose. *Seeds* ovoid, brown, surface warty or produced into finger-like papillae, each with apical tuft of minute trichomes. *Basic chromosome number*: $x = 12$ (Goldblatt & Manning 1989).

3 spp., southern and southern tropical Africa.

Etymology: the genus is named for Horace Waller, who made the first collections of both tropical African species during an expedition to central Africa in 1863.

Ethnobotany: the corms comprise part of the traditional diet of the San, Tswana, and other indigenous tribes (e.g. Leffers 2008; also Luard 289, Maguire 2194, Snyman & Noailles 231, Story 6117).

Key to species

- 1a Flowers erect, tepals 13–22 mm long; anthers free, not connivent, blue, purple, or black with yellow base and apex, 6–12 mm long; style 8–15 mm long 1. *W. mackenzii*
- 1b Flowers nodding, tepals 6–16 mm long; anthers connate and connivent, yellow at least in basal 1/2, 4–8 mm long; style 4.0–8.5 mm long:

- 2a Plants erect or sprawling, free-standing, mostly unbranched; stems and pedicels smooth, scabrid or with hooked prickles; leaves not cirrhose; tepals plain white, pink, mauve, or blue 2. *W. nutans*
- 2b Plants usually straggling or climbing, well branched; stems and pedicels always armed with hooked prickles; upper leaves cirrhose, with tendril-like apex; tepals white with basal purple blotch 3. *W. gracilis*

1. ***Walleria mackenzii*** J.Kirk in Transactions of the Linnean Society 24: 497, t. 52/2 (1864). Type: Nyasaland [Malawi], Manganja Hills, near Bishop Mackenzies Mission, 1863, *H. Waller sub J. Kirk s.n.* K256015 (K, holo.). Illustration: Cowley & Brummitt (2001).

W. angolensis Baker: 262 (1878). Type: Angola, Huilla, 18 Dec. 1859, *Welwitsch* 1749 (BM, holo.; K, iso.).

Deciduous geophyte, 180–900 mm high. *Corm* subglobose or depressed-globose, 20–40 mm diam. *Stem* erect, mostly simple or with 1 or 2 branches, smooth or rarely scabrid or minutely prickly. *Leaves* ovate to narrowly lanceolate, 30–110 $\times$ (4–)5–20(–28) mm, upper narrower, base cuneate or weakly cordate but not amplexicaul, apex acute or rarely cirrhose, midrib smooth, sometimes scabrid or minutely prickly. *Flowers* solitary in axils in central portion of stem, erect, sometimes with additional flower developed in axil of bracteole; pedicels ascending and $\pm$ erect at flowering, straight or flexible, becoming deflexed or pendulous in fruit, 13–60 mm long, smooth or scabrid, with lanceolate bracteole 10–26 mm long inserted $\pm$ halfway, rarely lacking; tepals white, pink, or mauve to pale or bright blue, spreading, elliptic-lanceolate, 13–22 $\times$ 2.5–6.5 mm, inner slightly narrower than outer. *Stamens* erect, free and not connivent; filaments 1–3 mm long, awl-shaped; anthers 6–12 mm long, blue to purple or black with yellow base and apex, pores circular, apical. *Ovary* subglobose-pyramidal, 3-lobed above, $\pm$ 3 mm long; style 8–15 mm long. *Capsule* subglobose or ovoid, 10–20 mm long, maturing to dark yellow. *Seeds* ovoid, $\pm$ 5 mm long, dark mahogany-brown, papillate, papillae becoming longer and more finger-like in distal half, each with apical tuft of minute trichomes. *Flowering time*: mainly Nov.–Jan.(–Mar.), shortly after the onset of the rains.

Distribution and ecology: distributed across southern tropical Africa, from the higher-lying parts of central Angola, Zambia, and southern Democratic Republic of Congo, through Malawi into southern and western Tanzania [see Carter (1962) for map]. The species is largely restricted to higher rainfall areas, where it occurs in open woodland and savanna, often in rocky outcrops.

Diagnosis and relationships: distinguished from other species of *Walleria* by its generally more robust habit, erect, mostly larger flowers with tepals 13–22 mm long, and free anthers not cohering at the tips, predominantly blue to purple or black with only the base and tips yellow, and dehiscent through terminal, circular pores. *Walleria mackenzii* is likely to be confused only with *W. nutans*, which has nodding flowers with tepals 6–16 mm long and connivent anthers, connate at the tips, and dehiscent through short, subapical, introrse slits.

2. *Walleria nutans* J.Kirk in Transactions of the Linnean Society 24: 497, t. 52/1 (1864). *W. mackenzii* var. *nutans* (J.Kirk) Baker: 498 (1879). Type: Nyasaland [Malawi], Manganja Hills, near Bishop Mackenzies Mission, 1863, *H. Waller* sub *J. Kirk* s.n. K256018 (K, holo.). Illustration: Dyer: 1321 (1960).

W. muricata N.E.Br.: 145 (1909). Type: Bechuanaland [Botswana], near Palapye, Jan. 1898, *Lugard* 289 (K, holo.).

W. baumii Dammer: 361 (1912). Types: Angola, Kunene-Kubangoland, Kalolo, 22 Nov. 1899, *Baum* 448 (BM, syn.); Angola, Habungo, 28 Nov. 1899, *Baum* 448 (BM, syn.).

W. hockii De Wild.: 8 (1915). Type: Northern Rhodesia [Zambia], Kafue Valley, 1911, *A. Hock* s.n. BR8642639 (BR, holo.).

Deciduous geophyte (70–)100–300 mm high. *Corm* subglobose or depressed-globose, 20–30 mm diam. *Stem* erect or sprawling but never climbing, mostly simple or with 1 or 2 branches, rarely more, smooth or variously prickly with delicate, recurved prickles 0.5–1.5 mm long. *Leaves* linear to narrowly lanceolate, (30–)70–150 × (2–)5–7(–12) mm, upper narrower and attenuate, base cuneate or weakly cordate but not amplexicaul, midrib smooth or with recurved prickles beneath. *Flowers* solitary in axils in central portion of stem, nodding, sometimes with additional flower developed in axil of bracteole; pedicels suberect but sharply decurved distally, 20–50(–80) mm long, smooth or scabrid, with lanceolate bracteole 10–15 mm long inserted in upper third or quarter; tepals white, pink, or mauve to pale blue, recurved or reflexed, lanceolate, (6–)10–16 × 2–5 mm. *Stamens* connivent, connate at tips; filaments 0.5–1.0 mm long; anthers (4–)6–8 mm long, mostly yellow with narrow purple band across distal third and with grey tips, slits short, subapical, introrse. *Ovary* subglobose-pyramidal, 3-lobed above, ± 3 mm long; style 5.0–8.5 mm long. *Capsule* ovoid, shortly apiculate and 3-lobed above, 8–17 mm long, green, yellow or orange. *Seeds* ovoid, ± 5 mm long, dark mahogany-brown, papillate, papillae becoming longer and more finger-like in distal half, each with apical tuft of minute trichomes. *Chromosome number*: $2n = 12$ (Goldblatt & Manning 1989). *Flowering time*: Nov.–Jan.(–Mar.). Figure 1A, B.

Distribution and ecology: widely distributed through subtropical Africa, from the higher-lying parts of central and northern Namibia and southern Angola through Zambia into eastern Botswana and the northern part of South Africa, where it has been recorded from the Soutpansberg into central Limpopo, adjacent Mpumalanga and North West Province, and southwest as far as Taung in Northern Cape (Figure 2). Plants occur in open savanna, mostly in sandy soils but also on limestone flats and dolomite rock sheets.

Diagnosis and relationships: closely resembling the southwestern Cape *W. gracilis*, with which it shares nodding flowers with apically connivent anthers dehiscing through introrse, subapical pores and sometimes prickly stems, pedicels, and abaxial leaf midribs. *Walleria nutans* is distinguished by its free-standing, mostly

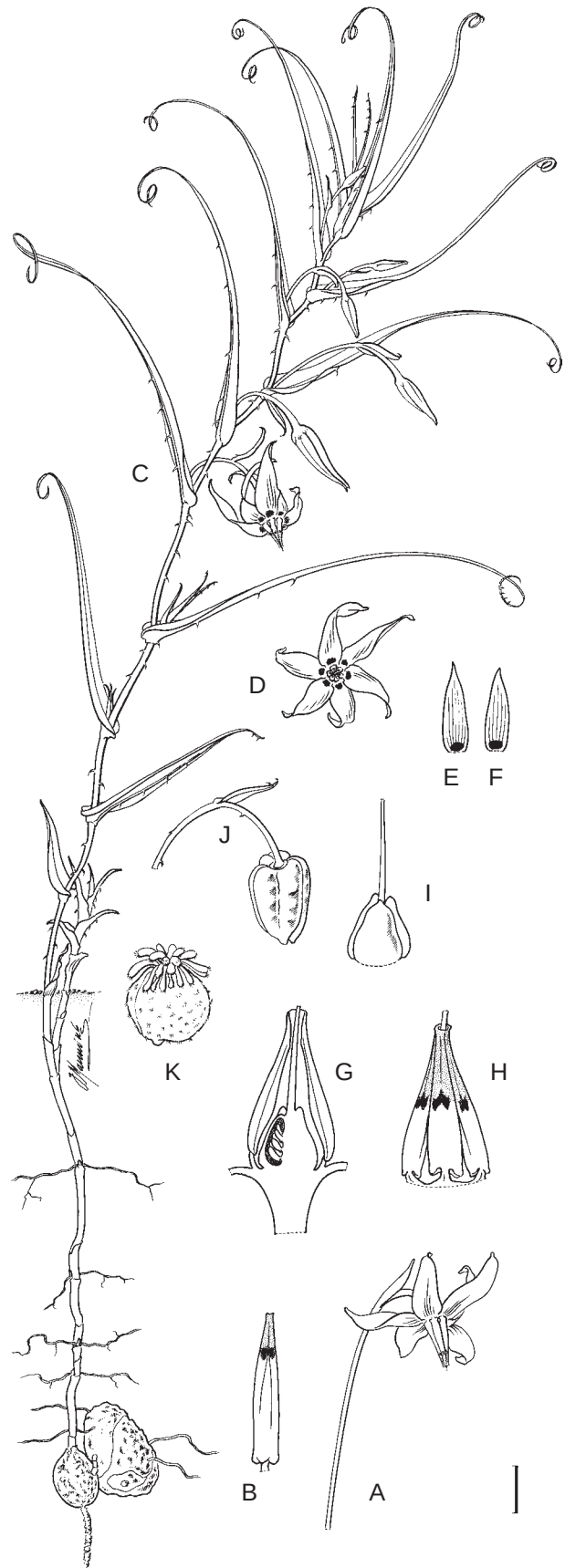


FIGURE 1.—A, B, *Walleria nutans*: A, flower; B, detached anther. C–K, *W. gracilis*: C, flowering plant; D, flower; E, outer tepal; F, inner tepal; G, half-flower; H, androecium with style; I, gynoecium; J, capsule; K, seed. Scale bar: A, C–F, J, 10 mm; B, G–I, 2 mm. Artist: John Manning.

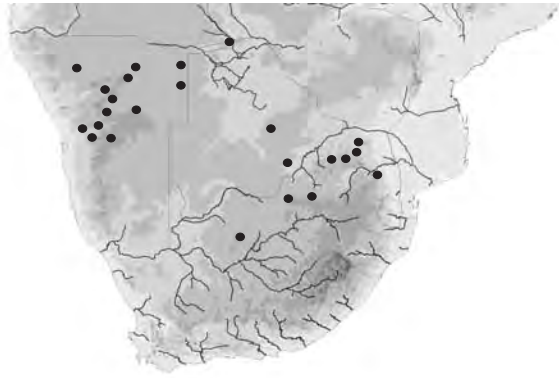


FIGURE 2.—Distribution of *Walleria nutans*.

unbranched stems, leaves without tendril-like tips, and unmarked, white, pink, or mauve to pale blue tepals. The stems, pedicels and underside of the leaf midribs may be smooth or variously armed with recurved prickles, but these are delicate, almost bristle-like, and mostly < 1 mm long, and the anthers are mostly yellow, with the purple and grey banding restricted to the apical third. The presentation of the flowers is subtly different in the two species: pedicels in *W. nutans* are essentially suberect up to the level of insertion of the bracteole in the upper third or quarter, at which point the pedicels are sharply decurved, whereas the bracteoles in *W. gracilis* are mostly inserted $\pm$ midway along the pedicels, which are therefore more arcuate.

Vernacular name: bush potato.

Representative specimens

NAMIBIA.—1723 (Singalamwe): Singalamwe, (–CB), 23 Nov. 1973, Pienaar & Vahrmeijer 209 (PRE). 1820 (Tarikora): Gautscha Pan, E of Karakuwise, (–DD), 27 Dec. 1952, Maguire 2194 (NBG); Cigarette, NE of Karakuwise, (–DD), 19 Jan. 1953 (fruiting), Maguire 2275 (NBG). 1914 (Kamanjab): Ombutu, (–BC), 25 Feb. 1969, Grobelaar 85 (PRE). 1917 (Tsumeb): Tsumeb, (–BA), Dec. 1935, Boss 35483 (PRE). 1920 (Tsumkwé): 157 miles [250 km] E of Grootfontein, Simkue, (–DA), 14 Jan. 1958, Story 6117 (PRE). 2016 (Otjiwarongo): Farm Uitsig, 60 km E–NE of Otjiwarongo, (–BC), 5 Mar. 1984 (ex hort.), Lavranos 21034 (NBG). 2017 (Waterberg): Waterberg, Farm Okamura, (–CA), 5 Mar. 1974, Merxmüller & Giess 30063 (PRE). 2118 (Steinhausen): 15 km along Kapps Farm road from Steinhausen to Windhoek, (–CC), 15 Mar. 1988 (fruiting), Goldblatt & Manning 8802 (MO, PRE). 2215 (Trekopje): Aukas, (–AA), 28 Nov. 1980, Dinter 654 (SAM); Farm Neuschwaben, Undasbank, (–DB), 8 Mar. 1953 (fruiting), Kinges 3061 (PRE). 2217 (Windhoek): Windhoek, Farm Lichtenstein, (–CD), 20 Jan. 1923, Dinter 4310 (SAM).

BOTSWANA.—2225 (Mokatini): N of Lephephe, 100 km W of Serowe, (–BC), Feb. 1982 (fruiting), Snyman & Noailles 231 (PRE). 2426 (Mochudi): Mochudi, (–AC), without date, Rogers 6739 (BOL).

LIMPOPO.—2229 (Waterpoort): Soutpansberg, Wylies Poort, Ingwe Farm, (–DD), 18 Dec. 1960, Hardy 407 (PRE). 2329 (Pietersburg) [Polokwane]: Buffelsberg near Munnik, (–DB), Dec. 1932, Schweickerdt 1036 (PRE); Broederstroom, (–DD), 19 Nov. 1949, Prosser 1361 (NBG). 2428 (Nylstroom): Vaalwater Poort on Nylstroom road, (–AC), 16 Dec. 1960, Hardy & Bayliss 421 (PRE).

NORTH WEST.—2526 (Zeerust): Lichtenburg, Grasfontein, (–CC), Dec. 1929, Sutton 338 (PRE). 2527 (Rustenburg): Broederstroom, (–DD), 19 Nov. 1949, Prosser 1361 (PRE).

MPUMALANGA.—2430 (Pilgrim's Rest): Nooitgedacht mtn, near Branddraai, (–DA), 24 Nov. 1933, Young A688 (BOL, PRE).

NORTHERN CAPE.—2724 (Taung): Barkly West, Madipelessa, (–CA), 26 Feb. 1937, Acocks 1822 (PRE).

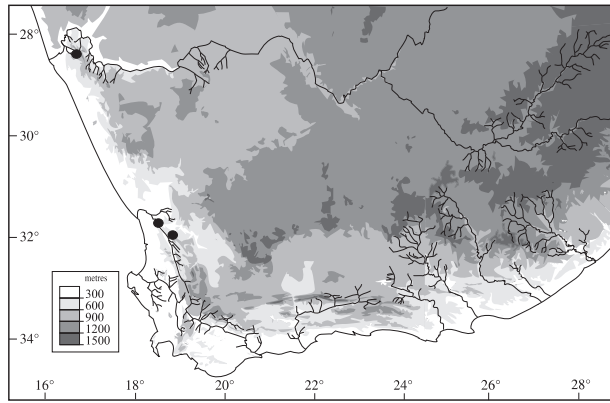
3. *Walleria gracilis* (Salisb.) S.Carter in Kew Bulletin 16: 189 (1962). *Androsyne gracilis* Salisb.: 61 (1866). Type: stated as from Nicobar Islands but probably from South Africa, Western Cape, comm. William Marsden [BM, holo!; drawing in Salisbury mss. 8: 818 (BM)]. Illustration: Manning *et al.*: 44–47 (2001).

W. armata Schltr. & K.Krause in Krause: 235 (1921). Type: South Africa, [Western Cape, near Klawer], [Farm] Windhoek, 8 July 1896, R. Schlechter 8074 (B, holo. [not seen]; BM!, BR!, COI!, GRA!, K, MO!, PRE!, S!, iso.). [The collection was published as Schlechter 2074 in the protologue, evidently a misprint].

Deciduous geophyte, 100–700 mm high. *Corm* subglobose or depressed-globose, 20–30 mm diam. *Stem* straggling or climbing, well branched, with recurved prickles 1.0–1.5 mm long in upper parts. *Leaves* lanceolate to narrowly lanceolate, (30–)70–120 $\times$ 5–10 mm, upper narrower and attenuate-cirrhose, apex coiling and tendril-like, amplexicaul, midrib with recurved prickles beneath. *Flowers* solitary in axils in central portion of stem, nodding, rose-scented; pedicels arcuate, 20–40 mm long, sparsely prickly, with lanceolate bracteole 6–10 mm long inserted $\pm$ midway; tepals white with purple blotch at base, recurved or reflexed, lanceolate, 10–16 $\times$ 2.5–3.5 mm. *Stamens* connivent, connate at tips; filaments 0.5–1.0 mm long; anthers 5–6 mm long, yellow in lower 1/2 and purple above with grey tips, slits short, subapical, introrse. *Ovary* subglobose-pyramidal, 3-lobed above, $\pm$ 2 mm long; style $\pm$ 4 mm long. *Capsule* ovoid, $\pm$ 15 mm long, shortly apiculate and 3-lobed above. *Seeds* ovoid, $\pm$ 5 mm long, dark mahogany-brown, with conspicuous apical cluster of finger-like papillae, each topped with tuft of minute trichomes, rest of seed $\pm$ smooth but covered with trichome-tufts. *Flowering time*: June and July. Figure 1C–K.

Distribution and ecology: the species has a limited, curiously scattered distribution along the west coast of South Africa. It is best known from the lower reaches of the Olifants River in Western Cape, where it has been recorded along the foot of the Gifberg east of Klawer and on Pakhuis Pass, some 50 km to the south (Figure 3). At these localities, the species occurs in deep sand among outcrops of Cape sandstone in arid fynbos vegetation. There is evidently a large disjunction in the distribution, based on a single enigmatic collection made by Rudolph Marloth in 1925 from near Kuboes in the Richtersveld. This locality, 60 km upstream from the mouth of the Orange River, is 350 km north of Klawer, and to date *W. gracilis* has not been re-collected there; nor from the intervening country. Although the identity of the Kuboes collection is not in doubt, it is unfortunately a plant that was cultivated to flowering in Cape Town five years later; and although the label is explicit in identifying the location at which the tuber was originally collected, the possibility that the locality has been confused must be considered until the species is rediscovered in the Richtersveld.

Plants may reach up to 600 mm in height when supported by small shrubs, but are much shorter in the open. The nodding, *Solanum*-like flowers are evidently adapted to buzz pollination, probably by solitary bees in the family Apidae: Anthophorinae (Manning *et al.* 2001).

FIGURE 3.—Distribution of *Walleria gracilis*.

Diagnosis and relationships: the species closely resembles *W. nutans* from subtropical Africa and was treated as conspecific with it by Phillips (1951), but the two are quite distinct. *Walleria gracilis* is recognized by its straggling or climbing habit, well-branched stem, more robust prickles ± 1.0 – 1.5 mm long, upper leaves drawn into coiled, tendril-like tips, distinctive white flowers marked with a large purple blotch at the base of each tepal, and anthers that are yellow only in the lower half. The seeds of *W. gracilis* are also distinctive in being essentially smooth in the basal half (apart from the trichome-tufts) with a dense apical cluster of finger-like papillae. Flowering in *W. gracilis* takes place during the winter, whereas *W. nutans* blooms in summer.

Additional specimens seen

NORTHERN CAPE.—2817 (Vioolsdrif): Kubus [Kuboes] main kloof, 29 Aug. 1925 [fl. in cult. June 1930], Marloth 12358 (PRE).

WESTERN CAPE.—3118 (Vanrhynsdorp): Klawer, Farm Windhoek, NW foothills of Gifberg, (–DA), mid-July 1998, Manning 2180 (NBG), 25 June 2005, Manning 2951B (NBG), Forest & Manning 542 (NBG). 3219 (Wuppertal): Clanwilliam, Cedarberg [Pakhuisberge], Farm Alpha, (–AA), 20 July 1941, Bond 1053 (BOL, NBG).

Eremiolirion J.C.Manning & F.Forest in Bothalia 35: 117 (2005). Type species: *Eremiolirion amboense* (Schinz) J.C.Manning & C.A.Mannheimer.

Deciduous geophyte with deep-seated, tunicated corm, tunics decaying into firm-leathery, coarsely netted fibres extending into neck. *Cataphyll* 1, extending to ground level and enclosing leaf sheaths. *Foliage leaves* 2, basal, narrowly lanceolate-canaliculate, leathery. *Inflorescence* a divaricately branching, paniculate cyme with bracts subtending branches and pedicels only; pedicels ebracteolate, cernuous at tip, elongating slightly in fruit and straightening. *Flowers* actinomorphic, nodding, campanulate, white flushed pink or maroon abaxially; tepals connate below into short tube with minute, fringed corona present at mouth of tube, dimorphic, outer oblong, inner pandurate. *Stamens* 6, monomorphic, erect-symmetrical, inserted near mouth of tube; filaments short; anthers basifixed, erect and connivent around style, narrowly lanceolate, dehiscing by oblong apical pores. *Ovary* half inferior, with several ovules per locule; style terete, erect, filiform. *Capsules* ovoid to globose. *Seeds* ellipsoid-pyriform, blackish brown, testa surface rugose.

1 sp., central and northwest Namibia, southwest Angola.

Etymology: the name is a compound of the Greek *eremios* (desert or wilderness) and *lirion* (lily).

Ethnology: the corms are part of the traditional diet of the local tribes (Giess, Volk & Bleissner 6039).

Eremiolirion amboense (Schinz) J.C.Manning & C.A.Mannheimer in Bothalia 35: 117 (2005). *Cyanella amboensis* Schinz: 943 (1902). Type: South West Africa [Namibia], Amboland [Ovamboland], Ondonga, [Ondongwa], without date, Rautanen 344 (Z, holo.).

Plants (60–)100–250 mm high. *Corms* deep-seated, 30 mm diam; tunics decaying into firm-leathery, coarsely netted fibres extending into neck 10–60 mm long, pale whitish brown. *Leaves* 2, basal, suberect, narrowly lanceolate, (10–)15–25 $\times$ (8–)10–20 mm, attenuate, canaliculate with prominent midrib abaxially, leathery. *Inflorescence* a divaricately branching, paniculate cyme with (1–)3–7-branches, up to 30-flowered; pedicels cernuous at tip, 15–25 mm long, elongating slightly in fruit and straightening, ultimately 20–40 mm long. *Flowers* nodding, campanulate, white flushed pink or maroon abaxially at base of outer tepals, fragrant; perianth tube ± 4 mm long, with fringed corona 0.5–1.0 mm high at mouth of tube forming collar extending over ovary to surround base of style; outer tepals spreading from base, oblong, 15–20 $\times$ 5–7 mm, obtuse, margins revolute, inner tepals at first suberect but spreading in upper 1/2, pandurate and short-clawed, claw ± 2 mm long, blade ovate, 13–18 $\times$ 7–10 mm, apex slightly cucullate, margins crisped. *Stamens* monomorphic; filaments terete, ± 0.25 mm; anthers narrowly lanceolate, 9–10 mm long, yellow, dehiscing by oblong apical pores 1.5 mm long. *Ovary* half-inferior; ovules ± 6 per locule; style 10–12 mm long, extending shortly beyond anthers, white. *Capsules* ovoid to globose, 10–12 $\times$ 8–12 mm. *Seeds* ellipsoid-pyriform, 4.0–4.5 $\times$ 3.0–3.5 mm, blackish brown; testa surface rugose. *Flowering time:* (mid-Jan.–)Feb.–Mar.(–early Apr.). Figure 4.

Distribution and ecology: locally common through the higher-lying parts of west-central and northwestern Namibia, occurring along the better watered, western edge of the escarpment from west of Mariental in the south to Kaokoland in the north (Figure 5) and in southwestern Angola near Lake Arco. The species typically occurs in colonies, often numbering many individuals, in sandy loam or heavy clay soils, especially in stony or gravelly situations. Flowering is dependent on rainfall.

The flowers close at night $\pm 21:00$, re-opening in the morning $\pm 09:00$. They are fragrant during the day, with a jasmine-like fragrance at first but later smelling of stale urine, and are visited by bees and the occasional moth (Ward, Ward & Ward 10518).

Vernacular name: desert snowdrop.

Representative specimens

ANGOLA.—Namibe Prov., Lake Arco, Jan. 2009 (fl. ex cult. Mar. 2012), Harrower 4061 (NBG).



FIGURE 4.—*Eremiolirion amboense*: A, flowering plant; B, flower; C, inner tepal; D, outer tepal; E, half-flower; F, androecium with style; G, capsule; H, seed. Scale bar: A–D, G, 10 mm; E, F & H, 2 mm. Artist: John Manning.

NAMIBIA.—1713 (Swartbooisdrif): West of Ombazu, (–DD), 9 Apr. 1973, *Giess & Van der Walt* 12658 (WIND). 1913 (Sesfontein): Kunene, Barab River, (–DB), 23 Mar. 2001, *Burke* 1020 (WIND).

1914 (Kamanjab): Etendeka Mountain Camp, (–DD), 28 Feb. 2004, *Mannheimer* 2510 (NBG, WIND). 1915 (Okaukuejo): Etosha, Adamax, (–BB), 16 Jan. 1974, *Le Roux* 597 (PRE, WIND). 2014

(Khorixas): S side of watershed Ugab/Huab Rivers W of Brandberg, (–CA), 10 Apr. 1989, Ward, Ward & Ward 10518 (PRE, WIND). 2114 (Uis): Omaruru, (–BA), 20 Mar. 1967, Giess 9708 (PRE, WIND). 2315 (Rostock): Swakopmund, W of Kuiseb Canyon, (–BD), 10 Feb. 1966, Giess 9131 (PRE, WIND); Farm Greylingshof SW 107, (–BD), 16 Feb. 1963, Giess, Volk & Bleissner 5158 (PRE, WIND).

Cyanella Royen ex L., Genera plantarum, edn. 5: 149 (1754). Type species: *Cyanella hyacinthoides* Royen ex L.

Pharettella Salisb.: 47 (1866). *Cyanella* sect. *Pharettella* (Salisb.) Pax & K.Hoffm.: 427 (1930). Type species: *P. alba* (L.f.) Salisb. = *Cyanella alba* L.f.

Trigella Salisb.: 46 (1866). *Cyanella* sect. *Trigella* (Salisb.) Pax & K.Hoffm.: 427 (1930). Type species: *T. orchidiformis* (Jacq.) Salisb. = *Cyanella orchidiformis* Jacq.

Note: Pax & Hoffmann (1930) inadvertently transposed the species and diagnoses of their sections *Pharettella* and *Trigella*, assigning *Cyanella alba* to sect. *Trigella* and *C. orchidiformis* to sect. *Pharettella*, thus precisely opposed to Salisbury's (1866) original placement. As Pax & Hoffmann were explicitly making combinations based on Salisbury's genera, however, the types are fixed according to Salisbury's designations, which are followed here.

Deciduous geophytes with deep-seated, tunicated corm, tunics decaying into fibrous or firm-leathery, coarsely netted fibres, sometimes extending into neck. *Cataphyll* 1, extending to ground level and enclosing leaf sheaths, entirely sheathing or with short leafy blade. *Stem* simple or branched, smooth or minutely and sparsely scabridulous. *Foliage leaves* 3–12, basal, lanceolate to linear-lanceolate and canaliculate or filiform-terete, firm-textured or softer, margins plane, undulate or crispulate, smooth or scabridulous or ciliate, sur-

face mostly glabrous, rarely puberulous. *Inflorescence* a raceme, usually branched, rarely highly condensed and flowers apparently solitary, with bracts subtending branches and pedicels; pedicels suberect or spreading, with solitary bracteole inserted $\pm$ midway. *Flowers* zygomorphic (perianth only weakly so through tepal orientation) or asymmetric (enantiomorphic) through stylar flexure, spreading-rotate, white, yellow, orange, pink, or mauve to blue, sometimes distinctly veined or patterned, scented; tepals free, spreading or reflexed, $\pm$ similar or weakly dimorphic with inner broader, ovate to oblanceolate, lower concave or $\pm$ cucullate. *Stamens* 6, dimorphic, either with 3 smaller posterior stamens plus 3 larger anterior stamens, or 5 smaller posterior stamens plus 1 larger anterior stamen and then lowermost either median or flexed laterally to left or right, suberect, upper stamens arcuate, lower stamen(s) declinate; filaments stout; anthers basifixed, upper sometimes adherent, narrowly lanceolate, dehiscing by apical pores or short, introrse slits. *Ovary* half-inferior, with several ovules per locule; style terete, declinate, filiform, median or flexed opposite lower stamen in enantiomorphic species. *Capsules* ovoid to globose. *Seeds* ovoid, black, or dark brown, testa surface rugose or scalariform. *Basic chromosome number*: $x = 12$ (Ornduff 1979).

9 spp., southern Namibia and southwestern South Africa, mainly winter rainfall parts.

Etymology: the name is a compound of the Greek *kyanus* (blue) and *-ella* (diminutive), alluding to the small blue flowers of *Cyanella hyacinthoides*, the first species to be described.

Ethnobotany: the corms comprise part of the traditional diet of the Nama tribes (Archer 410).

I. Section **Trigella** (Salisb.) Pax & K.Hoffm. in Die natürlichen Pflanzenfamilien 15a: 427 (1930). *Trigella*

Key to species

1a Stamens 3 + 3; flowers pink or mauve (sect. *Trigella*):

2a Leaves linear, occasionally narrowly lanceolate, 2–8 mm wide; perianth not patterned; capsules subglobose-ovoid, 6–10 mm long; plants from southern Namibia and Richtersveld:

3a Tepals 10–12 mm long; filaments connate < halfway into short tube $\pm$ 1 mm long; anthers yellow throughout; style 10–15 mm long, $\pm$ twice as long as lower stamens 1. *C. ramosissima*

3b Tepals 13–20 mm long; filaments connate halfway or more into tube 1–2 mm long; anthers greyish or mauve distally; style $\pm$ 6 mm long, only slightly longer than lower stamens 2. *C. marlothii*

2b Leaves lanceolate, 10–30 mm wide; perianth sometimes patterned; capsules ovoid-ellipsoid to oblong, 10–25 mm long; plants from Richtersveld to Western Cape:

4a Tepals (8–)10–15(–20) mm long; posterior (upper) filaments arcuate or geniculate-sigmoid, $\pm$ evenly thick throughout, not flexuous distally; anterior (lower) anthers 5–6 mm long 3. *C. orchidiformis*

4b Tepals 8–10 mm long; posterior (upper) filaments swollen basally, geniculate-sigmoid and filiform in distal half and strongly flexuous; anterior (lower) anthers 2.5–3.0 mm long 4. *C. cygnea*

1b Stamens 5 + 1; flowers white, yellow, orange, pink, or mauve to blue (sect. *Cyanella*):

5a Pedicels suberect; filaments connate at base only; style laterally deflexed to left or right opposite lower stamen and flowers enantiomorphic:

6a Raceme not congested; pedicels 15–30 mm long 8. *C. lutea*

6b Raceme congested, flowers apparently solitary among leaves; pedicels 80–120 mm long 9. *C. alba*

5b Pedicels $\pm$ geniculate, spreading horizontally at first then sharply flexed upwards, rarely suberect or arcuate; filaments connate for half or more; style median and flowers not enantiomorphic:

7a Raceme lax, lower flowers 1.5–3.0 $\times$ their length apart; bracteoles sub-basal; perianth orange 7. *C. aquatica*

7b Raceme dense, lower flowers 0.5–0.6 $\times$ their length apart; bracteoles usually inserted in distal half of pedicel, rarely sub-basal; perianth white, pink, or mauve to blue:

8a Upper cataphyll purple-reticulate; leaves linear, mostly 1–4 mm wide, margins conspicuously ciliate in basal half with long, shaggy cilia 2–3 mm long but $\pm$ smooth distally 6. *C. pentheri*

8b Upper cataphyll usually pale, rarely purple-reticulate; leaves linear or lanceolate, mostly 4–15 mm wide, margins smooth or ciliate along entire length with short hairs up to 1 mm long 5. *C. hyacinthoides*

Salisb.: 46 (1866). Type species: *Cyanella orchidiformis* Jacq.

Flowers never enantiostylous; perianth pink to mauve, sometimes patterned. *Stamens* 3 + 3, lower anthers tapering, upper anthers $\pm$ sagittate. *Ovary*: style median.

1. *Cyanella ramosissima* (Engl. & Krause) Engl. & Krause in Krause, Botanische Jahrbücher für Systematik 57: 239 (1921). *Iphigenia ramosissima* Engl. & Krause: 124 (1910). Type: Namibia, Aus, Kubub, Oct. 1906, *P. Range* 139 (Z, holo.; SAM, iso!).

C. krauseana Dinter & G.M.Schulze: 525 (1941). Type: Namibia, Klinghardttsgebirge, 23 Sept. 1922, *M.K. Dinter* 3955 (B, holo.†; PRE!, SAM!, iso.).

Plants 80–200 mm high. *Corms* moderately or very deep-seated, 15–30 mm diam., tunics of coarsely netted, wiry fibres, extending shortly into a fibrous neck to 20 mm long, pale brown or grey. *Basal leaves* 4–6, spreading or suberect, linear to narrowly lanceolate, 50–150(–200) $\times$ 2–8 mm, acute to attenuate, plane, canaliculate or rarely involute, with prominent midrib and ribbed veins abaxially, firm-textured, glabrous, margins often $\pm$ undulate, usually ciliolate. *Inflorescence* a dense raceme up to 15(–20)-flowered, simple or 1- or 2-branched, lower flowers 0.2–0.5 $\times$ pedicel length apart; pedicels suberect but deflexed at bracteole, mostly 15–30 mm long; bracteoles mostly inserted in upper third or quarter. *Flowers* facing outwards, pale to deep pink or mauve with darker veins, fragrant; tepals spreading, outer elliptic, 13–20 $\times$ 3–4 mm, apiculate, inner oblanceolate, 13–20 $\times$ 4–7 mm, narrowed below. *Stamens* dimorphic, 3 + 3; filaments of posterior cluster sometimes almost geniculate, 2.5–3.0(–4.0) mm long, swollen basally and connate into short tube up to 1 mm long, yellow, anthers $\pm$ sagittate, outer smaller, $\pm$ 1.5 mm long, median $\pm$ 2 mm long, yellow; filaments of anterior cluster deflexed, 2.0–2.5 mm long, shortly connate for up to 1 mm, anthers 4–5 mm long, yellow. *Ovary* half-inferior, style medially deflexed, 10–15 mm long, almost twice as long as lower stamens. *Capsules* erect, subglobose-ovoid, 7–10 $\times$ 7 mm, 3-lobed. *Seeds* unknown. *Flowering time*: mainly Jul. and Aug.(–early Oct.).

Distribution and ecology: restricted to the winter rainfall part of southern Namibia, where it has been

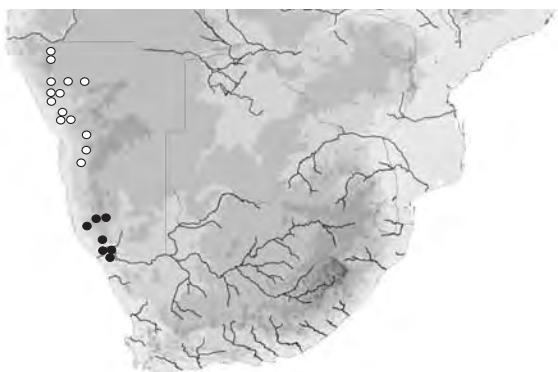


FIGURE 5.—Distribution of *Eremiolirion amboense*, ○; *Cyanella ramosissima*, ●.

recorded on the higher ground, 350–1 050 m, from Aus and the Klinghardt Mtns along the Huib Hoch Plateau, extending into the central Richtersveld in South Africa as far south as Eksteenfontein (Figure 5). The species occurs on open stony flats, alluvial ridges, rocky terraces or sometimes on sandy or calcareous flats, in arid succulent karoo shrubland or sparse desert vegetation.

Diagnosis and relationships: readily recognized by the linear leaves, 2–8 mm wide, and dense raceme of large, pink to mauve flowers with 3 + 3 arrangement of stamens with plain yellow anthers, and a consistently long style, 10–15 mm long, thus almost twice as long as the lower stamens. *Cyanella ramosissima* may be confused with vegetatively similar *C. marlothii*, which has smaller flowers with the filaments of all six stamens connate for half or more of their length into a tube 1–2 mm long, bicoloured anthers, and a short style, $\pm$ 6 mm long.

The distinctive combination of narrow leaves and a long style separates *C. ramosissima* from the forms of *C. orchidiformis* with unpatterned tepals. The two species share smaller upper lateral anthers and otherwise resemble one another very closely although they are readily distinguished in fruit, as *C. ramosissima* has much smaller, subglobose or ovoid capsule, 7–10 mm long vs. the large, oblong or ellipsoidal capsules, 12–15 mm long of *C. orchidiformis*. Although *C. orchidiformis* mostly has the style shorter than the lower anthers, occasional collections (see below) have elongated styles like those of *C. ramosissima*. In the absence of fruits, such aberrant plants can be identified by their broader, soft-textured leaves and slightly larger anthers, tinged greyish distally. The two species are essentially allopatric, overlapping in their distribution only in the Richtersveld, where *C. ramosissima* is restricted to the mountainous central region whilst *C. orchidiformis* extends around the fringes.

Representative specimens

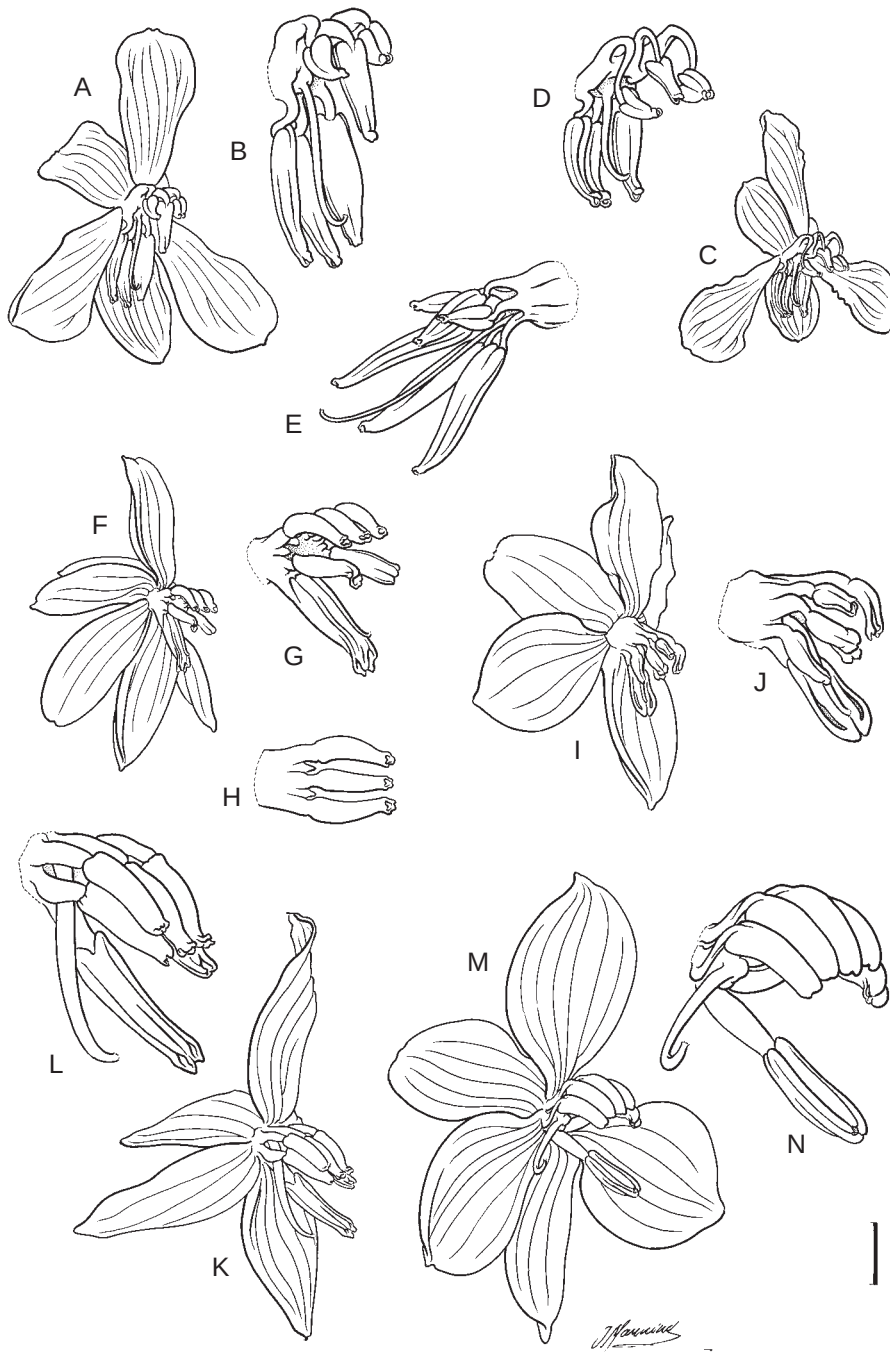
NAMIBIA.—2616 (Aus): Farm Klein Aus, (–CB), 11 Aug. 1959, Giess & Van Vuuren 756 (BOL, PRE); 200 m N of T-junction, (–CB), 21 Oct. 1983, Van Berkel 538 (NBG); Luderitz District, Farm Aub, (–CB), without date, Lavranos & Pehlemann 21700 (MO); Aus Townlands, (–CB), Sept. 1983, Lavranos & Pehlemann 21592 (MO). 2715 (Bogenfels): Klinghardtberge, (–BD), 17 Aug. 1986, Van Berkel 571 (NBG, PRE); W Höckster Mtns, 2 km NW of Höckster, (–BD), 21 July 1986, Van Berkel 558 (NBG). 2716 (Witpütz): Namuskluft, (–DD), 11 July 1988, Bruyns 3191 (NBG); Farm Spitskop, Rosh Pinah, (–DD), Aug. 1981, Lavranos 19935 (MO). 2817 (Vioolsdrif): Orange River just east of confluence with Fish River, (–AA), 1 July 1989, Oliver 9177 (NBG).

NORTHERN CAPE.—2817 (Vioolsdrif): crest of ridge near Tentotsparadys, (–AC), 9 Sept. 1996, Bayer & Puttock SAF96157 (NBG); Stinkfontein Mtns, near foot of Cornellsberg, (–CA), 22 Aug. 1994, Goldblatt & Manning 9952 (NBG); E of Eksteenfontein, (–CD), July 1989, Williamson 4264 (NBG).

2. *Cyanella marlothii* J.C.Manning & Goldblatt, sp. nov.

TYPE.—Northern Cape, 2817 (Vioolsdrif): sandy flats between Jasper's werf and Doornpoort [Doringpoort Farm at W foot of Ploegberg], (–CA), 26 Aug. 1925, R. Marloth 1211 (PRE, holo.).

Plants 200–350 mm high. *Corms* moderately deep-seated, 15–30 mm diam., tunics of coarsely netted, wiry

FIGURE 6.—*Cyanella* floral details.

A, B, *C. orchidiformis*: A, flower; B, stamens and style. C, D, *C. cygnea*: C, flower; D, stamens and style. E, *C. marlothii*, stamens and style. F–H, *C. hyacinthoides*: F, flower; G, stamens and style; H, dorsal view of upper stamens. I, J, *C. aquatica*: I, flower; J, stamens and style. K, L, *C. lutea*: K, flower; L, stamens and style. M, N, *C. alba*: M, flower; N, stamens and style. Scale bar: A, C, F, I, K, M, 10 mm; B, D, E, G, H, J, L, N, 2 mm. Artist: John Manning.

fibres, extending shortly into a fibrous neck to 20 mm long, pale brown or grey. *Basal leaves* 4–6, suberect, linear or linear-lanceolate, 50–100 × 2–6 mm, acute to attenuate, canaliculate or involute, with prominent midrib and ribbed veins abaxially, firm-textured, glabrous, margins ± undulate, sparsely scabridulous-ciliolate. *Inflorescence* a moderately dense raceme up to 20-flowered, with up to 2 branches, lower flowers 0.5–0.6 × pedicel length apart; pedicels suberect, deflexed at bracteole, mostly 20–30 mm long; bracteoles inserted in upper third. *Flowers* facing outwards, pale mauve ('blue') with darker veins, presumably fragrant; tepals spreading, outer elliptic, 10–12 × 2–3 mm, apiculate, inner oblanceolate, 10–12 × 2–3 mm, narrowed below. *Stamens* dimorphic, 3 + 3; filaments erect but deflexed apically, 2–3 mm long, connate halfway or more into cylindrical tube 1–2 mm long; posterior anthers ± sag-

ittate, outer smaller, 1.5–2.0 mm long, median 2.0–2.5 mm long, yellow but greyish or mauve distally, anterior anthers 3–4 mm long, yellow basally but greyish or mauve in distal 2/3. *Ovary* half-inferior; style medially deflexed, ± 6 mm long, extending shortly beyond anthers. *Capsules* subglobose, 6–7 mm diam., 3-lobed. *Seeds* unknown. *Flowering time*: Aug.–Sept. Figure 6E.

Distribution and ecology: thus far known from a single collection from sandy flats near the Ploegberg, south of Kuboes in the Richtersveld (Figure 7).

Diagnosis and relationships: this distinctive species has the 3 + 3 arrangement of stamens that characterizes sect. *Trigella*, but is distinguished from other members in the section by having the filaments of all six stamens connate for half to two-thirds of their length into a cylindrical or conical tube that completely encloses

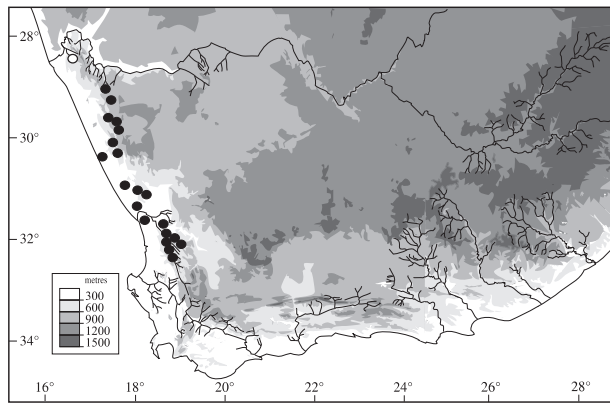


FIGURE 7.—Distribution of *Cyanella marlothii*, ○; *C. orchidiformis*, ●.

the ovary. Although the species is based on just a single collection, this comprises three essentially identical individuals. These plants were included in *C. orchidiformis* until now, despite their unique androecium. In this context it is significant that Marloth, who also collected true *C. orchidiformis* from Steinkopf on the same trip as *C. marlothii*, correctly identified the former but treated the latter as *C. capensis* (now *C. hyacinthoides*), a clear indication that he considered the Ploegberg collection to be distinct from *C. orchidiformis*, although he was misled by the connate filaments into misidentifying it as *C. hyacinthoides*. The latter does not occur in the Richtersveld, and is in any event immediately distinguished by its 5 + 1 arrangement of anthers and by the spreading-geniculate pedicels.

Among the members of sect. *Trigella*, *C. marlothii* resembles *C. ramosissima* in its narrow leaves, 2–6 mm wide, pale mauve or blue flowers with darker veins, and apparently ± globose capsules, but is separated from it by its smaller flowers with tepals 10–12 vs. 13–20 mm long, bicoloured vs. plain yellow anthers, and shorter style, ± 6 mm long and only slightly longer than the anthers vs. 10–15 mm long and ± twice as long as the anthers.

We have considered the possibility that the collection may be hybrid between a member of sect. *Trigella* (*C. cygnea* is recorded from the Kuboes area) and *C. hyacinthoides*, but discount this in view of the consistent appearance of the plants and the lack of other intermediate characters. This possibility did not suggest itself to Marloth, who did not record any potential parent species at the site. The absence of additional collections of the taxon is unfortunate but not unique—no further plants of *W. gracilis* have been recorded from the Richtersveld since Marloth's collection on 29 August 1925, just three days after his collection of *C. marlothii* (but see this species for further comment).

3. ***Cyanella orchidiformis* Jacq.**, Collectanea 4: 211 (1791). *Trigella orchidiformis* (Jacq.) Salisb.: 46 (1866). Type: South Africa, without locality or collector, illustration in Jacquin, *Icones plantarum rariorum* 2: t. 447 (1786–1793).

Plants 150–500 mm high. *Corms* moderately or very deep-seated, 15–30 mm diam., tunics of coarsely net-

ted, woody fibres, sometimes connate below into flat claws, extending shortly into a fibrous neck up to 20 mm long, chestnut-brown. *Basal leaves* 4–6, suberect or spreading, lanceolate, 70–250 × 10–25(–30) mm, acute to attenuate, plane or canaliculate, with prominent midrib abaxially, soft-textured, glabrous, margins plane or undulate, smooth or ciliolate-scabridulous. *Inflorescence* a moderately dense raceme up to 35-flowered, with 1 or 2 branches, lower flowers 0.5–0.8 × pedicel length apart; pedicels suberect and deflexed at bracteole, mostly 15–30 mm long; bracteoles mostly inserted in upper third or quarter, sometimes in lower half or quarter. *Flowers* facing outwards, pink or mauve with darker veins, sometimes with darker centre, or with paler centre variously speckled with dark pink, the whole outlined with darker shading, fragrant; tepals spreading, outer elliptic, (8–)10–15(–20) × 4–5 mm, apiculate, inner oblanceolate, (8–)10–15(–20) × 5–6 mm, narrowed below. *Stamens* dimorphic, 3 + 3; filaments of posterior cluster arcuate to geniculate-sigmoid, 2–5 mm long, connate at extreme base only, ± evenly thick throughout, yellow with white base, anthers ± sagittate, outer smaller, 1–2 mm long, median 2–3 mm, yellow, but grey to purple distally; filaments of anterior cluster deflexed, 1.5–2.5 mm long, connate at extreme base, anthers 5–6 mm long, pale yellow at base, greyish or purple distally. *Ovary* half-inferior; style medially deflexed, (4–)5–13 mm long, ± as long as or extending well beyond anthers. *Capsules* erect, ovoid-ellipsoid to oblong, 14–25(–30) × 8–10 mm, pale with purplish reticulation. *Seeds* ovoid-ellipsoid, 3–4 × 1.5–2.0 mm, glossy black, rugose. *Chromosome number*: $2n = 24$ (Ornduff 1979). *Flowering time*: (mid–)late Jul.–late Sept. Figure 6A, B.

Distribution and ecology: occurring along the western escarpment, from just north of Steinkopf in northern Namaqualand to Citrusdal in the Olifants River Valley (Figure 7). Collections from the Richtersveld cited under this species by Scott (1991) are referable to *C. cygnea*, evident from their filiform, sigmoid upper filaments and smaller anthers. Plants grow mostly in clay or loamy soils, often in rock crevices in granite or sandstone, where they benefit from extra moisture through run-off among rocks along the courses of seasonal streams, especially in Namaqualand.

Diagnosis and relationships: the most common and widespread of the three species of sect. *Trigella*, *C. orchidiformis*, is recognized by its lanceolate leaves, 10–25 mm wide, and racemes of pink to mauve flowers, mostly darker or patterned toward the centre, with the anthers partially or almost wholly greyish or purple, and large, ovoid-ellipsoid fruits, 14–25 mm long. The three species are essentially parapatric or allopatric, although both *C. cygnea* and *C. orchidiformis* have been collected near Steinkopf (Marloth 6761, 6761A). An exceptionally large-flowered variant with tepals 20 × 6–7 mm has been collected on the Gifberg Pass, growing in sandstone soil after fire (Goldblatt & Porter 13190), and may be polyploid.

Cyanella orchidiformis is closely allied to *C. cygnea*, with which it shares the distinctive large fruits, patterned perianth, and coloured anthers, but from which it is distinguished by its generally larger flowers, with tepals mostly 10–13 mm long vs. 8–10 mm long, and its unex-

ceptional stamens. The upper filaments in *C. orchidiformis* are arcuate or weakly geniculate, without a bulbous base and not evidently filiform in the distal half, and the lower anthers are relatively large, 5–6 mm long. The style is very variable in length, mostly 5–10 mm long, but occasionally up to 15 mm long. In contrast, *C. cygnea* has mostly smaller flowers, with tepals 8–10 mm long and very distinctive stamens, with the upper filaments geniculately sigmoid and sharply narrowed and filiform in the distal half, with much smaller lower anthers, 2.5–3.0 mm long, and a short style 3–4 mm long. The range of *C. orchidiformis* is largely to the south and east of *C. cygnea* but both species have been collected near Steinkopf.

The relatively broad leaves, 10–30 mm wide, and large capsules, readily distinguish *C. orchidiformis* from *C. marlothii* and *C. ramosissima*, which have narrow leaves 2–8 mm wide and smaller, subglobose-ovoid fruits 7–10 mm long.

Vernacular name: waterraap.

Representative specimens

NORTHERN CAPE.—2917 (Springbok): Steinkopf, (–BA), Aug. 1925, *Marloth 6761* (NBG); 6.5 km W of Steinkopf, (–BA), 29 Sept. 1986, *Perry & Snijman 3560* (NBG); between Springbok and Steinkopf beyond Bulletrap, (–BC), 29 Sept. 1986, *Perry & Snijman 3555* (NBG); Spektakel, (–DA), 25 Aug. 1941, *Compton 11398* (NBG); Eselsfontein, (–DA), 8 Sept. 1950, *Barker 519* (NBG). 3017 (Hondeklipbaai): Spoegivier, (–AD), 12 Sept. 1982, *Archer 295* (NBG). 3018 (Kamiesberg): 6 miles [9.6 km] north of Garies, (–CA), 3 Sept. 1945, *Leighton 1398* (PRE); Kamiesberg, 41.5 km from turn-off to Kliprand, (–DC), 15 Sept. 2006, *Goldblatt & Porter 12759A* (MO, NBG). 3117 (Lepelfontein): Towerberg Pass between Komkans and Kotzesrust, (–BB), 3 Sept. 1976, *Boucher 3160* (NBG). 3119 (Calvinia): Lokenburg, (–AC), 23 Aug. 1980, *Van Berkel 204* (MO).

WESTERN CAPE.—3118 (Vanrhynsdorp): Meerhofkasteel, (–AA), 8 Aug. 1984, *Snijman 805* (NBG); Farm Quaggaskop 125, (–AB), 11 Aug. 1977, *Le Roux 2282* (NBG); 15 miles [24 km] NW of Koekenaap, (–AD), 19 Aug. 1970, *Hall 3766* (NBG); between Trawal and Olifants River bridge, shale bank, (–DC), 27 Aug. 1991, *Goldblatt & Manning 9121* (MO); Gifberg Pass, Keurlandshoek, (–DD), 25 Sept. 2008, *Goldblatt & Porter 13190* (MO, NBG). 3218 (Clanwilliam): Clanwilliam, (–BB), 5 Aug. 1896, *Schlechter 8417* (MO, NBG); 29 July 1943, *Lewis NBG1814/32* (NBG); Olifants Dam, (–BB), 14 Sept. 1847, *Barker 4768* (NBG). 3219 (Wuppertal): Biedouw [Bidouw] Valley, (–AA), 23 Sept. 1952, *Barker 1748* (NBG); Cedarberg Forest Reserve, Langrug, (–AC), 21 Aug. 1983, *Viviers 496* (NBG); Rondegat River Valley 16 km NW of Algeria, (–BC), 8 Sept. 1976, *Thompson 2812* (NBG); near Citrusdal, (–CC), 6 Sept. 1949, *Steyn 390* (NBG).

Long-styled morphs

3017 (Hondeklipbaai): Grootvlei, (–BB), Sept. 1945, *Lewis 1380* (SAM); 7 Sept. 1945, *Barker 3716* (SAM). 3118 (Vanrhynsdorp): Holbak Farm, near Doornbaai [Doringbaai], (–CD), 5 Sept. 1964, *Hall 164* (NBG). 3218 (Clanwilliam): S of Clanwilliam, (–BB), 20 Sept. 1954, *De Vos 1719* (NBG); 10 miles [18 km] S of Clanwilliam, (–BB), July 1948, *Lewis 2999* (SAM).

4. *Cyanella cygnea* G.Scott in South African Journal of Botany 57: 50 (1991). Type: South Africa, [Northern Cape], 51.4 km from Springbok along road to Komaggas, 16 Sept. 1988 [cult. at Karoo Botanic Garden, Worcester from material collected ± 1978], *P.L. Perry 1119* (NBG, holo.!; K, MO, PRE!, iso.).

Plants (150–)200–500 mm high. *Corms* moderately or very deep-seated, 15–30 mm diam., tunics

of coarsely netted, woody fibres, sometimes connate below into flat claws, extending shortly into a fibrous neck up to 20 mm long, chestnut-brown. *Basal leaves* 4–6, suberect, lanceolate, 80–200 × 10–20(–25) mm, acute to attenuate, plane or canaliculate, with prominent midrib and ribbed veins abaxially, soft-textured, glabrous, margins smooth or ciliolate-scabridulous. *Inflorescence* a dense or moderately dense raceme up to 35-flowered, with 1–4 branches, lower flowers 0.2–0.5 × pedicel length apart; pedicels suberect, deflexed at bracteole, mostly 15–30 mm long; bracteoles mostly inserted in upper third or quarter. *Flowers* facing outwards, pink with paler centre variously speckled with dark pink, the whole outlined with darker shading, fragrant; tepals spreading, outer elliptic, 8–10 × 4–5 mm, apiculate, inner obovate, 8–10 × 5–6 mm, narrowed and short-clawed below. *Stamens* dimorphic, 3 + 3; filaments of posterior cluster geniculate-sigmoid, 2–5 mm long, distally filiform and strongly flexuous, swollen basally, connate at extreme base only, yellow with white base, anthers ± sagittate, 1.5–2.0 mm long; filaments of anterior cluster deflexed, 1.0–1.5 mm long, connate at extreme base, anthers 2.5–3.0 mm long, pale yellow but greyish in distal half or third. *Ovary* half-inferior; style medially deflexed, 3–4 mm long, not extending beyond anthers. *Capsules* erect, ovoid-ellipsoid, (12–)15–20 × 8–10 mm. *Seeds* ovoid-ellipsoid, 3–4 × 1.5–2.0 mm, glossy black, rugose. *Flowering time*: late Aug.–early Oct.(–early Nov.). Figure 6C, D.

Distribution and ecology: restricted to the higher-lying parts of northern Namaqualand, where it has been collected in the Richtersveld along the Ploegberg and Stinkfontein Mtns, from Kuboes to Eksteenfontein, near Steinkopf, and along the edge of the escarpment around Komaggas, some 60 km to the south (Figure 8). Plants grow in rocky situations in open succulent karoo shrubland, typically where there is additional moisture such as along watercourses or in gorges.

Diagnosis and relationships: closely allied to *C. orchidiformis*, with which it shares characteristically mottled flowers and large, ovoid-ellipsoid capsules ± 15 mm long, and greyish or purple markings or speckling on the anthers. *Cyanella cygnea* typically has smaller flowers, with tepals 8–10 vs. (8–)10–15(–20) mm long, but is best identified by its stamens. The

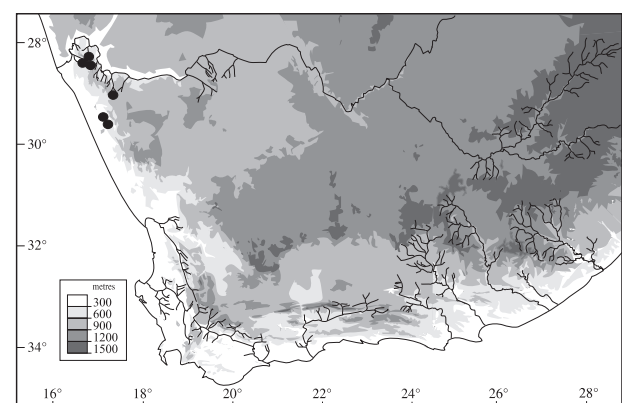


FIGURE 8.—Distribution of *Cyanella cygnea*.

strongly geniculate-sigmoid filaments of the posterior (upper) stamens are bulbous at the base and filiform in the distal half, giving them a characteristic flexuous form, the outer pair slightly longer than the median. All three anthers in the posterior cluster are subequal in size, 1.5–2.0 mm long, and the lower anthers are equally larger, 2.5–3.0 mm long. In contrast, the upper stamens in *C. orchidiformis* are $\pm$ uniformly thick except at the extreme apex and not evidently flexuous, the outer anthers are slightly smaller than the median, and the lower anthers are larger, 5–6 mm long, sometimes with the median larger than the laterals. The distributions of the two species are largely complementary, with *C. cygnea* occurring to the north and west of *C. orchidiformis*, but they overlap around Steinkopf.

Vernacular name: wildebeet (wild beet) (Scott 1991).

Representative specimens

NORTHERN CAPE.—2816 (Oranjemund): mtns SW of Kuboos [Khubus], (–BD), 11 Sept. 1973, *Lavranos 10834* (MO, PRE). 2817 (Vioolsdrif): Richtersveld, Kodaspiek, (–AA), 2 Sept. 1977, *Oliver, Tölken & Venter 492* (MO); Armmanshoek, (–AC), Aug. 1995, G. & F. Williamson 5654 (NBG); Richtersveld, near Kubus [Khubus], (–CA), 13 Aug. 1983, *Archer 391* (NBG, PRE); Ploegwater at S portion of Ploegberg, (–CA), 7 Sept. 1991, *Germishuizen 5483* (PRE); Stinkfonteinberg SW of Vanzylsrus, (–CA), 4 Sept. 1977, *Oliver, Tölken & Venter 626* (NBG); stony flats 4 km N of Eksteenfontein, (–CD), 23 Aug. 2001, *Goldblatt & Porter 11751* (MO); 8 km N of Eksteenfontein, 22 Aug. 1994, *Goldblatt & Manning 9940* (MO). 2917 (Springbok): Steinkopf, (–BA), Aug. 1925, *Marloth 6761A* (NBG); Steinkopf, (–BC), 9 Aug. 1898, *M. Schlechter 119* (MO, PRE); Klipfontein, (–BA), Sept. 1929, *Grant 4840B* (MO); Komaggas, Van Reenen se Water, (–DC), 26 Aug. 1983, *Van Wyk 6501* (PRE).

II. Section *Cyanella*

Flowers sometimes enantiostylous; perianth white, yellow, orange, pink to mauve, or blue, never patterned. *Stamens* 5 + 1; anthers $\pm$ oblong. *Ovary*: style sometimes flexed to left or right.

Series *Hyacinthoides* J.C.Manning & Goldblatt, ser. nov.

Flowers not enantiostylous; pedicels $\pm$ geniculate (horizontally spreading then flexed sharply upwards) or arcuate; perianth white, orange, pink, or mauve to blue. *Stamens*: filaments connate halfway or more. *Ovary*: style not flexed sideways. Type species: *Cyanella hyacinthoides* Royen, ex L.

5. *Cyanella hyacinthoides* Royen ex L., *Genera plantarum*, edn 5: addendum [522] (1754). *C. capensis* L.: 985 (1759), nom. illegit. superfl. *C. pulchella* Salisb.: 249 (1796), nom. illegit. superfl. [Note: Scott's (1991) lectotypification of *C. pulchella* against Jacquin's (1776–1777) illustration of *C. capensis* L. is unwarranted and incorrect. There is no indication that Salisbury had any intention other than of replacing Linnaeus's name with his own]. Type: South Africa, without precise locality, date or collector, ex herb. Royen *Herb. Linn.* 430.2 (LINN, holo.).

Plants 150–400(–500) mm high. *Corms* deep-seated, 25–30 mm diam., tunics of coarsely netted, wiry or woody fibres, not or extending shortly into a fibrous neck to 20 mm long, pale brown or grey. *Basal leaves* 4–9(–12), suberect or spreading, linear to narrowly lan-

ceolate, 60–200(–250) $\times$ (2–)4–15(–25) mm, acute to attenuate, plane, canaliculate or rarely involute, midrib and veins prominent beneath (abaxially), firm-textured, usually glabrous but veins sometimes scabridulous or puberulous to villous abaxially with hairs up to 1 mm long, rarely both surfaces densely puberulous throughout, margins $\pm$ undulate or crispulate, usually ciliolate-scabridulous, sometimes flushed purple basally; upper cataphyll usually pale, rarely purple-reticulate or fenestrate. *Inflorescence* a moderately dense raceme up to 25-flowered, with 2–4 branches, rarely with second order branchlets and thus paniculate, lower flowers 0.3–0.6 $\times$ pedicel length apart; pedicels usually geniculate, horizontal in basal 1/2 or 2/3 then abruptly flexed upwards at $\pm$ right angles, rarely suberect or arcuate, mostly 20–30 mm long; bracteoles mostly inserted between lower and upper third, rarely sub-basal. *Flowers* facing outwards, pale to deep mauve or blue, rarely white or pink, fragrant; tepals spreading, ovate to obovate, 8–10 $\times$ 3–4 mm, apiculate. *Stamens* dimorphic, 5 + 1; filaments of posterior cluster 1.0–2.5 mm long, outer sometimes slightly longer than inner, connate $\pm$ halfway or almost completely into tube 1.0–2.0 mm long, yellow, sometimes with small intrastaminal lobules between bases of filaments, anthers 1.5–2.0(–2.8) mm long, yellow; anterior stamen with filament $\pm$ 1 mm long, connate to upper cluster for $\pm$ half length, anther 2.5–4.0 mm long, yellow. *Ovary* half-inferior; style medially deflexed, 3–4 mm long, not extending beyond anthers. *Capsules* erect on geniculate pedicels, subglobose, 5–6 mm diam., 3-lobed and retuse. *Seeds* ovoid, $\pm$ 2 mm diam., rugulose. *Chromosome numbers*: $2n = 24, 28$ & 48 (Ornduff 1979). *Flowering time*: mainly mid-Sept.–mid-Dec. but mid-Aug.–mid Oct. in Namaqualand. Figure 6F–H.

Distribution and ecology: *Cyanella hyacinthoides* is widely distributed through the southern African winter-rainfall region, from just north of Steinkopf southwards through the higher-lying parts of Namaqualand into the southwestern Cape as far east as the Gouritz River (Figure 9), from near sea level to over 1 200 m. It has been recorded along the Roggeveld Escarpment south to Matjiesfontein but is absent from the arid Tanqua River basin and Little Karoo, apart from a single collection south of Oudtshoorn at the foot of the Outeniqua Mtns. The species has a wide edaphic amplitude and has

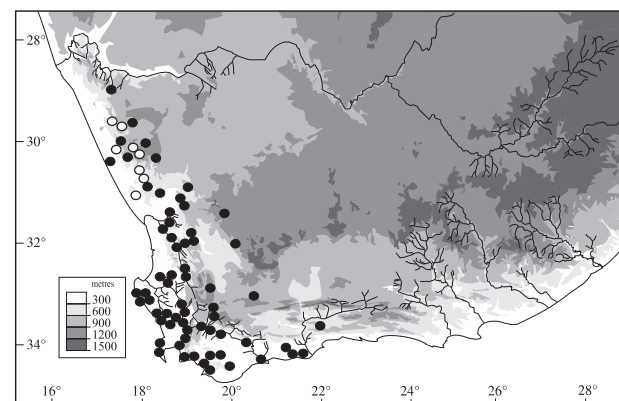


FIGURE 9.—Distribution of *Cyanella hyacinthoides* (pubescent forms, ●).

been collected on granite, sandstone, and limestone substrates, although it favours loamy or clay soils, where it is most often found as a component of renosterveld or succulent karoooid communities. It is tolerant of disturbance and thrives in old lands and along road verges.

Cyanella hyacinthoides is extremely variable in its foliage. Plants typically produce 4–6 lanceolate leaves but some forms may produce up to a dozen linear-involute leaves. These narrow-leaved plants are scattered throughout the range of the species. A more circumscribed ecotype occurs along the higher parts of central Namaqualand, between Kotzesrus and Springbok. Plants there tend to have the lower leaf surface variously scabridulous or villous, with the hairs restricted to the leaf margins and the adaxial veins and midrib. In extreme forms, the hairs are shaggy and up to 1 mm long but there is a significant variation in the density and length of the vestiture, even within a single locality, from scarcely puberulous to densely villous leaves. A collection from north of Komaggas (Barker 7412) shows a second type of vestiture, with both leaf surfaces closely and evenly puberulous. Populations from elsewhere in the range generally have the leaf surfaces glabrous, but some plants may have the lower surface sparsely and minutely scabridulous along the veins. There is no association between vestiture and other vegetative features, such as leaf width or shape. The development of leaf pubescence in populations from this part of Namaqualand has also been recorded in species of *Trachyandra* (Asphodelaceae) (Manning & Goldblatt 2007) and *Haemanthus* (Amaryllidaceae) (Snijman 1984), and appears to represent a widespread ecological strategy.

Tetraploids have been detected among several wild populations of *Cyanella hyacinthoides* (Ornduff 1979), and it is thus possible that unusually robust specimens that have been remarked on by various collectors are polyploids.

Diagnosis and relationships: *Cyanella hyacinthoides* is distinguished by the moderately dense, branched racemes of mauve to blue (rarely white or pink) flowers with 5 + 1 arrangement of stamens with the filaments connate for $\pm$ half their length or more. The connate filaments and generally horizontally spreading pedicels serve to distinguish the species from pink-flowered forms of *C. lutea*, in which the stamens are $\pm$ free and the pedicels mostly suberect.

The species is closely allied to *C. pentheri*, with which it has been much confused, and the two were treated as conspecific by Scott (1991). They are essentially alike in their inflorescence, although the flowers in *C. pentheri* are typically paler, mostly white to pale mauve, but they differ strikingly in their foliage. The leaves of *C. pentheri* are linear-aristate and canaliculate-involute with margins that are often crispulate and conspicuously ciliate only towards the base with shaggy hairs 2.0–3.0 mm long. Similar long cilia also fringe the upper cataphyll, which is funnel-shaped, and boldly pigmented with deep purple along the edges and veins, giving it a characteristic fenestrate appearance. Although *C. hyacinthoides* is highly variable in its foliage, the species only rarely produces similarly narrow, crispulate

leaves and in such cases they are either glabrous or are ciliate-pubescent along their entire length, with much shorter hairs 0.2–1.0 mm long, and the upper cataphyll is usually unmarked, very rarely (Goldblatt & Porter 11896) purple-fenestrate. Although the two taxa have been recorded growing in close proximity in several localities (see discussion under *C. pentheri*), no intermediates between them have been found.

Vernacular names: *raap*, *hotnotsraap*, *klipraap*.

Representative specimens

Typical form

NORTHERN CAPE.—2917 (Springbok): E of Kosies, (–BA), 15 Oct. 1988, *Williamson* 3978 (NBG); Springbok, 15 miles [24 km] E of town, (–CB), 12 Oct. 1947, *Rodin* 2193 (PRE); between Spektakelberg and Komaggas, (–DA), 21 Aug. 1982, *Le Roux* 2957 (NBG). 3017 (Hondeklipbaai): Spoegrivier, (–AD), 20 Sept. 1983, *Archer* 410 (NBG); Kamieskroon, Skilpad Nature Reserve, (–BB), 18 Sept. 1995, *Cruz* 92 (MO, NBG); sandy flats E of Kamieskroon at foot of pass, (–BB), 3 Nov. 1982, *Goldblatt* 6651 (MO). 3118 (Vanhynsdorp): 5 km S of Bitterfontein, (–AB), 9 Sept. 1985, *Duncan* 184 (NBG); Vanhynsdorp, Zandkraal Farm, (–DB), 7 Sept. 1949, *Barker* 5662 (NBG); 13 km from Vanhynsdorp on road to Nieuwoudtville, (–DB), 31 Aug. 1986, *Fellingham* 1116 (PRE). 3119 (Calvinia): Oorlogskloof Nature Reserve, Farm Driefontein, (–AC), 1 Nov. 1996, *Pretorius* 398 (NBG); along Nieuwoudtville–Loeriesfontein road, (–AB), 11 Sept. 1986, *Steiner* 1360 (NBG); Doringbos Valley, (–CC), 27 Sept. 1970, *Barker* 10725 (NBG). 3217 (Vredenburg): Witteklip Rocks, (–DD), 19 Sept., *Perry* 3197 (MO). 3218 (Clanwilliam): Lamberts Bay, Nortier Experimental Farm, (–AB), 6 Nov. 1974, *Boucher* 2569 (NBG); irrigation dam near Clanwilliam, (–BB), Sept. 1935, *Smuts* PRE59124 (PRE); Clanwilliam, 6.2 km S of Ramskop, (–BB), 26 Sept. 1986, *Perry* 3523 (NBG); Piketberg, approaching Moravian Mission at Goedverwag, (–DC), 3 Oct. 1984, *Perry* 3214 (MO, NBG). 3219 (Wuppertal): Bidouw, Welbedacht Farm, (–AA), 22 Sept. 1952, *Johnson* 537 (NBG). Koue Bokkeveld, Ondertuin, (–CC), 28 Dec. 1978, *Hanekom* 2519 (MO). 3220 (Sutherland): Roggeveld, Soekop Farm, (–AA), 11 Sept. 2006, *Rösch* 660 (NBG). 3219 (Wuppertal): Citrusdal, (–CC), 30 Sept. 1944, *Barker* 3075 (NBG). 3318 (Cape Town): Langebaan, (–AA), 5 Oct. 1969, *Axelsson* 80 (NBG); Yzerfontein, De la Rey Farm, (–AC), 15 Oct. 1995, *Boucher* 2557 (NBG); Groenekloof [Mamre], (–AC), 1850, *Zeyher* 1718 (NBG); Buck Bay Farm, (–CA), 29 Nov. 1978, *Boucher* 4156 (PRE); Robben Island, (–CD), 14 Nov. 1985, *Lloyd* 574 (NBG); Cape Peninsula, Kamps [Camps] Bay, (–CD), Dec. 1897, *Thode s.n.* (NBG); Malmesbury, Burgers Post Farm, (–DA), 17 Oct. 1979, *Boucher & Shepherd* 4839 (NBG); Langverwacht above Kuils River, (–DC), 22 Nov. 1973, *Oliver* 4806 (NBG); Paarl Mountains Nature Reserve, (–DD), 26 Oct. 1994, *Swanepoel* 50 (NBG); Jonkershoek, (–DD), 27 Nov. 1973, *Smith* 141 (NBG). 3319 (Worcester): Ceres, Lakenvlei Farm, (–BC), 19 Oct. 1941, *Barker* 2004 (NBG); Rawsonville, (–CA), 18 Oct. 1980, *Walters* 2322 (NBG); Worcester, (–CB), 17 Oct. 1980, *Walters* 2310 (NBG); E approach to Franschhoek Pass, (–CC), 8 Nov. 1987, *Goldblatt & Manning* 8583 (MO, PRE); Madeba Farm, W of Robertson, (–DD), 8 Oct. 1986, *Hilton-Taylor* 1765 (NBG). 3320 (Montagu): Matjiesfontein, (–BA), 24 Oct. 1921, *Foley* 120 (PRE). 3322 (Oudtshoorn): lower N slopes of Outeniqua Mtns, near Sebrafontein Farm, (–CC), 23 Oct. 1985, *Vlok* 1216 (NBG). 3418 (Simonstown): Simonstown, Redhill Plateau, (–AB), 19 Nov. 1970, *Goldblatt* 5168 (MO); Cape Peninsula, Noord Hoek, (–AB), 30 Nov. 1943, *Wasserfall* 674 (NBG); Muizenberg, (–AB), Feb. 1907 (mostly in fruit), *Rogers* TM25828 (PRE); Betty's Bay, 2 Dec. 1970, *Ebersohn s.n.* (NBG). 3419 (Caledon): Hermanus, Vogelgat, (–AD), 30 Oct. 1986, *Williams* 3719 (MO, NBG); Genaden-dal, (–BA), 1854, *Roser* PRE15439 (PRE); Gansbaai, Grootbos Nature Reserve, (–CB), 8 Dec. 2007, *Lutzeyer s.n.* (NBG). 3420 (Bredasdorp): Swellendam, Bontebok National Park, (–AB), Dec. 1962, *Liebenberg* 6779 (NBG, PRE); De Hoop, Potberg Nature Reserve, (–AD), 28 Nov. 1978, *Burgers* 1598 (NBG); Riversdale, Reisiesbaan Siding, (–AB), 31 Oct. 1979, *Bohnen* 7043 (NBG). 3421 (Riversdale): near Still Bay on Rietvlei Road, (–AD), 13 Nov. 1982, *Bohnen* 8152 (NBG); limestone hills S of Albertinia, (–AD), 4 Dec. 1985, *Goldblatt* 7421 (MO); Farm Platbos, 2 km S of Aasvogelberg to Gouritz River, (–BC), 10 Dec. 1981, *Stirton* 10261 (NBG).

Hairy forms

NORTHERN CAPE.—2917 (Springbok): Spektakel Pass, (–DA), 4 Sept. 1951, *Martin* 835 (NBG), 11 Sept. 1993, *Goldblatt & Manning* 9715 (MO); Ezelsfontein, (–DA), 8 Sept. 1950, *Barker* 6656 (NBG); 5 miles [8 km] N of Komaggas, (–DB), 4 Sept. 1951, *Barker* 7412 (NBG); between Brakwater and Komaggas, (–DB), 9 Sept. 1950, *Barker* 6679 (NBG); 64.5 km W of Okiep towards Nababiep, (–DB), 26 Sept. 1986, *Perry* 3550 (NBG). 3017 (Hondeklipbaai): 7 miles [11 km] NW of Kamieskroon, (–BB), 25 Sept. 1952, *Acocks* 16477 (PRE); Kamieskroon, (–BB), 22 Aug. 1959, *Barker* 9001 (NBG); Garies Hill, (–BD), 2 Sept. 1951, *Barker* 7403 (NBG); 19 km S of Kotzesrus, (–DD), 16 Sept. 2001, *Goldblatt & Porter* 11896 (MO, NBG). 3018 (Kamiesberg): 26 km S of Garies on road to Bitterfontein, Farm Mostertsvlei, (–CA), 30 Sept. 1987, *Reid* 1310 (PRE).

6. *Cyanella pentheri* Zahlbr. in *Annalen des kaiserlichen naturhistorischen Museums* 15: 26 (1900). Type: South Africa, [Western Cape], Olifanttrivier [Olifants River], Aug. [without year], *Penther* 400 (W, holo.†). Neotype: South Africa, [Western Cape], Clanwilliam, Biedouw [Bidouw], Welbedacht Farm, 22 Sept. 1952, *A.J. Middelmoot* 1741 (NBG, neo., designated here; SAM, iso.).

Note: The type of *Cyanella pentheri* is presumed lost (Scott 1991) but Zahlbruckner's (1900) description is quite clear and we designated an extant specimen to serve as a neotype.

Plants 100–400 mm high. *Corms* deep-seated, 25–30 mm diam., tunics of coarsely netted, wiry or woody fibres, extending in a short or very long fibrous or papery neck to 100 mm long, pale brown. *Basal leaves* (5–)9–17, suberect, often $\pm$ twisted or coiled apically, linear, 60–150 $\times$ 1–4(–5) mm, attenuate, canaliculate-involute, with prominent midrib and ribbed veins abaxially, firm-textured, glabrous or veins puberulous abaxially, margins straight or $\pm$ undulate or crispulate, conspicuously ciliate in basal parts only with shaggy hairs 2.0–3.0 mm long but glabrous distally; upper cataphyll prominent, with crispulate margins villous as in leaves, strongly flushed purple towards edge and along veins, thus fenestrate, sometimes also villous on veins. *Inflorescence* a moderately dense raceme up to 25-flowered, simple or up to 4-branched, lower flowers 0.3–0.6 $\times$ pedicel length apart; pedicels geniculate, horizontal in basal half or 2/3 then abruptly flexed upwards at $\pm$ right angles, mostly 20–30 mm long; bracteoles mostly inserted between lower and upper third, rarely sub-basal. *Flowers* facing outwards, white to pale mauve or blue, fragrant; tepals spreading, ovate, 7–11 $\times$ 3–4 mm, apiculate. *Stamens* dimorphic, 5 + 1; filaments of posterior cluster 2.0–3.5 mm long, connate $\pm$ 1/3 to 2/3 into tube 1.0–1.5 mm long, yellow, anthers 1.5–2.5 mm long, yellow; anterior stamen with filament $\pm$ 1 mm long, connate to upper cluster for $\pm$ half length, anther 2.5–3.5 mm long, yellow. *Ovary* half-inferior; style medially deflexed, 3–4 mm long, not extending beyond anthers. *Capsules* erect on geniculate pedicels, subglobose, 5–6 mm diam., 3-lobed and retuse. *Seeds* unknown. *Flowering time:* late Aug.–early Oct.

Distribution and ecology: *Cyanella pentheri* has a restricted distribution through the middle reaches of the Olifants River Valley from north of Citrusdal to Klawer, extending along the foot of the Gifberg onto the Bokkeveld Escarpment, and inland to the Bidouw and Doring River Valleys (Figure 10). Plants favour rocky

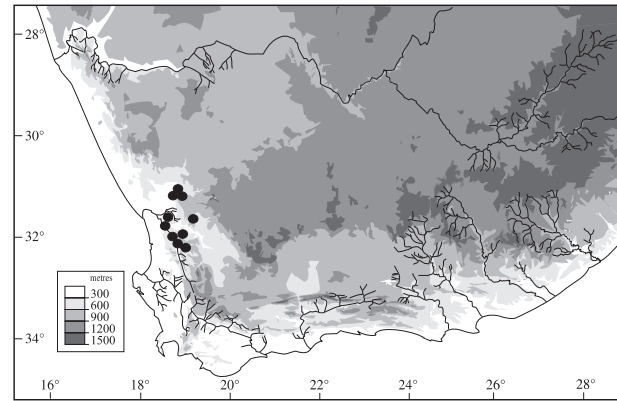


FIGURE 10.—Distribution of *Cyanella pentheri*.

places, often sandstone, mainly in arid fynbos.

Diagnosis and relationships: *Cyanella pentheri* has mostly been treated as conspecific with *C. hyacinthoides*, essentially because of the confusion between true *C. pentheri* and what we regard as pubescent forms of *C. hyacinthoides*. Florally, the two species are certainly alike in their moderately dense, branched racemes of spreading, white or mauve to blue flowers with 5 + 1 arrangement of stamens with the filaments connate for $\pm$ half their length or more, but they differ significantly in their foliage. The leaves of *C. pentheri* are consistently linear and canaliculate-involute, mostly 1–4 mm wide, with margins that are conspicuously ciliate only towards the base with long, shaggy hairs 2.0–3.0 mm long. Similar, long cilia also fringe the upper cataphyll, which is funnel-shaped, and strikingly pigmented with deep purple along the edges and veins, giving it a characteristic fenestrate appearance. The leaves of *C. hyacinthoides*, in contrast, are mostly lanceolate and 4–15 mm wide, rarely narrower, with margins either smooth or ciliate-pubescent along their entire length, with much shorter hairs 0.2–1.0 mm long, and the upper cataphyll is usually unmarked. Pubescent forms of *C. hyacinthoides* from central Namaqualand have leaves that are variously puberulous to villous, but never with the long cilia characteristic of *C. pentheri*.

The variation in vestiture in *C. hyacinthoides* is not correlated with leaf shape, unlike the situation in *C. pentheri*. This is compelling evidence that *C. pentheri* represents a distinct genotype, which is further corroborated by the fact that the vegetative differences between the two species are maintained wherever the two have been collected together, notably north of Klawer at Zandkraal Farm (*Barker* 5648 vs *Barker* 5662), Welbedacht Farm in the Bidouw Valley (*Middelmoot* 1741 vs *Johnson* 537) and Clanwilliam (*Perry* 3526 vs *Barker* 4771). We have examined both taxa growing together just outside Clanwilliam ourselves and at none of these localities have we found intermediates between them.

Vernacular name: klipraap.

Representative specimens

NORTHERN CAPE.—3119 (Calvinia): Nieuwoudtville, Willem's River Farm, (–AC), Sept. [without year], *Leipoldt* 789 (NBG); Nieuwoudtville, hills near Groenrivier, (–AC), Sept. [without year], *Leipoldt* 790 (NBG).

WESTERN CAPE.—3118 (Vanrhynsdorp): Zandkraal, (–DA), 7 Sept. 1949, *Barker 5648* (NBG). 3119 (Calvinia): foot of Van Rhyn's Pass, (–AC), 22 Aug. 1950, *Barker 6447* (NBG, SAM). 3218 (Clanwilliam): intersection of Citrusdal road with Klawer–Clanwilliam road, (–BB), 14 Sept. 1985, *Scott 25* (NBG); Olifants Dam, (–BB), 14 Sept. 1947, *Barker 4771* (NBG, SAM); Clanwilliam, near dam, (–BB), Sept. 1947, *Lewis 2400* (SAM); Botterkloof Pass SE of Kameelberg, (–CD), 9 Sept. 1983, *Oliver 8052* (NBG); Kanolvlei, (–DD), 6 Sept. 1951, *Barker 7448* (NBG). 3219 (Wuppertal): Diamond Drift, Biedouw River between Pakhuis and Wuppertal, (–AA), Aug. 1939, *Leipoldt 3114* (PRE); Biedouw Valley, 2 km along road to Doorn River, (–AA), 22 Aug. 1993, *Goldblatt & Manning 9632* (MO); road to Algeria, (–AC), 6 Sept. 1980, *Le Roux 2813* (NBG). *Without precise locality*: Olifantsrivier, Dec. [without year], *Zeyher s.n.* SAM20551 (SAM).

7. *Cyanella aquatica* Oberm. ex G.Scott in South African Journal of Botany 57: 40 (1991). Type: South Africa, [Northern Cape], Nieuwoudtville, Klipkoppies, 21 Sept. 1986, G. Scott 66 (NBG, holo.!, PRE, iso.!).

Plants up to 500 mm high. *Corms* shallow or moderately deep-seated, 20 mm diam., tunics of papery or leathery layers, not extending into neck, pale whitish brown. *Basal leaves* ± 5 or 6, suberect, linear-lanceolate or narrowly lanceolate, 200–350 $\times$ 10–15 mm, attenuate, canaliculate with prominent midrib abaxially, soft-textured, bright green, glabrous. *Inflorescence* a lax raceme, up to 15-flowered, simple or with 1–3 branches from near base, lower flowers 1.5–3.0 $\times$ pedicel length apart; pedicels geniculate, horizontal in basal 1/2 to 2/3 then abruptly flexed upwards at $\pm$ right angles, mostly 15–20 mm long but lowermost up to 30 mm long; bracteoles basal or sub-basal. *Flowers* facing outwards, bright orange, veined green on reverse, fragrant; tepals spreading, outer ovate, 9–12 $\times$ 3–4 mm, recurved-apiculate, inner short-clawed, claw ± 1 mm long, blade ovate, 9–11 $\times$ 4–5 mm. *Stamens* dimorphic, 5 + 1; filaments of posterior cluster 2.0–2.5 mm long, outer slightly longer than inner, connate $\pm$ halfway or more into tube 1.5–2.0 mm long, yellow, anthers 1.5–2.0 mm long, yellow; anterior stamen with filament ± 1 mm long, connate to upper cluster for most of length, anther ± 3 mm long, yellow. *Ovary* half-inferior; style medially deflexed, ± 3 mm long, not extending beyond anthers. *Capsules* erect on geniculate pedicels, subglobose, $\pm 8 \times 6$ mm, 3-lobed and retuse. *Seeds* ovoid, 3.0 $\times$ 2.5 mm, rugulose. *Chromosome number*: $2n = 24$ (Ornduff 1979: as 'Klipkoppies' population of *C. hyacinthoides*). *Flowering time*: mid-Sept.–early Nov. Figure 6I, J.

Distribution and ecology: known originally only from the rocky outcrops immediately east of Nieuwoudtville, inland of the edge of the Bokkeveld Escarpment, *C. aquatica* has recently been collected significantly further inland just south of Calvinia, but is still the most local one of species in the genus (Figure 11). Plants are restricted to dolerite dykes, along watercourses or drainage lines where the soil becomes seasonally waterlogged during the winter months.

Diagnosis and relationships: distinguished by the lax, sparsely branched racemes, $\pm$ basal bracteoles on sharply sigmoid pedicels, and bright orange flowers. *Cyanella aquatica* is superficially similar to *C. hyacinthoides*, which also has a 5 + 1 arrangement of stamens with the filaments connate for $\pm$ half their length or more, but which differs in its fibrous corm tunics and dense racemes of white or pink to blue flowers with

the bracteoles usually inserted near the middle of the pedicels or above, only rarely near the base. The two taxa are ecologically separated, with *C. hyacinthoides* favouring better drained, sandy or gritty soils. In perianth colour, *C. aquatica* might be confused with yellow-flowered *C. lutea*, but that species has suberect pedicels with the bracteoles inserted $\pm$ midway along, filaments that are $\pm$ free to the base, and a laterally deflexed style. *Cyanella lutea* is also ecologically separated, favouring fine-grained clay soils in renosterveld or drier karroid vegetation.

Representative specimens

NORTHERN CAPE.—3119 (Calvinia): Nieuwoudtville, Klipkoppies, (–AC), 15 Sept. 1961, *Barker 9531* (BOL, NBG, PRE); 5 Nov. 1962, *Barker 9764* (NBG); trek path E of Nieuwoudtville near Calvinia road, (–AC), 29 Oct. 1996, *Goldblatt & Manning 10581A* (MO); Farm Driefontein, SW of Calvinia, SW slopes of Driefontein-se-Berg, in watercourse among dolerite rocks, (–DA), 23 Sept. 2009, *Goldblatt & Manning 13419* (NBG, MO).

Series *Luteae* J.C.Manning & Goldblatt, ser. nov.

Flowers $\pm$ enantiomorphic; pedicels suberect; perianth white, yellow, or pink. *Stamens*: filaments free, anthers sometimes spotted or maculate. *Ovary*: style and lower anther weakly or strongly flexed sideways in opposite directions. Type species: *Cyanella lutea* L.f.

8. *Cyanella lutea* L.f., Supplementum plantarum: 201 (1782). Type: South Africa, without precise locality or date, *Sparrman s.n.* Herb. Linn. 430.1 (LINN, holo.!).

Plants (120–)150–350 mm high. *Corms* moderately to deep-seated, 20–25 mm diam., tunics of coarsely netted, fibrous, leathery or woody fibres, sometimes connate below into claws, extending shortly in a neck to 30 mm long, rarely into a fibrous neck up to 100 mm long, brown. *Basal leaves* 4–15 mm, suberect or spreading, linear-hemiterete to lanceolate, 30–200(–250) $\times$ 2–15(–20) mm, acute to attenuate, leathery, plane or canaliculate, glabrous, margin smooth or ciliolate-scabridulous. *Inflorescence* a moderate or dense raceme up to 15-flowered, with 1–3 branches congested near base, thus emerging from among leaves, rarely with accessory branchlets and thus paniculate, lower pedicels 0.2–0.8 $\times$ their length apart; pedicels suberect, rarely arcuate or almost geniculate, 15–30(–50) mm long; bracteoles mostly inserted between $\pm$ halfway and upper third, sometimes in basal third or sub-basal. *Flowers* $\pm$

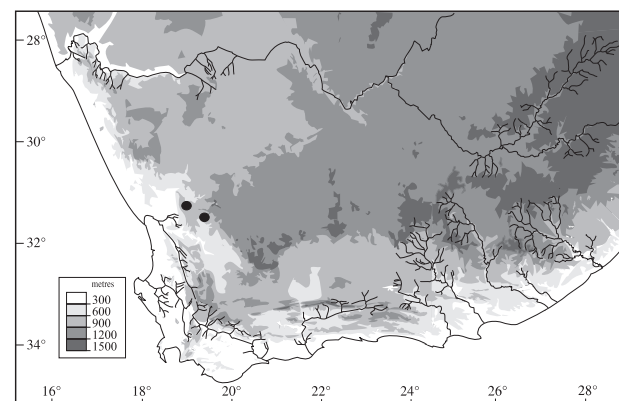


FIGURE 11.—Distribution of *Cyanella aquatica*.

enantiomorphic, facing outwards, yellow or pink to purple, usually flushed darker on reverse, with dark veins, fragrant; tepals spreading, outer oblong-elliptic, 10–15(–18) × 2–4 mm, apiculate, inner elliptic-ovate, 10–15(–18) × 3–7 mm, acute, narrowed basally or very short-clawed. *Stamens* dimorphic, 5 + 1; filaments of posterior cluster 2.5–4.0 mm long, connate only at extreme base, ± linear, yellow, anthers 2–4 mm long, yellow, usually finely spotted black or maroon; anterior stamen with filament deflexed ± laterally, 4–5 mm long, linear, connate to upper cluster at extreme base only, anther 4–7 mm long, thus ± twice as large as upper, yellow, brown, or mauve. *Ovary* half inferior; style ± laterally deflexed to left or right opposite lower stamen, 6–10 mm long, not

extending beyond lower anther. *Capsules* erect, subglobose-retuse, 6–8 mm diam., 3-lobed. *Seeds* ovoid, ± 2 mm diam., rugulose. *Chromosome number*: $2n = 24$ (subsp. *lutea*: Ornduff 1979). *Flowering time*: mainly Aug.–Nov. Figures 6K, L; 12.

Distribution and ecology: the most widely distributed species in the genus, *C. lutea*, extends through the winter rainfall region of southern Namibia and South Africa and around the interior margin of the central plateau but is absent from the central and Great Karoo (Figure 13).

Pink-flowered plants, often with narrower leaves, have been distinguished taxonomically several times, but differ consistently from the typical yellow-flowered form only in perianth colour. Baker (1871) initially recognized var. *rosea* from the Eastern Cape but subsequently (Baker 1880) changed his mind. This decision was followed by Scott (1991). However, the two colour morphs are geographically segregated: pink-flowered plants are recorded from the edges of the winter rainfall region into interior southern Africa, typically in sandy soils; and yellow-flowered plants are restricted to the southwestern Cape and nearby, on clay soils. We accordingly treat them here as distinct subspecies.

Diagnosis and relationships: distinguished from other members of sect. *Cyanella* by its racemes of pink or yellow, ± enantiostylous flowers with almost free filaments, connate only at the extreme base, and the lower anther ± twice as large as the upper anthers. Yellow-flowered plants are readily recognized by their colour but pink-flowered plants could be confused with *C. hyacinthoides* around Springbok in Namaqualand, where both occur. *Cyanella hyacinthoides* is recognized by its partially connate upper filament cluster, with the lower anther mostly less than twice as long as the upper, and by its spreading-geniculate pedicels. Subspecies *rosea* has also been confused with *C. ramosissima* (sect. *Trigella*), but the arrangement of the stamens is quite different in the two species.

Key to subspecies

- 1a Leaves mostly lanceolate, (2–)5–15(–20) mm wide; perianth pale to golden yellow, rarely orange, often flushed reddish on reverse; plants from southwestern Cape, from Nieuwoudtville to Uitenhage 8a. subsp. *lutea*
 1b Leaves linear to linear-lanceolate, 2–10(–12) mm wide; peri-

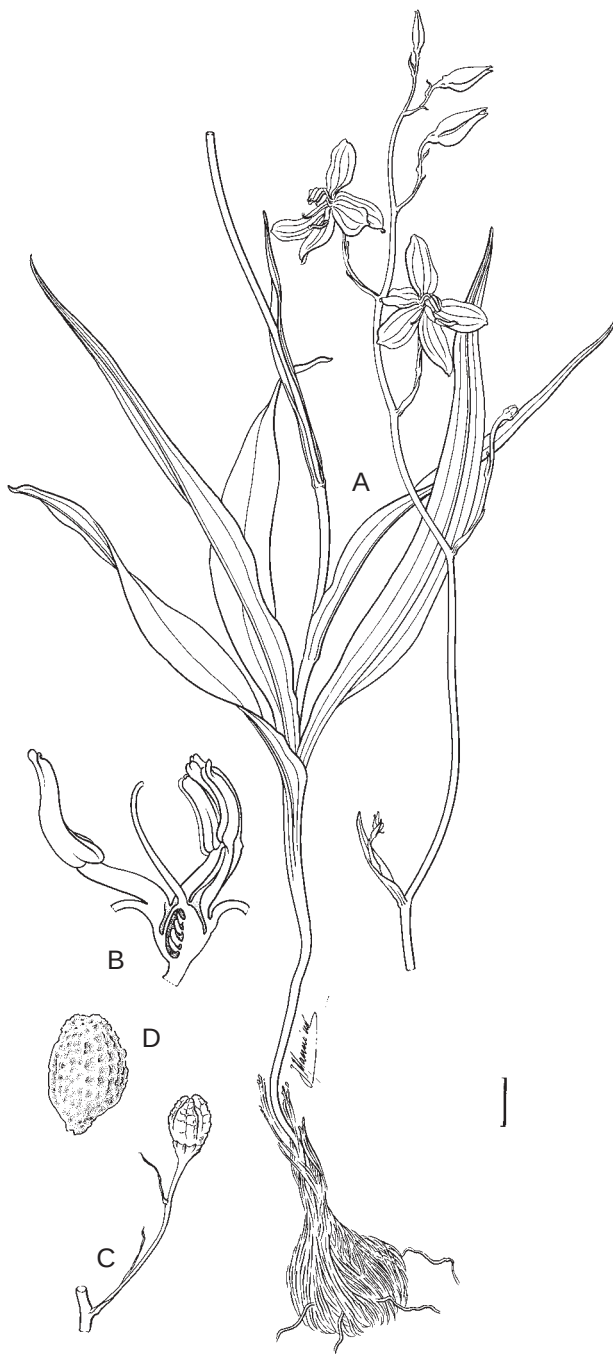


FIGURE 12.—*Cyanella lutea*: A, flowering plant; B, half-flower; C, capsule; D, seed. Scale bar: A–C, 10 mm; D, 2 mm. Artist: John Manning.

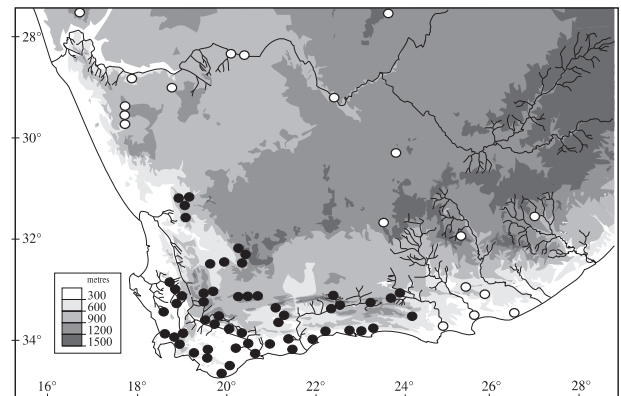


FIGURE 13.—Distribution of *Cyanella lutea* subsp. *lutea*, ●; *C. lutea* subsp. *rosea*, ○.

anth pink to purple; plants from southern Namibia and northern Namaqualand across interior of South Africa into Eastern Cape as far as Humansdorp 8b. subsp. *rosea*

8a. subsp. *lutea*

C. racemosa Schinz: 394 (1895). Type: South Africa, [Western Cape], in arenosis [sandy] Camp Ground proper [proper], Cape Town, 12 June 1892, *Schlechter* 839 (Z, holo.; PRE, iso.!).

C. lutea forma *angustior* Zahlbr.: 27 (1900). Type: South Africa, [Western Cape], Caledon, Oct. [without year], *Penther* 494 (W, holo.†).

Leaves 4–10, mostly lanceolate, rarely linear, (2–)5–15(–20) mm wide. *Flowers* pale to golden yellow, often flushed reddish on reverse or tinged orange.

Distribution: endemic to winter rainfall South Africa, where it has been recorded from the Bokkeveld Escarpment and southern Roggeveld to the Cape Flats and Bredasdorp in the south and eastwards through the Little Karoo to Uitenhage. The subspecies is essentially restricted to renosterveld shrubland on fine-grained clay or laterite soils, rarely on stony limestone flats.

Diagnosis: recognized by the yellow perianth, often flushed reddish on the reverse and thus with an orange tinge, and the typically lanceolate leaves, mostly 5–15(–20) mm wide, rarely narrower and grass-like. *Flowering time*: mainly Sept.–Oct. but to Nov. in the southern Cape.

Representative specimens

NORTHERN CAPE.—3119 (Calvinia): Nieuwoudtville Reserve, (–AC), 12 Oct. 1983, *Perry & Snijman* 2372 (NBG, PRE); Oorlogskloof Nature Reserve, 15 km SW of Nieuwoudtville, (–AC), 14 Oct. 1996, *Pretorius* 388 (NBG); Lokenburg, (–AC), 23 Aug. 1980, *Van Berkel* 207 (MO). 3220 (Sutherland): Roggeveld Escarpment, Ouberg Pass, (–AD), 6 Sept. 2006, *Rösch* HR538 (NBG); Sutherland, Houthoek, (–CA), 13 Sept. 1971, *Hanekom* 1575 (PRE); Koedoesberg, (–CC), 1 Sept. 1973, *Oliver* 4378 (NBG).

WESTERN CAPE.—3218 (Clanwilliam): Farm Nurust, about 8 miles [13 km] N of Porterville, (–DD), 22 Sept. 1966, *Loubser* 2107 (NBG). 3318 (Cape Town): Bobbejaanberg above Groene Kloof [near Mamre], (–AD), Oct., *Ecklon & Zeyher* 269 (MO); N of Tigerberg [Tygerberg], (–CC), 20 Sept. 1947, *Barker* 4808 (NBG); Stellenbosch, Elsenburg, (DD), 5 Oct. 1938, *Penfold* 153 (NBG). 3319 (Worcester): Saron, (–AA), Oct. 1896, *Schlechter* 10633 (MO); Tulbagh, (–AC), Oct. 1920, *Marloth* 9939 (NBG); 5 miles [8 km] from Ceres at bottom of Theron's Pass, (–AD), 11 Nov. 1974, *Snijman* 9 (NBG); Karooport, (–BA), 26 Sept. 1944, *Compton* 16054 (NBG); Tanqua Karoo, near Bloukop, (–BD), 22 Sept. 1975, *Thompson* 2549 (NBG); Karoo Garden, Worcester, (–CB), 11 Sept. 1969, *Tarr* s.n. (NBG); Worcester, Langerug Koppe, (–CB), 23 Sept. 1974, *Walters* 1207 (NBG); Rooihooft Pass, (–DB), 28 Oct. 1980, *Mauve, Reid & Wikner* 197 (NBG). 3320 (Montagu): Laingsburg, Cabidu, (–AB), 28 Sept. 1951, *Compton* 22890 (NBG); Whitehill, (–BA), 20 Sept. 1943, *Compton* 14874 (NBG); S of Ashton, (–CC), 21 Sept. 1941, *Barker* 2032 (NBG); 14 km E of Montagu, Klipheuwel Farm, (–CC), 16 Oct. 1998, *Manning* 2195 (NBG). 3321 (Ladismith): Vleiland, N of Klein Swartberge, (–AC), 10 Oct. 1976, *Thompson* 3183 (NBG); road to Waterkloof NW of Ladismith, (–AD), 23 Oct. 1980, *Mauve, Reid & Wikner* 105 (NBG); S side of Rooiberg, (–CB), 22 Nov. 1983, *Mauve, Van Wyk & Pare* 40 (NBG); Van Wyksdorp, (–DA), 12 Sept. 1983, *Bohnen* 8297 (NBG). 3322 (Oudtshoorn): Prince Albert route 407 to Klaarstroom, Farm Welgelegen, (–AC), 1 Sept. 2006, *Roux* 4199 (NBG); George Forest, (–CD), 25 Nov. 1950, *Martin* 638 (NBG); De Rust, Ostekloof Farm, (–DA), 28 Sept. 1971, *Dahlstrand* 2088 (MO, PRE); Knysna, Barrington, (–DD), 14 Nov. 1949, *Barker* 6068 (NBG). 3419 (Caledon): Kogelberg State Forest, Remhoogte, (–AA), 25 Oct. 1984, *Brijs* 23 (NBG); Greyton, (–BA), 21 Oct. 1967, *Bayliss* 4019

(MO, NBG); 5 miles [8 km] NW of Riviersonderend, (–BB), 17 Sept. 1949, *Heginbotham* 83 (NBG); Swellendam to Stormsvlei, (–BB), 3 Oct. 1974, *Goldblatt* 2924 (MO); slopes of Kleinberg, ± 3 km NW of Napier, (–BD), 19 Oct. 1976, *Thompson* 3206 (NBG, PRE); ± 15 km NW of Napier, Fairfield Farm, (–BD), 3 Oct. 1994, *Kemper* IPC644 (NBG); Bredasdorp, Bosheuwel, (–BD), 6 Oct. 1982, *Cowling* 1882 (NBG). 3420 (Bredasdorp): Kathoek Farm, 30 km E of Bredasdorp, (–AD), 11 Oct. 1981, *Mauve & Hugo* 140 (NBG); De Hoop, Potberg Nature Reserve, (–AD), 12 Oct. 1978, *Burgers* 1276 (NBG); Swellendam, Bontebok Park, (–AB), 20 Sept. 1965, *Grobler* 490 (NBG); Struisbaai, ± 5 km on Bredasdorp road, (–CC), 26 Oct. 1987, *Fellingham* 1366 (NBG). 3421 (Riversdale): Blombos Road, 8–10 km S of Riversdale, (–AA), 11 Oct. 1993, *Goldblatt & Manning* 9792 (NBG); Reisesbaan siding, (–AB), 31 Oct. 1979, *Bohnen* 7051 (NBG); Still Bay, (–AD), 16 Oct. 1978, *Bohnen* 4463 (NBG). 3422 (Mossel Bay): Great Brak, (–AA), 21 Sept. 1959, *Lewis* 5601 (NBG). 3423 (Knysna): Plettenberg Bay, (–AB), 21 Nov. 1953, *Taylor* 4320 (NBG).

EASTERN CAPE.—3323 (Willowmore): flats between Hotsprings and Toorwater, (–AC), 5 Oct. 1971, *Oliver* 3646 (NBG, PRE); Vledermuis area between Fullerton & Heuningklip, (–BA), 14 Sept. 1973, *Oliver* 4582 (NBG); Baviaanskloof, Adamskraal, (–BC), 22 Oct. 1999, *Desmet* 2095 (NBG); Bellvue, ± 4 km from Avontuur, (–CC), 11 Nov. 1978, *Botha* 2188 (PRE); Suuranysberge, Voëlkraal Farm, (–CC), 1 Oct. 1984, *Stirton* 10903 (NBG). 3324 (Steytlerville): Kruisrivier–Hankey Dist., (–CB), [without date], *Manson* 297 (NBG); poort between Patensie and Cambria, (–DA), 11 Sept. 1973, *Thompson* 1885 (NBG).

8b. subsp. *rosea* (Eckl. ex Baker) J.C.Manning & Goldblatt, stat. nov. *Cyanella lutea* var. *rosea* Eckl. ex Baker: t. 259 (1871). Type: South Africa, [Eastern Cape], Queenstown, 1860, *T. Cooper* 270 (K, holo.!).

Note: Scott (1991) was of the opinion that no material of Cooper's collection had been preserved and thus lectotypified the name against the illustration in *Refugium Botanicum*, which was drawn from plants collected and cultivated by Thomas Cooper. There exists, however, a specimen at Kew, collected by Cooper in 1860 at Queenstown in the Eastern Cape where this form has since been re-collected, and labelled with the name *Cyanella rosea*. There seems no reason to doubt that it represents the original collection from which the cultivated plants were derived. This material, as the holotype, takes precedence over the illustration (McNeil *et al.* 2006: Art. 9.10 & 9.17). Baker's (1871) citation of the Ecklon manuscript name, *Cyanella rosea* Eckl., which appeared as a printed label on some herbarium collections, including *Ecklon* 255 (NBG), is a clear indication that the correct author citation for the epithet is Eckl. ex Baker.

C. lineata Burch.: 589 (1812). Type: South Africa, Bechuanaland [Northern Cape], near Moshowa [Moshaweng] River, without exact date [1811–1812], *Burchell* 2256-2 (K, holo.!).

C. odoratissima Ker Gawl.: t. 1111 (1827). Type: South Africa, Cape of Good Hope, without precise locality, date or collector, cultivated in Tate's nursery, London, apparently not preserved, illustration in Ker Gawl., *The Botanical Register* 13: t. 1111 (1827). [*Note*: Scott's (1991) attribution of the name to Lindley is incorrect, as John Bellenden Ker [–Gawler] wrote the text for the first 14 volumes (Stafleu & Cowan 1976), and John Lindley only assumed authorship from vol. 15].

C. lutea var. *angustifolia* Schinz: 48 (1896). Type: Namibia, Oas [Huib-Hoch Plateau], Oct. 1891, *Fleisch* 232 (Z, holo.!).

Leaves 6–12, linear-hemiterete to linear-lanceolate,

2–10(–12) mm wide. *Flowers* pale to deep pink or purple. *Flowering time*: mainly Aug.–Sept. in Namaqualand and Bushmanland; Oct.–Dec. in the interior and Eastern Cape.

Distribution: recorded from central Namaqualand around Springbok and the Huib-Hoch Plateau in southern Namibia, inland through Bushmanland along the Orange and Vaal Rivers as far as Kuruman in Northern Cape and Smithfield in the southern Free State, thence southwards through the eastern Upper Karoo to Humansdorp (Figure 13). Plants have been recorded mainly from sandy, sometimes calcareous, flats in Nama-Karoo shrubland or drier grassland, in the Kuruman area typically beneath small bushes. The subspecies is relatively poorly documented for such a large range.

Diagnosis: distinguished by its generally narrower, often grass-like leaves 2–12 mm wide, and its pink perianth. Plants from Namaqualand-Bushmanland and southern Namibia are especially distinctive in their very small stature, numerous, semi-terete leaves, and $\pm$ congested inflorescence branching near the base, giving them a characteristic caespitose appearance.

Representative specimens

FREE STATE.—3026 (Aliwal North): Smithfield, (–BA), Oct. [without year or collector], STE12787 (NBG).

NORTHERN CAPE.—2623 (Morokweng): Vryburg, (–DB), Sept. 1924, *Henrici 160* (PRE). 2723 (Kuruman): 36 miles [57.6 km] E-NE of Van Zylsrus, 2 miles [3 km] N of Kuruman River on Tsabong road, (–AD), 17 Oct. 1961, *Leistner 2886* (PRE). 2818 (Warmbad): 2 miles [3 km] S of Goodhouse, (–DD), 27 July 1950, *Lewis 3003* (SAM), 63739 (PRE); Goodhouse, (–BD), 27 July 1950, *Barker 6262* (NBG). 2819 (Ariamsvlei): Augrabies, (–DB), 21 Aug. 1954, *Compton 24474* (NBG); Augrabies Falls National Park, (–DB), 22 Aug. 2005, *Steyn 759* (NBG, PRE). 2820 (Kakamas): 12 miles [19 km] E of Kakamas, (–DB), 28 Aug. 1963, *Hardy & Rauh 1560* (PRE). 2823 (Griekwastad): Brakfontein, (–CD), 20 Sept. 1988, *Saaiman 227* (PRE). 2824 (Kimberley): Kuruman River 16 miles [25.6 km] W of Kuruman-Gordonia boundary, (–BA), 18 Oct. 1961, *Leistner 2893* (PRE). 2917 (Springbok): along Goodhouse road, (–BD), 20 Sept. 1980, *Van Berek 260* (NBG); near Springbok, (–DD), Sept. 1939, *Lewis 750* (SAM); Droëdap [SE of Springbok], (–DD), 27 Aug. 1941, *Barker 2029* (NBG). 2918 (Gamoep): Aggenys, (–BD), 13 Oct. 1971, *Wisura 2264* (NBG). 2922 (Prieska): Prieska, (–DA), [without date], *Bryant s.n. PRE38351* (PRE). 3017 (Hondeklipbaai): Theunis se Dam, 36 km S of Little Rock Caravan Park on Droëdap road, (–BB), 25 Aug. 1977, *Thompson & le Roux 37* (NBG); Droëdap, (–BB), 27 Aug. 1941, *Esterhuysen 5894* (PRE). 3023 (Britstown): De Aar, (–DB), 30 Aug. 1895, *Solly s.n. PRE38315* (PRE). 3024 (De Aar): Rolfontein Nature Reserve, Springbok Flats, (–BB), 9 Sept. 1982, *Coetzee s.n. PRE61030* (PRE).

WESTERN CAPE.—3223 (Rietbron): 20 km from Farm Rietbron on road to Murraysburg, (–BA), 13 Oct. 1983, *Retief & Reid 521* (PRE).

EASTERN CAPE.—3126 (Queenstown): lower slopes, (–DD), 1893, *Galpin 1568* (PRE). 3127 (Lady Frere): Little Bushy near Cala, (–DA), Dec. 1910, *Royffe s.n. TM25721* (PRE). 3225 (Somerset East): Mountain Zebra National Park, (–AD), 4 Oct. 1979, *Du Toit 155* (PRE); Addo National Park, (–BC), Nov. 1962, *Liebenberg 6620* (PRE). 3226 (Fort Beaufort): Bushman's River Mouth, (–DB), 2 Dec. 1941, *Barker 2034* (NBG). 3227 (Stutterheim): Queenstown, Bram Neck, (–AA), 28 Oct. 1946, *Thorns s.n.* (NBG); between Fish River and Governor's Kop, (–BD), 16 Oct. 1961, *Batten 1-Pl.83* (NBG). 3325 (Port Elizabeth): Kommadagga, (–BB), 27 Nov. 1973, *Bayliss 6199* (MO); Vanstadensberg, (–CC), Dec. [without year], *MacOwan 1086* (SAM); near Zwartkop River, (–DC), Nov. [without year], *Ecklon 255* (NBG, SAM). 3424 (Humansdorp): Humansdorp, (–BB), 14 Oct. 1928, *Gillet 2397* (NBG).

9. *Cyanella alba* L.f., Supplementum plantarum: 201

(1782). *Pharetrella alba* (L.f.) Salisb.: 47 (1866). Type: South Africa, without precise locality or date, *Thunberg s.n. Herb. Linn. 430.4* [LINN, lecto!., designated by Scott: 46 (1991)].

Plants 80–200 mm high. *Corms* deep-seated, 15–25 mm diam., tunics of coarsely netted fibres, extending into neck up to 50 mm long, pale brown. *Basal leaves* $\pm$ 10–20, erect, filiform to linear, (40–)50–100 $\times$ 0.5–3.0 mm, attenuate, leathery, bright green, glabrous. *Inflorescence* a highly congested, simple raceme such that flowers apparently solitary among leaves; pedicels suberect, (80–)100–200 mm long; bracteoles either sub-basal or inserted in upper half. *Flowers* enantiomorphic, facing outwards, white or pale pink or pale yellow, fragrant; tepals spreading, cucullate, outer elliptic, 12–20 $\times$ 5–7 mm, recurved-apiculate, inner ovate, 12–20 $\times$ 7–12(–15) mm, acute, narrowed basally or short-clawed, claw up to 1 mm long. *Stamens* weakly dimorphic or submonomorphic, 5 + 1; filaments of posterior cluster 3–5 mm long, connate only at extreme base, awl-shaped, white, anthers 3.5–5.5 mm long, yellow, sometimes marked with black spot on upper surface near base, sometimes cohering; anterior stamen with filament deflexed laterally, 3–4 mm long, awl-shaped, connate to upper cluster at extreme base, anther 4–6 mm long, yellow. *Ovary* half-inferior; style laterally deflexed opposite lower stamen, 7–9 mm long, not extending beyond lower anther. *Capsules* erect, ellipsoid, 13–15 $\times$ 7–8 mm, 3-lobed. *Seeds* ovoid, $\pm$ 2 mm diam., rugulose. *Chromosome number*: $2n = 24$ (subsp. *flavescens*: Ornduff 1979). *Flowering time*: (late Aug.–)mid-Sept.–mid-Oct.(Nov.). Figures 6M, N; 14.

Distribution and ecology: the species has a scattered distribution along the western mountains in Western Cape, where it is known from the Bokkeveld Escarpment, the Cedarberg and Olifants River Mtns, and the base of the Swartuggens (Figure 15). These three areas of occurrence correspond to the distribution of the three subspecies that we recognize. *Cyanella alba* is restricted to clay soils in renosterveld shrubland.

Diagnosis and relationships: one of the easiest species to identify on account of its highly congested inflorescence axis with extremely elongate pedicels, the flowers thus apparently borne on 1-flowered peduncles rather than in a raceme. The raceme is never branched, and up to a maximum of nine flowers are produced, thus very much fewer than in other species. The flowers are strongly enantiostylous, and either white to pale pink with uniformly yellow anthers, or pale yellow with maculate anthers. These colour morphs, which are geographically segregated, correlate with the position of the bracteole on the pedicels, and we recognize them as three subspecies. The large, ellipsoid capsule, 13–15 mm long, is unique in sect. *Cyanella*, resembling those of *C. cygnea* and *C. orchidiformis* in sect. *Trigella*.

Key to subspecies

- 1a Leaves filiform, 0.5–1.5 mm diam.; flowers white; bracteoles subbasal, not readily visible among leaves and thus apparently absent 9c. subsp. *minor*
- 1b Leaves linear-filiform, 1–3 mm wide; flowers white or yellow; bracteoles inserted in distal half of pedicel, thus



FIGURE 14.—*Cyanella alba*: A, subsp. *alba*, showing distal bracteole; B, subsp. *minor*, showing subbasal bracteole. Scale bar: 10 mm. Artist: John Manning.

clearly present:

- 2a Flowers 3–9 per plant, white or pale pink; anthers uniformly yellow 9a. subsp. *alba*
 2b Flowers 1–4 per plant, pale yellow or outer tepals white; upper anthers marked with black blotch adaxially near base 9b. subsp. *flavescens*

9a. subsp. *alba*

Plants (80–)100–200 mm high. *Leaves* linear, 1–3 mm wide. *Inflorescence* 3–9-flowered; pedicels with bracteole in distal half. *Flowers* white to pale pink. *Stamens*: anthers uniformly yellow. Figure 14A.

Distribution: endemic to the Bokkeveld Escarpment, from just north of Nieuwoudtville southward to Menzieskraal near Botterkloof (Figure 15).

Diagnosis: characterized by the long pedicels, (80–)100–200 mm long, with the bracteole inserted between one third and three-quarters along, and white or pale

pink flowers flushed darker pink on the reverse. The anthers are uniformly yellow, with the upper cluster free or coherent. Plants are often well grown, producing 3–9 flowers. The position of the bracteoles in the distal half of the pedicels distinguishes subsp. *alba* from subsp. *minor* from the Tanqua Basin to the south, which has similar flowers but subbasal bracteoles.

Representative specimens

NORTHERN CAPE.—3119 (Calvinia): N of Nieuwoudtville, Grasberg Farm, (–AC), 16 Sept. 1961, *Barker 9457* (NBG); Nieuwoudtville Reserve, (–AC), 8 Sept. 1983, *Perry & Snijman 2351* (NBG); ± 15 km S of Nieuwoudtville, Matjiesfontein Farm, (–AC), 13 Sept. 1976, *Thompson 2902* (NBG); Lokenberg Farm, (–CA), 26 Sept. 1933, *Acococks 17263* (PRE); 4 Sept. 1985, *Snijman 905* (NBG); Menzieskraal Farm, (–CA), 29 Sept. 1933, *Markotter s.n.* (NBG).

9b. subsp. *flavescens* J.C.Manning in Manning *et al.* in *Bothalia* 35: 119 (2005). Type: South Africa, Western Cape, Biedouwberg, 26 Aug. 1896, *Schlechter 8686* (SAM, holo.!, BOL!, PRE!, iso.).

Plants 120–200 mm high. *Leaves* linear-filiform, 1–2 mm wide. *Inflorescence* 1–4-flowered; pedicels with bracteole in distal 1/2. *Flowers* pale yellow or outer tepals white. *Stamens*: anthers yellow, upper five coherent and maculate with dark blotch on upper side near base.

Distribution: restricted to the northern Cedarberg and Olifants River Valley, between Clanwilliam and Wuppertal, and especially common in the Biedouw River Valley (Figure 15).

Diagnosis: a very distinctive taxon recognized by its pale yellow flowers (sometimes the outer tepals white) with the upper anthers coherent and marked on the upper side with a black blotch near the base. Up to four flowers are produced per plant.

Representative specimens

WESTERN CAPE.—3218 (Clanwilliam): Clanwilliam, (–BB), 4 Aug. 1896, *Schlechter 8405* (BOL, PRE); 10 km S of Clanwilliam, (–BB), 12 Sept. 1997, *Goldblatt & Manning 10741* (MO, NBG). 3219 (Wuppertal): Biedouw Mtn, (–AA), 20 Sept. 1937, *Lewis s.n.* (NBG); bottom of hill to Biedouw Valley, (–AA), 9 Aug. 1984, *Perry 3145*

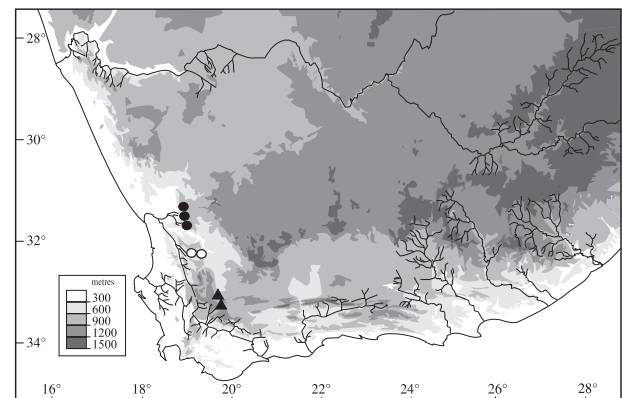


FIGURE 15.—Distribution of *Cyanella alba* subsp. *alba*, ●; subsp. *flavescens*, ○; subsp. *minor*, ▲.

(NBG); Farm Welbedacht, (–AA), 20 Sept. 1937, *Barker 283* (NBG); Koudeberg near Wuppertal, (–AA), 4 Oct. 1897, *Bolus 9095* (NBG); Citadel Kop, (–AA), 7 Sept. 1953, *Compton 24237* (NBG); near Wuppertal, (–AA), 28 Aug. 1951, *Martin 811* (NBG).

9c. subsp. **minor** J.C.Manning in Manning *et al.* in *Bothalia* 35: 119 (2005). Type: South Africa, Western Cape, Karooport, 27 Sept. 1944, *Barker 3024* (NBG, holo.).

Plants 80–150 mm high. *Leaves* filiform, 0.5–1.5 mm wide. *Inflorescence* 1–3-flowered; pedicels with bracteole subbasal. *Flowers* white to pale pink with darker pink on reverse. Stamens: anthers uniformly yellow. Figure 14B.

Distribution: highly localized and known only from just north of Karooport in the southern Tanqua Karoo basin (Figure 15).

Diagnosis: distinguished from the typical subspecies, which has similar white or pale pink flowers and uniformly yellow anthers, by the shorter pedicels, mostly < 100 mm (rarely up to 150 mm long) with the bracteoles sub-basal and thus difficult to distinguish from the leaves. This led Manning *et al.* (2005) to conclude that bracteoles were absent, and we were only able to establish the true situation after having the opportunity of dissecting live plants. The plants are typically small in stature, with only 1–3 flowers per plant.

Representative specimens

WESTERN CAPE.—3319 (Worcester): Karooport, (–BA), 19 Sept. 1938, *Levyns 6236* (BOL); Tanqua Karoo N of Karooport, (–BA), 9 Sept. 2007, *Goldblatt & Porter 12970* (NBG); 13 Sept. 2009, *Goldblatt, Manning & Porter 12970* (MO, NBG).

EXCLUDED SPECIES

Walleria paniculata Fritsch: 493 (1896). Type: Madagascar, Ins. St Marie, without date, *Paulay s.n.* (GZU, holo.) = *Dianella ensifolia* (L.) DC. (Hemerocallidaceae) (Perrier de la Bathie 1938).

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Notes on African plants

VARIOUS AUTHORS

HYACINTHACEAE

DRIMIA ECHINOSTACHYA, CORRECTING A NOMENCLATURAL OVERSIGHT

Crouch *et al.* (2010) reassessed the distribution and correct identification of a bulb species recently noted in the ethnomedicinal plant trade in KwaZulu-Natal. They used the name *Drimia cooperi* (Baker) Baker, following Jessop (1977) and subsequent checklist citations (Reid 1993; Manning & Goldblatt 2003, 2006).

Subsequently, it was discovered that this name is an illegitimate later homonym (McNeill *et al.* 2006: Art. 53.1) of *Drimia cooperi* Baker (1868), which is regarded as a synonym of *Ledebouria concolor* (Baker) Jessop by Jessop (1970). The name *Drimia cooperi* (Baker) Benth. ex Baker was actually the combination for *Ornithogalum cooperi* Baker (1873) made by Baker (1897). Transfer of the epithet *cooperi* to the genus *Drimia* is illegitimate because the resulting combination is preoccupied by *Drimia cooperi* Baker (1868). According to the rules of Botanical Nomenclature (McNeill *et al.* 2006), the next earliest available epithet must be used. Crouch *et al.* (2010) determined that the holotype of *Urginea echinostachya* Baker (1897) is conspecific with *Ornithogalum cooperi* Baker (1873), and *Urginea echinostachya* Baker is therefore the next earliest available name for the species. The necessary transfer to the genus *Drimia* is published below. In the past, *D. echinostachya* was regarded as a synonym of *D. macrocentra* (Baker) Jessop (Jessop 1977), despite the conspicuous morphological differences (Crouch *et al.* 2010).

An argument could be raised concerning the correct place of transfer of *Ornithogalum cooperi* Baker (1873) to *Drimia*: Baker (1897) attributed the new combination for this taxon to Benth. (in Benth. & Hooker 1883). However, consideration of Benth. & Hooker (1883) reveals that Benth. did not actually use the name *Drimia cooperi*, but simply remarked that *Ornithogalum cooperi* Baker appeared to belong to *Drimia*. This cannot be interpreted as a valid combination under the present nomenclatural rules (McNeill *et al.* 2006: Art. 33.1, Ex. 2). Herbarium acronyms follow Holmgren *et al.* (1990).

***Drimia echinostachya* (Baker) Eggl. & N.R. Crouch**, comb. nov. *Urginea echinostachya* Baker, *Flora capensis* 6: 468 (1897). Type: Natal [KwaZulu-Natal], Inanda, J.M. Wood 276 (K, holo.; NH, iso!).

Ornithogalum cooperi Baker: 284 (1873), syn. nov.; Benth.: 808 (1883). *Drimia cooperi* (Baker) Benth. ex Baker: 443 (1897), nom. inval. (Art. 33.1) et illegit. (Art. 53.1), non *D. cooperi* Baker: t. 18 (1868) [= *Ledebouria concolor* (Baker) Jessop]. Type: Cape [Eastern Cape], ‘ad oram orientalis’, *Barber s.n.* (TCD, lecto., designated by Jessop: 287 (1977);–K, photo!).

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FABACEAE

A NEW SPECIES OF *BAUHINIA* FROM SOUTHERN MOZAMBIQUE AND THE REINSTATEMENT OF *BAUHINIA MACRANTHA****Bauhinia burrowsii* E.J.D.Schmidt, sp. nov.**

TYPE.—Mozambique: Inhambane Province, near Mapinhane, 22° 13.385' S and 34° 54.347' E, 4 April 2010, E.J.D. Schmidt 5022 (PRE, holo.; BNRH, Ernst Schmidt Herbarium, K, LMA, PRU, iso.).

Shrub up to 5 m high; bark smooth and grey, sometimes covered with small lenticels; branches terete, reddish brown, sparsely puberulous, hairs reddish and soon lost, becoming grey with age; remnants of older branchlets form stout, branched thorn-like structures. Leaves alternate, 2-lobed to $\pm$ two-thirds of way, lobe apices rounded, base truncate to rounded; leaf lamina wider than long, 20–50 $\times$ 30–70 mm; venation palmate with 9 primary veins, veins darker than lamina in dried specimens, reticulation not prominent; dark green and hairless above, slightly paler below with white minutely appressed-puberulous indumentum, virtually invisible to the naked eye; margin entire; petiole 8–20 mm long. Inflorescence a terminal minutely appressed-puberulous raceme, up to 55 mm long, with up to 18 flowers; pedicels 3–10 mm long. Flowers bisexual and pentamerous, buds $\pm$ 45 mm long, upper part (sepals) $\pm$ 25 mm long and linear-lanceolate in outline; hypanthium $\pm$ 20 mm long, finely puberulous. Petals white, very narrowly elliptic to obovate, 20–33 $\times$ 2–4 mm, margin crisped, outside covered in small basifixed glands ($\pm$ 2 mm long), also present in young vegetative parts. Stamens 5, very slender, 30–40 mm long, white; anthers 2.5–3.5 mm long, dorsifixed close to middle of anther. Stigma 1.0–1.5 mm in diam., peltate. Style 3–6 mm long. Pod dehiscent, narrowly oblanceolate to linear-oblong, 60–220 $\times$ 17–28 mm, dark brown. Seeds up to 14 per pod, brown to olive, obovate to subcircular, 7–12 $\times$ 5–10 mm. Figures 1–5.

Diagnostic characters and affinities: the limited distribution and small flowers with narrow petals are diagnostic for *B. burrowsii*. The closest affinity would be *Bauhinia petersiana* Bolle. In flower, the new species is easily distinguished by the lack of prominent pink stamens and the generally smaller flowers. The width of petals in *B. petersiana* is at least 6 mm, whereas in *B. burrowsii*, the maximum is 4 mm. Furthermore, the anthers in the latter species are dorsifixed close to the middle of the anther; whereas in *B. petersiana*, they are situated more towards one side and are much larger—a minimum of $\pm$ 6 mm (up to 14 mm) long—as opposed to a maximum of 3.5 mm long in *B. burrowsii* (Brenan 1967; Coates Palgrave 2002; Schmidt *et al.* 2007). In short, the flowers of *B. burrowsii* are about half the size of *B. petersiana* with a different colour and a morphologically different anther attachment (Figure 5). In herbarium specimens, the leaves of *B. burrowsii* are glossier above than those of *B. petersiana*.

Distribution and habitat: currently only known from the type locality to the east of Mapinhane and a collection made by Barbosa & Balsinhas on 28 March

1952 [G. Barbosa & A. Balsinhas 5042 (K, photo!)]. Although collected the same time of the year, the latter specimen does not have flowers and is therefore easily mistaken. There is some doubt as to where exactly this specimen was collected, since it refers to a Vilanculos-Mabote-Mambone-‘cruzamento’ [crossing]. If this refers to the turn-off at Mapinhane (which seems to be the only logical conclusion, although the name is not used), this would be close to the type locality for *B. burrowsii*. It can be regarded as endemic to the area. It occurs in open woodland. This is part of the southern Zanzibar-Inhambane regional mosaic (White 1983). Another endemic, *Croton inhambanensis* Radcl.-Sm. was described from the same area. This species was subsequently collected as far south as Paidane on the coast and *B. burrowsii* may also occur as far south as the *C. inhambanensis*. Another endemic plant described from the vicinity is *Croton aceroides* Radcl.-Sm.

Status: *Bauhinia burrowsii* can be described as locally common where the type specimen was collected. The area is sparsely populated and the main economic activity is non-commercial existence agriculture, *i.e.* the planting of maize and cassava on a few scattered small plots. A commercial cattle farm has recently been established in the area. Thus far, this agriculture has had a minimal effect on the survival of the plant. Further studies are needed to establish if plants of the new species are indeed threatened. If it does occur further south in the Paidane area it would be under threat locally because of the threat of human expansion.

Etymology: the epithet honours John Burrows, for his unselfish contribution to the knowledge of the plants of southern Africa. The proposed common name for the species is the *Manyikeni Bauhinia*, after Zimbabwe de *Manyikeni*, a historical site close to the type locality. A visit to the site by the author led to the discovery of the plant.

Other specimens examined

MOZAMBIQUE.—2234 Mabote: ‘entre o cruzamento de estradas Vilanculos-Mambone-Maboti e o Maboti, a 8.7 km de cruzamento’ [between the cross-roads Vilanculos-Mambone-Maboti and the 8.7 km crossing], 28 Mar. 1952, G. Barbosa & A. Balsinhas 5042 (K, photo!); near Mapinhane, (–BA) 22° 13.388'S and 34° 54.395'E, 27 Mar. 2009, E.J.D.Schmidt 4670 (Ernst Schmidt Herbarium, LMA, PRE); *ibid.*, (–BA) 22° 13.371'S and 34° 54.370'E, 4 Apr. 2010, E.J.D.Schmidt 5020 (Ernst Schmidt Herbarium, LMA).

THE REINSTATEMENT OF *BAUHINIA MACRANTHA*

During the research into the species of *Bauhinia*, it became apparent that the current classification of *Bauhinia petersiana* Bolle is unsatisfactory. Brummitt & Ross (1975) treated the differences between the taxa previously known as *B. macrantha* Oliv. and *B. petersiana*, and came to the conclusion that they should be treated as subspecies, namely *B. petersiana* Bolle subsp. *serpae* (Ficalho & Hiern) Brummitt & J.H.Ross and *B. petersi-*



FIGURE 1.—*Bauhinia burrowsii*, E.J.D. Schmidt 4670 (PRE): A, flowering branchlet; B, fruit. Scale bar: 20 mm. Artist: Carla Grinstad.



FIGURE 2.—*Bauhinia burrowsii*, habit in type locality, April 2010. Photographer: Ernst Schmidt.



FIGURE 3.—*Bauhinia burrowsii*, flowers at type locality, March 2009. Photographer: Ernst Schmidt.



FIGURE 4.—*Bauhinia burrowsii*, flowers and fruit at type locality, March 2009. Photographer: Ernst Schmidt.

ana Bolle subsp. *petersiana*. The name *serpae* referred to the previously entity known as *B. macrantha* and was a result of an unfortunate decision in Seattle in 1969 at the International Code of Botanical Nomenclature meeting (Coetzer & Ross 1977). The subspecies name was later changed to *B. petersiana* Bolle subsp. *macrantha* (Oliv.) Brummitt & J.H.Ross (Brummitt & Ross 1982).

The main reasons for regarding the taxa as subspecies and not full species are that their distributions are almost entirely allopatric and that there is, according to the authors, sufficient overlap of characteristics to justify it.

An allopatric distribution may be an indication that two entities are geographical different races of the same species, and therefore subspecies. However, it is also a well-known source of full species known as allopatric speciation. It is interesting, however, that in Zimbabwe and Zambia the two entities do occur together. They are therefore strictly not allopatric. There are no reports or collections of intermediates from these areas in which they occur together. If they were indeed of the same species one would have expected intermediates. There are almost no variations within the entities throughout their respective ranges. Therefore the evidence on distribution supports the recognition of these entities as full species.

Furthermore a combination of overlapping features is not conclusive proof of entities being mere subspecies and not full species. It may also be used to differentiate between species. There are many keys that use a combination of overlapping keys to differentiate between species. Field observation and field botanists support the full species status of these entities.



FIGURE 5.—Photographic comparison between flowers of *Bauhinia petersiana* subsp. *petersiana* (left) and *B. burrowsii* (right). Photographer: Ernst Schmidt.

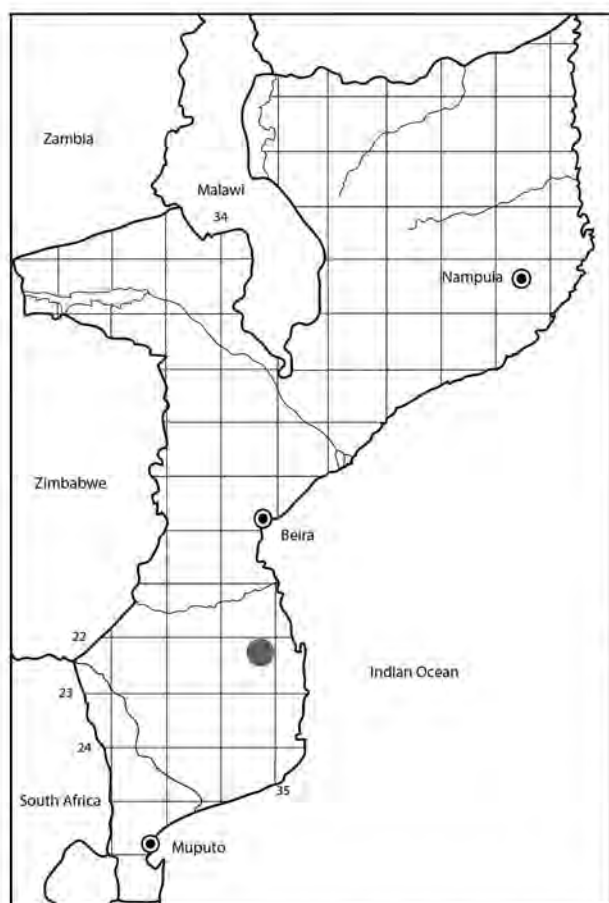


FIGURE 6.—Known distribution of *Bauhinia burrowsii*.

The author therefore respectfully reinstates the entities as full species as it was before 1975 and the correct names are as follows (there are no subspecies for these species):

Bauhinia macrantha Oliv. in Flora of Tropical East Africa 2: 289 (1871). Type: Angola, Ninda, *Serpa Pinto* 9 (LISU, holo.).

Bauhinia petersiana Bolle in Peters, Naturwissenschaftliche Reise nach Mossambique: '...' Botanik 1: 24 (1861). Type: Mozambique, 'rios de Sena', *Peters s.n.* (B, holo. †, K).

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HYACINTHACEAE

NEW COMBINATIONS IN *LEDEBOURIA*

The close relationship among *Drimiopsis* Lindl. & Paxton, *Ledebouria* Roth and *Resnova* Van der Merwe (Hyacinthoideae: Massonieae) that was highlighted by Jessop (1972) has subsequently resulted in their segregation as the subtribe Ledebouriinae within tribe Massonieae (Müller-Doblies & Müller-Doblies 1997). Characters that define the group include the mostly spotted or streaked leaves, commonly multiple inflorescences per annual growth cycle, reduced or obsolete bracts, and paired ovules per locule; often with just a single seed developing in only one or two of the locules. The leathery capsule walls and the complete dehiscence, with the locules reflexing completely, are diagnostic for the group.

The generic status of the three taxa is less clear, however, and *Resnova* has usually been treated as synonymous with either *Drimiopsis* (Jessop 1972) or

Ledebouria [as *Scilla*] (Phillips 1951). More recently, Müller-Doblies & Müller-Doblies (1997) proposed their reinstatement at generic level, a treatment that was followed by Lebatha *et al.* (2006). The development of molecular techniques has prompted a renewed interest in the systematic status of the three genera, but preliminary phylogenetic analyses of plastid sequence data have either failed to provide compelling evidence supporting the recognition of three genera (Manning *et al.* 2004), or have actually demonstrated that *Ledebouria* is paraphyletic unless it includes *Drimiopsis* and *Resnova*, although the latter two are evidently monophyletic (Pfosser & Speta 1999; Pfosser *et al.* 2003; Wetschnig & Pfosser 2003; Lebatha *et al.* 2006; Wetschnig *et al.* 2007). A morphological cladistic analysis of the group provided only weak support (jackknife support value 55) for a monophyletic *Ledebouria*, based on a limited sampling of just eight species in the genus (Lebatha *et al.*

2006). Proposed synapomorphies for *Ledebouria* s.str. were a conical and severally lobed ovary, a style that is longer than the ovary, and punctate-reticulate pollen (Lebatha *et al.* 2006). Of these states, ovary shape and lobing are not consistent across the genus, with both ovoid and turbinate and 3- or 6-lobed ovaries present in the genus (Venter 2008). *Ledebouria* s.str. thus remains very weakly diagnosable.

The lack of convincing molecular evidence supporting the recognition of the three genera as monophyletic lineages led Manning *et al.* (2004) to include both *Drimiopsis* and *Resnova* in a broadly circumscribed *Ledebouria*. They suggested that the various floral differences between the three taxa that are generally used to justify their separation at generic level probably represent linked pollination syndromes, and are thus not independent. In any event, there is no doubt that the three taxa are closely allied, and their taxonomic status at this stage is primarily a matter of choice, although molecular data favours their treatment as a single genus.

The broader circumscription of *Ledebouria* proposed by Manning *et al.* (2004) has been implemented in the latest checklist of southern African plants (Manning & Goldblatt 2006), but a new species of *Drimiopsis* described since then (Hankey *et al.* 2008) lacks a nomenclatural combination in *Ledebouria*. We provide this combination here to facilitate its integration into checklists and floras that adopt the broader generic circumscription. A combination is also provided for *Resnova transvaalensis* Van der Merwe, which was treated by Manning *et al.* (2004) as conspecific with *Resnova humifusa* Van der Merwe, following Müller-Doblies & Müller-Doblies (1997), but which we now consider to be distinct.

We also take this opportunity to formalize the status of *Drimiopsis* and *Resnova* at sectional level within *Ledebouria*. Current morphological and molecular analyses suggest that these two groups are monophyletic and it is useful to have a formal way of referring to them as infrageneric clusters within *Ledebouria* (Lebatha *et al.* 2006). It is likely that additional sections will be required in order to render sect. *Ledebouria* monophyletic, but this will require a more complete analysis of the group.

***Ledebouria* Roth, *Novae plantarum species praesertim Indiae orientalis*: 194 (1821). Type: *Ledebouria hyacinthina* Roth**

Section ***Drimiopsis*** (Lindl. & Paxton) J.C.Manning & Goldblatt, stat. nov.

Drimiopsis Lindl. & Paxton: 73 (1851). Type: *Drimiopsis maculata* Lindl. = *Ledebouria petiolata* J.C.Manning & Goldblatt

***Ledebouria linioseta* (A.J.Hankey & P.D.Lebatha) J.C.Manning & Goldblatt, comb. nov. *Drimiopsis linioseta* A.J.Hankey & P.D.Lebatha, in Hankey *et al.*: 72 (2008). Type: South Africa, Mpumalanga, between Roossenekal and Lydenburg, 25 Nov. 1999, Hankey & Turner 900 (PRE, holo.; K, iso.).**

Section ***Resnova*** (Van der Merwe) J.C.Manning & Goldblatt, stat. nov.

Resnova Van der Merwe: 46 (1946). Type: *Resnova humifusa* (Baker) U.Müll.-Doblies & D.Müll.-Doblies, designated by Müller-Doblies & Müller-Doblies (1997: 59).

***Ledebouria transvaalensis* (Van der Merwe) J.C.Manning & Goldblatt, comb. nov. *Resnova transvaalensis* Van der Merwe: 46 (1946). Type: South Africa, [Mpumalanga], Piet Retief Distr., Amsterdam, Van der Merwe s.n. PRE26432 (PRE, holo.).**

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AIZOACEAE

CORPUSCULARIA GRACILLIMA IS THE CORRECT BINOMIAL FOR THE ILLEGITIMATE *C. GRACILIS*

L. Bolus validly published *Delosperma gracile* L.Bolus in 1958 and later, in 1961, but based on a different type. She rectified this error (Bolus 1964) by providing the new name *D. gracillimum* L.Bolus for the illegitimate later homonym. Hartmann (2001), when transferring *D. gracillimum* from *Delosperma* to the genus *Corpuscularia* erred in using the epithet *gracilis* (Hartmann 2001). According to the International Code of Botanical Nomenclature, for any taxon below the rank of genus, the correct name is the combination of the correct genus name and the final epithet of the earliest legitimate name of the taxon in the same rank (McNeill *et al.* (2006): Article 11.4), which in this case is *D. gracillimum*. Therefore, the correct name within the genus *Corpuscularia* is *C. gracillima*. If no available epithet existed, Hartmann could have re-used the epithet *gracilis* as new, without reference to L.Bolus (Art. 58.1), but this was not the case. Furthermore, because she cited *Delosperma gracillimum* L.Bolus as a synonym, the binomial *Corpuscularia gracilis* H.E.K.Hartmann is superfluous and illegitimate (McNeill *et al.* (2006): Art. 52.1). Herbarium acronyms follow Holmgren *et al.* (1990).

***Corpuscularia gracillima* (L.Bolus) Niederle** comb. nov. *Delosperma gracillimum* L.Bolus in Journal of South African Botany 30: 243 (1964), as nom. nov. pro *D. gracile* L.Bolus (1961) non L.Bolus (1958). *D. gracile* L.Bolus: 180 (1961), hom. illegit. *Corpuscularia gracilis* (L.Bolus) H.E.K. Hartmann: 177 (2002 '2001'), nom. illegit. superfl. Type: South Africa, Cape [Eastern Cape], Seven Fountains near Grahamstown, 1959, Hall, H. NBG 102/59 (BOL 131214—central branch, lecto!., here designated).

L. Bolus treated the whole gathering Hall, H. NBG 102/59 as the type. According to McNeill *et al.* (2006), Art. 8.2, Ex. 1., the whole sheet BOL131214 cannot serve as type because it contains four branches, which

I interpret as belonging to the original collection, and further flowers dated 28 March 1961. The problem concerns nearly all sheets prepared by L. Bolus who later added flowers to specimens. The names published by her on or after 1 January 1958 would be problematic if the collections indicated as types were of living plants or seeds in reality. My lectotypification overcomes the problem, whether the branches belong to the original gathering or to plants cultivated by L. Bolus.

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IRIDACEAE

TAXONOMIC NOTES ON *MORAEA* (IRIDACEAE) IN CONGO AND ADJACENT COUNTRIES

The genus *Moraea* Miller, now with some 210 species (including several in press or manuscript), is centred in southern Africa (Goldblatt 1986; Goldblatt & Manning 2010), but extends through tropical Africa to Ethiopia and Eritrea in the north and to Nigeria and Cameroon in the west. Outside the continent, two species of sect. *Gynandris* (Parlatore) Goldblatt (Goldblatt 1998) occur in the Mediterranean basin and Middle East. Goldblatt (1977) recognised 24 species in tropical Africa, but later separated *M. stricta* Baker from *M. thomsonii* Baker (Goldblatt 1986). Of these 25 tropical African species, six are shared with eastern southern Africa, leaving 19 species restricted

to tropical Africa. Geerinck (2001), focusing on the genus in Shaba Province of Congo (Kinshasa), has recently described one new species, *M. schaijesiorum* Geerinck, and reduced two species recognised by Goldblatt (1977) to synonymy in *M. ventricosa* Baker: *M. macrantha* Baker to varietal rank as var. *macrantha* (Baker) Geerinck and *M. verdickii* De Wild. to the rank of forma in var. *macrantha*. In addition, Geerinck described f. *boussardiana* Geerinck of var. *ventricosa* and f. *witteana* Geerinck of var. *macrantha*. These infraspecific taxa were distinguished by minor details of perianth size and colour, with var. *ventricosa* and var. *macrantha* based on flower size, specifically

outer tepals and anthers, and f. *boussardiana* and f. *witteana* by flower colour alone.

Moraea ventricosa is particularly distinctive among the several large-flowered species of subgen. *Grandiflora* Goldblatt in its yellow, white, or blue flowers with outer tepals 40–55 mm long, inner tepals 37–45 mm long, and anthers 8–11 mm long. Both the larger outer and smaller inner tepal limbs are characteristically spatulate, obtuse and ultimately fully reflexed, with the broad style branches and crests arching to lie nearly horizontally, and the ovary is always included in the spathes (Goldblatt 1977, 1993, 1996). The species favours wet habitats such as stream banks, seeps, and dambos; and occurs across central Africa from Angola to Tanzania. *Moraea macrantha*, with much the same range, is a plant of well-drained, open woodlands or grasslands, and has larger, consistently blue flowers with outer tepals 57–80 mm long, inner tepals 55–75 mm long, and anthers 12–15 mm long. Both species flower late in the season, mainly March to May or June.

Moraea verdickii is less well known to us but it blooms early in the season, mostly November to February, usually has an exerted ovary, and has relatively large yellow, or rarely white flowers, with outer tepals mostly 60–80 mm long (rarely to 100 mm) and the inner tepals 45–70 mm long, acute and evidently erect (as far as we are able to determine) (Goldblatt 1977; see also Geerinck 2005: photo 4). In comparison, plants of *M. ventricosa* that we have examined always have smaller flowers with an included ovary and the diagnostic, markedly obtuse inner and outer tepals with fully reflexed limbs. These features are also evident in a photograph accompanying the type of f. *boussardiana*.

In view of the correlated morphological and ecological characteristics, we feel justified in maintaining *Moraea verdickii* and *M. macrantha* as separate species distinct from *M. ventricosa*. Within *M. ventricosa* as thus circumscribed, however, we consider the rank of forma to be trivial and not worthy of recognition, and we therefore reduce the forms to synonymy. The forms in this case appear to be local colour variants and a full review of the tropical African species over their entire ranges should be undertaken before any infraspecific taxa are identified. Those wishing to recognise Geerinck's forms remain free to do so as the names exist and constitute an alternative treatment of the group, at least in Congo.

Finally, we have examined the type of *Moraea schaijesiorum* and conclude that it differs in no significant way from *M. clavata* R.C.Foster, until now recorded in the literature only from Angola and Zambia, to the south and west of Congo. However, a collection of *M. clavata* from Shaba [*Schaijes & Michiel* 2083, 6 Sept. 1983, 17 km WSW of Kolwezi (K)], not cited by Geerinck, is the first record of the species in the Congo. The type of *M. schaijesiorum* was collected in 1988, and both it and the earlier Shaba collection match typical *M. clavata* in their relatively small, yellow flowers with outer tepals 20–35 mm long, short foliage leaf inserted in the middle of the stem, single sheathing leaf, and spathes 45–70 mm long. The early flowering time (November in the type), is also consistent with *M. clavata*, the main blooming time of which is from October to Decem-

ber (Goldblatt 1977). The occurrence of the species in Shaba, not far from the Zambian frontier is not surprising. We have no hesitation in reducing *M. schaijesiorum* to synonymy in *M. clavata*.

***Moraea clavata* R.C.Foster** in Contributions from the Gray Herbarium 114: 49 (1936), as nom. nov. pro *Moraea gracilis* Baker: 272 (1878), hom. illegit. non A.Dietr. (1833). Type: Angola, Huila, near Lopollo River, *Welwitsch 1545* (BM, lecto.), designated by Goldblatt: 287 (1977); K!, LISU!, isoleccto.).

M. schaijesiorum Geerinck: 11 (2003), syn. nov. Type: Congo, [Shaba], plateau de Manika, road from Kolwezi to Musokatanda, 8 Nov. 1988, *Schaijes 4144* (BR, holo.).

***Moraea macrantha* Baker**, Flora of tropical Africa 7: 340 (1898). *M. ventricosa* var. *macrantha* (Baker) Geerinck: 4 (2001). Type: Malawi, Northern Province, Whyte s.n. (K, holo.).

Moraea arnoldiana De Wild.: 16 (1902). Type: Congo, [Shaba], Kasenga, *Verdick 606* (BR, holo.).

***Moraea ventricosa* Baker** in Bulletin of Miscellaneous Information, Royal Botanic Gardens, Kew 1895: 73 (1895). Type: Zambia, Northern Province, Fwambo, *Carson 37/1984* (K, holo.).

M. bequaertii De Wild.: 540 (1913). *M. ventricosa* f. *bequaertii* (De Wild.) Geerinck: 4 (2001). Type: Congo, [Shaba], Lubumbashi, 5 Apr. 1912, *Bequaert 316* [BR, lecto.), designated by Goldblatt: 280 (1977)].

M. ventricosa f. *boussardiana* Geerinck: 4 (2001), syn. nov. Type: Burundi, Kigamba, 3 Apr. 1977, *Reekmans 5982* (BR, holo.).

***Moraea verdickii* De Wild.** in Annales du Musée du Congo Belge, Bot. 4: 17 (1902). *M. ventricosa* var. *macrantha* f. *verdickii* (De Wild.) Geerinck: 5 (2001). Type: Congo, [Shaba], Lukafu, *Verdick 281* (BR, holo.).

M. ventricosa var. *macrantha* f. *witteana* Geerinck: 5 (2001), syn. nov. Type: Congo, Parc National Upemba, Riv. Kenia, 28 Mar. 1947, *De Witte 2470* (BR, holo.).

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MONIMIACEAE

TAXONOMIC AND NOMENCLATURAL NOTES ON THE MONOTYPIC GENUS *Xymalos* AND GENERAL INFORMATION ON THE FAMILY MONIMIACEAE

INTRODUCTION

Harvey (1863) originally described *Xylosma monospora* Harv., based on specimens from KwaZulu-Natal but without precise localities (*Cooper 1251* and *Cooper 1204*), as belonging to the Flacourtiaceae. In 1878, Bentham described *Toxicodendrum acutifolium* Benth. from the Eastern Cape for the same taxonomic entity but placed it in the Euphorbiaceae. Later Engler (1895, 1900) described the species yet again, this time from Tanzania, under the name *Paxiodendron usambarense* Engl. but placing it in the Lauraceae.

Baillon (1887) compared Harvey's *X. monospora* (which has a monocarpellary ovary with a solitary ovule, sessile stigma, and drupaceous, non-dehiscent fruit) with *Hyaenanche* Lamb., then in the Euphorbiaceae but now in Picramniaceae (APG III 2009). Species of *Hyaenanche* have 4-locular ovaries with two ovules per locule, 3–5 styles connate in the lower half, and dehiscent capsules. Baillon (1887) concluded that the two entities placed respectively by Bentham (1878) in *Xylosma* G.Forst. and by Harvey (1863) in *Toxicodendrum* were in fact conspecific but did not belong in either *Toxicodendrum* or *Xylosma*. He therefore placed it in a new genus *Xymalos* Baill., which is an anagram of *Xylosma*, which means fragrant wood—referring to the leaves and wood that are lemon-scented when crushed. He placed *Xymalos* in the Bixaceae.

De Jussieu founded the family Monimiaceae in 1809 based on three genera, *Monimia* Thou., *Atherosperma* Labill. (a monotypic genus from Australia and Tasmania), and *Siparuna* Aubl. (a large neo-tropical genus with over 70 species). Oliver (1896) was the first to place *Xymalos* in the Monimiaceae and also emended the generic description. This familial transfer was followed by amongst others Baker & Wright (1909), Per-

kins & Gilg (1911), Wright (1912), Engler (1915), Verdcourt (1968), and Stannard (1997). Warburg (1893) recognized *Xymalos* as closely related to the Flacourtiaceae, but Gibbs (1917) and Hutchinson (1973) both placed *Xymalos* in the Trimeniaceae. Currently *Xymalos* is placed in Monimiaceae subfamily Mollinedioideae (Thorne 1974; Philipson 1987, 1993). Molecular data support this classification (Renner 1998, 1999). Monimiaceae is a pantropical family in the order Laurales and in a broad sense comprises 440 species and 34 genera (Philipson 1987, 1993). The small families Atherospermataceae and Siparunaceae have since been excluded from the Monimiaceae. Trimeniaceae is excluded from the order Laurales—a decision that is well supported by phylogenetic and morphological studies (Mooney *et al.* 1950; Renner 1999; Renner & Chanderbali 2000; Romanov *et al.* 2007; APG III 2009). Mabberley (2008) recorded 24 genera in the family but the new monotypic genus, *Graziellanthus*, from the Brazilian Atlantic Coastal Forest has since been described by Peixoto & Pereira-Moura (2008). The family currently comprises 150–220 species of shrubs and small trees in 25 genera (Renner *et al.* 2010). It has a highly disjunct, presumably Gondwanan distribution, mainly in the southern hemisphere (Renner *et al.* 2010). *Xymalos monospora* occurs in montane forests in east tropical and southern Africa, West Cameroon, and on Bioko, an island once connected to Africa (Figure 1).

Monimiaceae, together with the closely related families Lauraceae and Hernandiaceae (*Gyrocarpus* Jacq.), are characterized by having secretory cells containing so-called 'etheral oil' (etheral oil cells) and a unilacunar nodal anatomy (Mooney *et al.* 1950). Monimiaceae can be recognized by decussate to subopposite, exstipulate leaves; twigs that are often flattened below the somewhat swollen nodes; leaves that are pellucid-

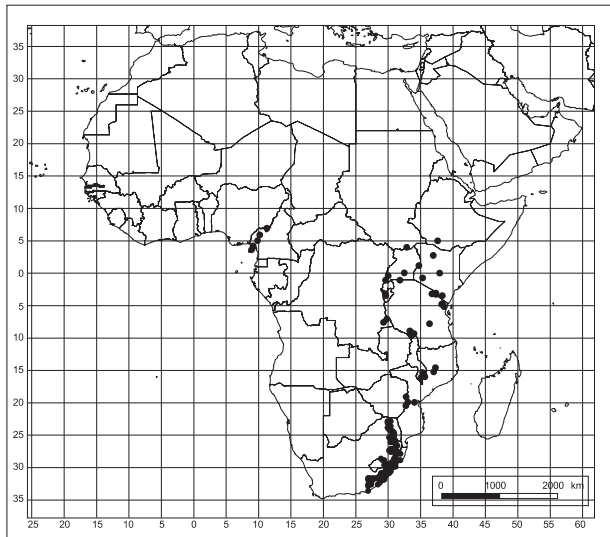


FIGURE 1.—Distribution of *Xymalos monospora* based on specimens housed in the National Herbarium, Pretoria, and on the literature (Verdcourt 1968; Stannard 1997).

dotted due to the presence of numerous glands or ‘ethereal oil cells’ (Lorence 1985), and are lemon-scented when crushed. The lack of stipules is considered by Hickey & Wolfe (1975) to be derived within the Laurales. *Xymalos* has leaves with margins that possess a ‘monimioid tooth’ with an undivided median vein and an indurated cap (Figure 4), another derived character in the Laurales (Lorence 1985), or the leaves are sometimes entire. Leaves are pinnately veined with prominent venation on the lower surface and the secondary veins originate at uniform angles to the costa (Lorence 1985), looping and joining well within the margin, sometimes leaving a bullate or puckered surface above. Plants are usually dioecious or monoecious and the yellow flowers are very small and mostly unisexual, except for *Hortonia* Wight ex Arn., which have bisexual flowers (Endress & Igersheim 1997). The latter is a Sri Lankan genus, sister to *Xymalos* (Renner *et al.* 2010), and possesses flowers with an elaborate perianth comprising spirally arranged petaloid and sepaloid series, 6–14 free, stalked carpels borne on a discoid receptacle, appendaged stamens and with staminodes present (Lorence 1985). The receptacle in Monimiaceae is deeply concave, cupuliform or urceolate (Mooney *et al.* 1950). The family is characterized by apocarpous gynoecia with uniovulate carpels (Endress & Igersheim 1997), surrounded by a flat or concave floral cup (Lorence 1985). The fruit(lets) are presented on the opened floral cup. Male flowers have a 4–8-lobed perianth with few to many stamens, with or without appendages and arranged in whorls or sometimes spirally or irregularly disposed, either without a pistillode or with remnants of one. The anthers are 2–4-sporangiate. Staminodes are absent or present in female flowers, carpels are few to many (only one in *Xymalos*) and sessile or stipitate, with a solitary, anatropous ovule. In the genera *Kibara* Endl. (Malaysia) and *Xymalos* (Africa) the discoid stigma is sessile on the turbinate ovary, but a style is present in all other genera, typically short and included, but exserted in *Monimia* (Philipson 1986, 1993). Ovules in *Xymalos* are crassinucellate and bitegmic (Leinfellner 1966) and the carpels are strongly ascidiate in the Mollinedioideae (Endress

& Igersheim 1997). The fruit are either separate drupelets with a $\pm$ strongly developed putamen formed by the lignified endocarp, or apocarpous berrylets frequently enclosed in a persistent, well-developed fleshy hypanthium and/or receptacle (Philipson 1986; Romanov *et al.* 2007). Romanov *et al.* (2007) described these two fruit forms in the family and distinguished four different types of drupe(lets) differing in their endocarp structure.

Klopper *et al.* (2006) record *Xymalos mossambicensis* Cavaco as occurring in tropical Africa. Cavaco (1949) described this species from Mozambique but the name was not taken up by Verdcourt in his account of the *Flora of tropical East Africa* (1968), nor by Stannard in his account for *Flora zambesiaca* (1997), both of which only mention *Xymalos monospora*. Both of these authors and subsequent publications by Philipson (1993), Jordaan (2000, 2003), Da Silva *et al.* (2004) and Mabberley (2008) consider *Xymalos* a monotypic genus occurring in tropical and southern Africa. In Mozambique, *Xymalos* is recorded north of the Zambezi River at Ribáuê, Gurué (Stannard 1997) and Nampula (Da Silva *et al.* 2004) and south of the Zambezi at Tsetssera (Stannard 1997). Cavaco collected a specimen south of the Save River (southern Mozambique) and somewhere between Mapai and Pafuri (Kruger National Park area) (type specimen mentioned in the protologue). In this area between Save River and Mapai there is certainly no suitable habitat for *Xymalos monospora*, which usually grows in Afromontane forest, and the closest locality, Tsetssera, is roughly 400 km to the north of the Mapai-Pafuri record. Therefore, the locality is very doubtful as given in the protologue, namely: ‘Sul do Save, entre Mapai et Pafuri, in Moçambique’.

Cavaco compared the holotype of *X. mossambicensis* with specimens of *X. monospora* from southern and tropical Africa housed in the Paris Herbarium (e.g. *Rudatis* 1418, *Stolz* 2063, *Holst* 4249) and concluded that his specimen constituted a new species. We have not seen the type but Cavaco’s (1949) protologue and accompanying illustration indicate that *X. mossambicensis* differs essentially from *X. monospora* in having larger leaves with entire margins and fasciculate rather than racemose inflorescences. Throughout the distribution range of *X. monospora*, the leaf margins vary from entire (Figure 2) to coarsely serrate with widely spaced gland-tipped teeth (Figure 3). Inflorescences are always axillary and vary from cymose to racemose. There are no significant differences between *X. mossambicensis* and *X. monospora*, and they are therefore considered as conspecific.

TAXONOMY

***Xymalos monospora* (Harv.) Baill.** in Bulletin Mensuel de la Société Linnéenne de Paris 1: 650 (1887); Warb.: 53 (1893); Oliv.: t. 2444 (1896); Sim: 288, t. 121 (1907); Baker & C.H.Wright: 170 (1909); Perkins & Gilg: 10, t. 5 (1911); C.H.Wright: 493 (1912); F.W.Andrews: 7 (1950); J.Léonard: 402, t. 39 (1951); Keay: 55 (1954); Verdc.: 1, t. 1 (1968); Fouilloy: 109 (1974); R.B.Drumm.: 237 (1975); Pooley: 96 (1993); A.E.van Wyk & P.van Wyk: 302 (1997); Stannard: 43 (1997); Lötter: 114 (2002); M.Coates Palgrave: (2002);



FIGURE 2.—*Xymalos monospora* showing entire leaves. Photographer: M. Lötter.



FIGURE 3.—*Xymalos monospora* showing toothed leaves and some leaf damage. Photographer: M. Lötter.

Boon: 104 (2010). *Xylosma monospora* Harv.: 52, t. 181 (1863). Type: South Africa, Natal [KwaZulu-Natal], without precise locality, *Cooper 1251* (TCD—digital image!, lecto., designated here; K—digital image!, PRE!, isolecto.). [Note: Of the two collections cited in Harvey's protologue of *Xylosma monospora*, *Cooper 1251* is chosen as the lectotype because there are more duplicates of this collection than of *Cooper 1204*.]

Toxicodendrum acutifolium Benth.: 214 (1878). Type: South Africa, Eastern Cape, 'British Caffraria', *Barber & Barber 10* (K—digital image!, holo.).

Paxiodendron usambarense Engl.: 182 (1895). *Xymalos usambarense* (Engl.) Engl.: 310 (1901). Type: Tanganyika [Tanzania], E Usambara Mountains, Gonja, Bulwa, *Holst 4249* (B, holo.†; P—digital image!, lecto., designated here; COI—digital image!, JE—digital image!, K—digital image!, isolecto.).

P. usambarense var. *serratifolia* Engl.: 182 (1895). Type: Tanganyika [Tanzania], Kilimanjaro, Marangu, *Volkens 2264* (B, holo.†; JE—digital image!, lecto., designated here).

P. ulugurense Engl.: 389 (1900). *Xymalos ulugurense* (Engl.) Engl.: 310 (1901); Baker & C.H.Wright: 170 (1909). Type: Tanganyika [Tanzania], Uluguru Mountains, Lukwangule Plateau, *Goetze 274* (B, holo.†; K—digital image!, lecto., designated here).

Xymalos mossambicensis Cavaco: 45 (1949). Type: 'Moçambique [Mozambique], Sul do Save, entre Mapai et Pafuri', *Cavaco 89* (P, holo.).

Note: Most type specimens were seen as digital images on websites. Where the holotypes have been destroyed during World War II in the Berlin Herbarium, as in the case of *Holst* and *Goetze* specimens, lectotypification is covered by article 9.15 of the Code (McNeill *et al.* 2006), which provides for narrowing the lectotype to a single specimen. There are records of duplicates of *Holst 4249* verified by Engler, isotypes of *Paxiodendron usambarense*, in K, COI, JE and P, all of them flowering material, and all specimens show entire leaves. The Paris specimen is selected because it is the only one which gives the exact type locality in Tanzania. All the syntypes of *Paxiodendron usambarense* Engl. var. *ser-*

ratifolia Engl. (three Volkens specimens) were destroyed in Berlin, but one extant isosyntype, *Volkens 2264*, is seen on ALUKA [<http://plants.jstor.org/>], housed at JE, and is therefore selected as the lectotype. This specimen has leaves with widely-spaced teeth in contrast with all the isotypes of the typical *P. usambarense* with entire leaves. There is only a fragment of the duplicate of *Goetze 274* at K, which is selected as the lectotype for *Xymalos ulugurense*.

Evergreen tree up to 8(–20) m, mostly single-stemmed, with dense, rounded, spreading crown. *Bark* silvery grey or grey-brown, rough, slightly fissured, with prominent lenticels, flaking in large scales to leave concentric, ridged markings; inner wood lemon-yellow; sap reddish. *Leaves* simple, opposite, glabrous, lemon-scented when crushed, pellucid-dotted; lamina narrowly elliptic to obovate, 40–200 × 15–100 mm, apex acute, rounded or shortly acuminate, base cuneate, margin usually irregularly and coarsely glandular-serrate, sometimes entire; midrib sunken above, prominent beneath, lateral veins 6–9, looping well within margin, reticulate venation prominent on both surfaces; petiole up to 30 mm long, glabrous. *Inflorescences* racemose or paniculate, solitary or paired in leaf axils, 10–35(–70) mm long; peduncles 5–10 mm long; bracts triangular, 1.0–2.5 mm long. *Flowers* unisexual, small, yellowish or greenish; pedicels 1–3 mm long, velvety. *Perianth* 1–2 mm long, hairy. *Petals* absent. *Male flowers*: perianth 4–6-lobed; lobes rounded to ovate; stamens 6–15 or more; anthers subsessile. *Female flowers*: perianth 3–5-lobed; lobes ovate, rounded to triangular, velvety, margins ciliate; ovary obovoid, cylindrical or turbinate, glabrous; stigmas sessile, discoid, thick, glabrous. *Fruit* an ovoid to ellipsoid drupe, (5–)10–25 × 3–15 mm, slightly asymmetrical, glabrous, orange or reddish, fleshy, crowned with persistent stigma. *Seed* solitary, ellipsoid, compressed, 10 × 8 mm, white (Figure 4). *Flowering time*: June–Oct.

Diagnostic characters: leaves of *Xymalos monospora* are opposite and translucent gland-dotted, with a lemon smell when crushed. The bark is very distinctive, flaking to reveal circular or worm-like markings, and when cut has a lemon-like smell (Lötter 2002). Small, fragrant yellow flowers, the sexes on separate trees, appear from June to October (Lötter 2002), arranged in racemes and

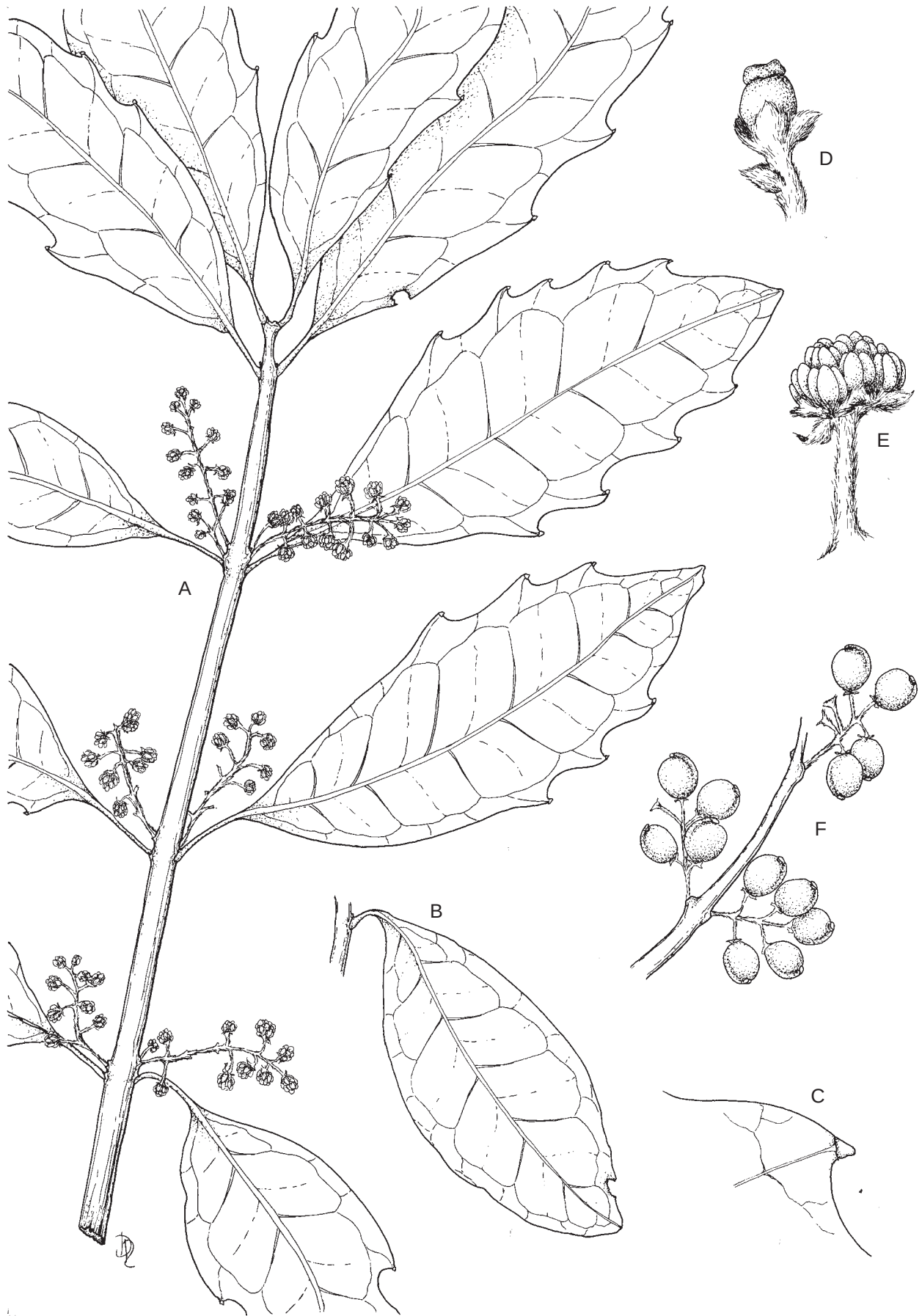


FIGURE 4.—*Xymalos monospora*, A, C & E, Mohle 389 (PRE); B, Van der Schijff 5630 (PRE); D, Compton s.n. (PRE53940); F, De Winter & Killick 8954 (PRE). A, flowering twig $\times 1$; B, leaf with entire margin $\times 1$; C, tip of tooth on leaf margin $\times 2$; D, female flower $\times 8$; E, male flower $\times 4$; F, fruiting branch $\times 1$. Artist: Daleen Roodt.

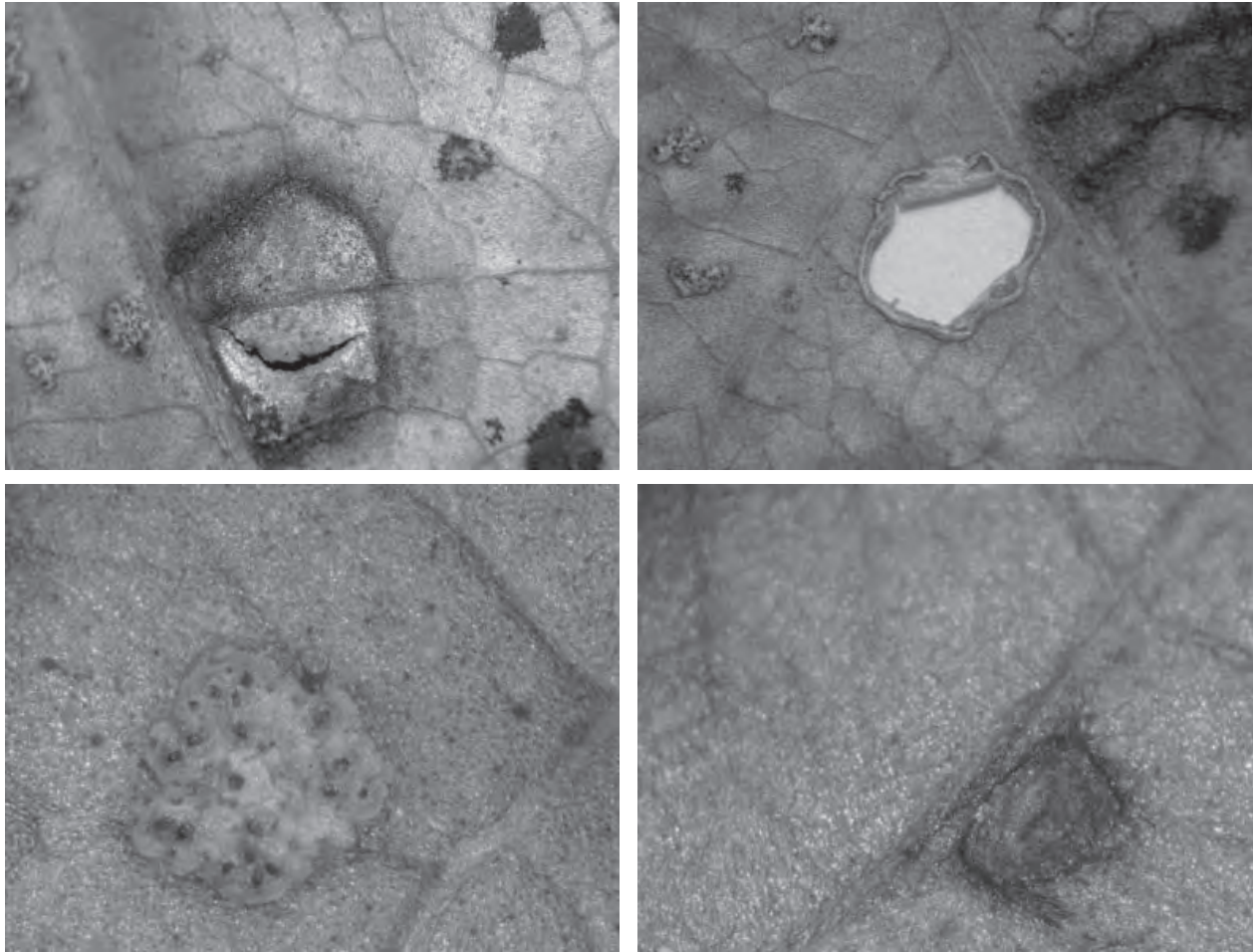


FIGURE 5.— *Xymalos monospora* showing leaf damage. Photographer: M. Jordaan.

often produced in clusters from old leafless wood (Sim 1907). The fruits are ovoid, smooth, 1-seeded drupes, often enclosed by a perianth or a fleshy receptacle, with a persistent stigma.

Distribution and habitat: *Xymalos monospora* grows in Afromontane, scarp or coastal forests, or in grasslands associated with forests, in moist areas near watercourses, from near sea level to above 2 000 m. It occurs in eastern tropical and southern Africa, from southern Sudan as far south as the Eastern Cape. Tadesse (2000) suggests that the species could also occur in Ethiopia but has not yet been recorded there. Distinctive disjunct populations occur in the highland forests of Nigeria on the Gotel Mountains (Aluka Library [<http://plants.jstor.org/>]), Cameroon Mountains (Cable & Cheek 1998) and on the Island of Bioko, formerly Fernando Pó (Keay 1954) (Figure 1). The range of *Xymalos monospora* falls well within the archipelago-like Afromontane Region of Endemism (White 1978, 1983). This African phytochorion is of special biogeographical and evolutionary significance because of its putatively ancient status.

Pollination: *Xymalos monospora* is wind- or insect pollinated, but this needs further investigation (Philipsen 1993). Quantities of pollen are produced by the male flowers, and most specimens collected possess male flowers, with very few of the ± 50 specimens in the National Herbarium, Pretoria, with female flowers.

Leaf damage: there is some damage to the leaves on ± 100 specimens examined, usually in the form of black patches or holes in the leaf blade (Figure 5). *Xymalos monospora* is the host for an unusually large number of fungal pathogens (Doidge 1950), which are probably the cause of the damage to the leaves. The leaf edges are also sometimes eaten away (Figure 3) and the species is a host for the larva of the butterfly *Papilio dardanus* Brown (mockerswallowtail) (Papilionidae) (Picker *et al.* 2004; butterflycorner website [en.butterflycorner.net]).

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ASTERACEAE

BERKHEYA JARDINEANA (ARCTOTIDEAE—GORTERIINAE), A NEW DWARF PERENNIAL FROM THE SWARTRUGGENS, WESTERN CAPE

Berkheya Ehrh., a genus of ± 80 species centred in southern Africa, was last revised by Roessler (1959) but many species remain poorly known; to some extent at least because of the challenges posed to collectors by these often viciously spinescent plants. *Berkheya* is distinguished by its shrubby or perennial habit, spinescent involucre bracts, mostly radiate (rarely discoid) capitula, $\pm$ deeply alveolate receptacle with uniformly thin-walled cavities, and pappus of ± 20 denticulate scales in one or two rows (Roessler 1959; Bremer 1994). The genus is polyphyletic as currently defined (Funk & Chan 2008; Funk *et al.* 2008; Karis *et al.* 2009), with a preliminary molecular analysis of the subtribe nesting the genera *Cullumia* R.Br. ex Aiton, *Cuspidia* Gaertn., *Didelta* L'Hér. and *Heterorachis* Sch.Bip. ex Walp. in various parts of *Berkheya*. Substantial revision of generic circumscription is required to render it monophyletic.

Of 23 species of *Berkheya* recorded from the core Cape Floristic Region, 16 are endemic (Goldblatt & Manning 2000; Manning *et al.* 2010), including the recently described *B. chrysanthemoides* J.C.Manning & Goldblatt from the Bokkeveld Mountains (Manning *et al.* 2010). Here we describe another novelty discovered in 2009 on the Swarttruggens northeast of Ceres.

***Berkheya jardineana* J.C.Manning & Goldblatt, sp. nov.**

TYPE.—Western Cape, 3219 (Wuppertal): Knolfontein, Swarttruggens, 60 km NE of Ceres, (–DC), 26 Oct. 2011, I. Jardine 1738 (NBG, holo.; MO, S, iso.).

Dwarf, tufted perennial to 10 cm high at flowering, forming small clumps from branching, woody rhizome; stems erect, cobwebby or thinly felted, flushed purple. Leaves crowded at base of stems, basal foliage leaves spatulate in outline, softly leathery, blade suborbicular, 15–35 mm diam., weakly folded along midline and coarsely 7- or 9-dentate, primary teeth excurrent in pale, relatively soft spine ± 3 mm long, with smaller secondary and tertiary antrorse spines 1–2 mm long between primary spines, cobwebbed or thinly felted on both surfaces and with scattered minute, gland-tipped hairs, glabrescent above, veins raised beneath, narrowed into petiole-like base 15–25 mm long, more densely cobwebbed than blade; cauline leaves smaller, lanceolate, 10–20 $\times$ 3–6 mm, sessile and weakly amplexicaul, weakly 3- or 4-jugate, teeth excurrent into soft spines ± 3 mm long and with 1 or 2 smaller antrorse spines along margins between primary spines, thinly felted on both surfaces and with scattered minute, gland-tipped hairs. Capitula 1–3 in shortly pedunculate racemes, discoid, 25–40 mm across involucre and 15–20 mm across disc; involucre bracts 4- or 5-seriate, bracts basally connate for ± 5 mm, patent-reflexed, narrowly lanceolate, flat, apex excurrent in a yellowish spine 2–3 mm long, outer and median series with 3–5 pairs of patent spines similar to apical spine, outer surface thinly cobwebbed and with minute, gland-tipped hairs, innermost bracts with 1–3

pairs of spines in distal half grading into several antrorse spinules in basal half, glabrous except towards apex, outer one or two series mostly 6–8 $\times$ 2–3 mm, median two series 10–12 $\times$ 3 mm, inner series oblong-lanceolate, 5–6 $\times$ 1.5 mm; receptacle deeply alveolate, margins irregularly fimbriate with straw-like spinules 0.5–1.0 mm long. Corolla funnel-shaped, yellow, densely glandular-pubescent on tube and more sparsely along lobe margins, ± 7 mm long, tube ± 3.5 mm long, lobes erect, narrowly lanceolate, ± 3.5 mm long, penicillate. Stamens: anthers tailed, with lanceolate apical appendage, ± 4 mm long; endothelial cells with inner periclinal wall thickenings not evidently displaced. Achenes turbinate, ± 2.5 mm long, 10-ribbed, those of outer florets densely antrorsely pubescent with short, twin hairs but inner achenes progressively more glabrous. Pappus scales sub-biseriate, ± 20 , oblong-obovate, denticulate, outer series slightly shorter than inner, 1.0–1.5 $\times$ 0.5 mm. Pollen lophate. Flowering time: Oct.–Dec. Figure 1.

Distribution and ecology: known so far only from the Farm Knolfontein on the Swarttruggens, a semi-arid mountain range 60 km east of Ceres at the eastern margin of the Cape Floristic Region (Figure 2). The species is locally common on sandy flats in areas of dry, rocky sandstone soils, mostly in full sun. It appears to be highly localized; although several subpopulations are known, they are all within approximately 1 km of one another.

Diagnosis and relationships: this petite species is distinguished in the genus by its diminutive size and curious growth form, developing into small, multi-stemmed clumps or low cushions through branching of the woody underground stem. The leaves are clustered at the base of the aerial stems, which reach only to 10 cm high at flowering, later elongating to 15 cm in fruit. The basal foliage leaves are highly distinctive, being softly leathery and spatulate in outline with a coarsely toothed, suborbicular blade only weakly armed with pale, relatively soft-textured spines. Both surfaces are thinly cobwebby-felted. The species is not pyrophytic and the low growth form is likely an adaptation to its exposed habitat.

The rosulate habit, relatively small, discoid capitula, and sub-biseriate pappus of small obtuse scales place *Berkheya jardineana* in ser. *Rigidae* (Roessler 1959). Other members of the series are larger perennial herbs or shrubs with pinnatifid or lobed leaves.

Etymology: the species is named for Ivor and Cora Jardine, who first collected specimens in 2009. They have devoted many years to documenting the flora of the Swarttruggens (Jardine & Jardine 2010), in the course of which they have discovered several novelties, including *Hesperantha lithicola* Goldblatt & J.C.Manning (Iridaceae) and *Trieneea occulta* J.C.Manning & Goldblatt (Scrophulariaceae).

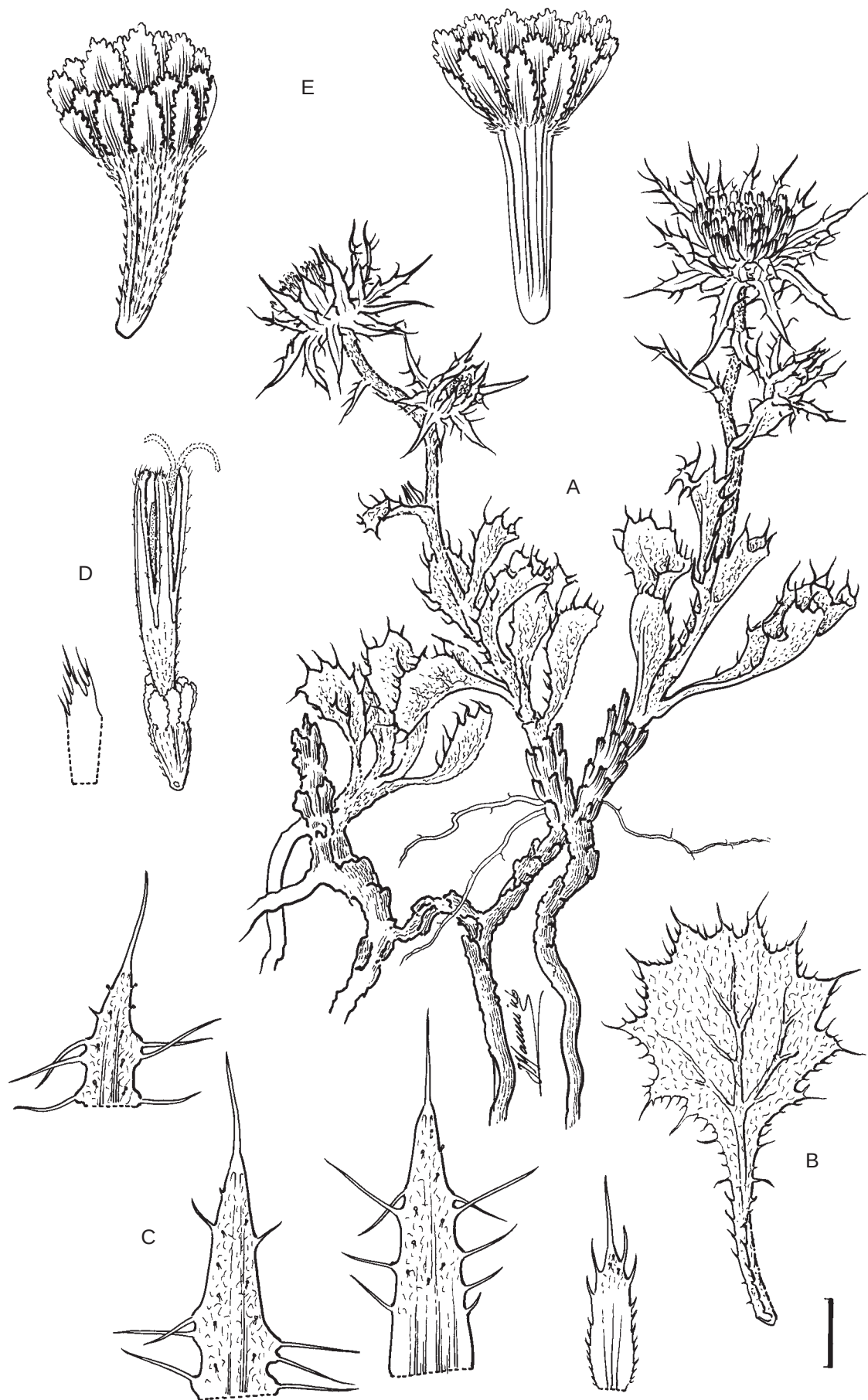


FIGURE 1.—*Berkheya jardineana*, Jardine 1738 (NBG). A, Plant; B, foliage leaf; C, involucre bracts (outermost on left, innermost on right); D, outer floret showing puberulous ovary and pappus of small, obtuse scales, plus portion of alveole margin; E, achenes (outer on left, inner on right) (Jardine 1747). Scale bar: A, B, 10 mm; C, 8 mm; D, E, 2 mm. Artist: John Manning.

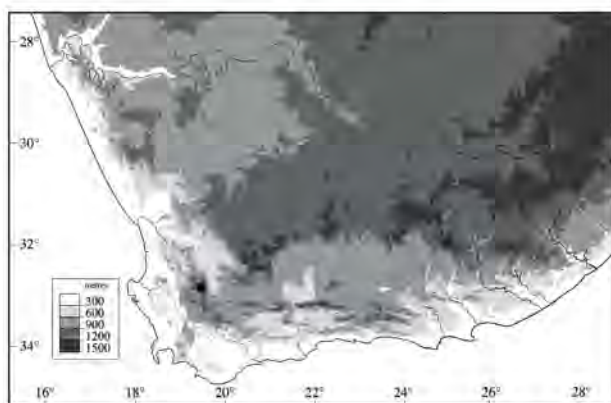


FIGURE 2.—Distribution of *Berkheya jardineana*, ●.

Additional specimens seen

WESTERN CAPE.—3219 (Wuppertal): Knolfontein, Swarttruggens, 60 km NE of Ceres, 1 201 m, (–DC), 26 Oct. 2009, *Jardine & Jardine* 570 (NBG); 21 Nov. 2011, *Jardine* 1747 (NBG); 12 Dec. 2011, *Jardine* 1761 (NBG); 14 Dec. 2011, *Jardine* 1766 (NBG).

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ASTERACEAE

OSTEOSPERMUM NORLINDHIANUM AND O. NORDENSTAMII, TWO NEW SPECIES OF OSTEOSPERMUM SECT. TREFENESTRATAE (CALENDULEAE) FROM THE GREATER CAPE FLORISTIC REGION

Calendulae is a small tribe of ± 120 spp. with a marked centre of diversity in southern Africa, where $\pm 80\%$ of the species occur (Nordenstam & Källersjö 2009). Available phylogenetic analyses (Nordenstam 1994, 2006; Nordenstam & Källersjö 2009) retrieve *Garuleum* Cass. and *Dimorphotheca* Vaill. ex Moench as two early-branching lineages, with no question about their taxonomic status. Generic delimitation within the remainder of the tribe, however, remains unsatisfactory (Manning & Goldblatt 2008). The species are currently segregated among ten genera: *Calendula* L. (± 15 spp.), *Chrysanthemoides* Fabr. (2 spp.), *Gibbaria* Cass. (2 spp.), *Inuloides* B.Nord. (1 sp.), *Monoculus* B.Nord. (2 spp.), *Nephrotheca* B.Nord. & Källersjö (1 sp.), *Norlindhia* B.Nord. (3 spp.), *Oligocarpus* Less. (2 spp.), *Osteospermum* L. (± 45 spp.) and *Tripteris* Less. (20 spp.) (Nordenstam 2007; Nordenstam & Källersjö 2009). In spite of recent generic fragmentation both *Osteospermum* and *Tripteris* remain polyphyletic (Nordenstam & Källersjö 2009), necessitating the recognition of additional genera if this treatment is to be carried to its logical conclusion.

In practical terms, few synapomorphies are available for the recognition of these new segregates, most of which are mono- or oligotypic, and it is unfortunate that dismemberment of the group has been implemented

piecemeal and in advance of a well-sampled and well-supported analysis of the tribe. Even with the very narrow circumscription of *Tripteris* proposed by Nordenstam (2007) to include just those species with winged, apically 3-fenestrate achenes, the molecular analysis in Nordenstam & Källersjö (2009) still locates taxa with other kinds of achenes (among them the genus *Monoculus*) among typical *Tripteris* species, rendering the latter polyphyletic.

The alternative, and in our opinion more useful treatment from both a practical and theoretical perspective (Manning & Goldblatt 2008), is to adopt a synthetic view of *Osteospermum* as constituting the monophyletic clade sister to *Dimorphotheca* as resolved in the phylogenetic analyses presented by Nordenstam (2006) and Nordenstam & Källersjö (2009), thus including the genera *Calendula*, *Chrysanthemoides*, *Gibbaria*, *Inuloides*, *Monoculus*, *Nephrotheca*, *Norlindhia*, *Oligocarpus* and *Tripteris*. Segregate lineages within *Osteospermum sens. lat.* are then usefully treated at sectional level, as was initiated by Norlindh (1943) in the last comprehensive revision of the tribe in sub-Saharan Africa. Although the current sectional boundaries clearly require substantial revision in the light of modern phylogenetic analyses, shuffling of species among them will have no impact on the nomenclature. This is the treatment that

has been adopted in the two floras treating the species of the Greater Cape Floristic Region (Manning & Goldblatt, in press; Snijman in press.) and we follow it here in describing two new species of *Osteospermum* subg. *Tripteris* (Less.) T.Norl. from the semi-arid parts of the Greater Cape Floristic Region.

Osteospermum sect. *Trifenestratae* T.Norl. [as *Trifenestrata*], which coincides with the narrow definition of the genus *Tripteris* (sensu Nordenstam 2007), comprises ± 18 species of perennial herbs, subshrubs or shrubs widely distributed through Africa, with some 7 species endemic to the winter rainfall parts of South Africa and southern Namibia. It is diagnosed by 3-winged achenes with all three sides of the apical airchamber thin-walled and translucent ('fenestrate') (Norlindh 1943). Here we describe two new species in the section. *Osteospermum norlindhianum* from the Cold Bokkeveld resembles *O. dentatum* Burm.f. from sandy flats along the West Coast of Western Cape in its herbaceous, perennial habit and its heteromorphic achenes but differs in details of the foliage and fruit. It had been recognized as distinct by Norlindh during the preparation of his monograph of the tribe (Norlindh 1943) but it is only now that fruiting material has become available. *O. nordenstamii* from quartz fields in southern Namaqualand, is a recently discovered, gnarled dwarf shrublet with consistently opposite, basally connate leaves, suggesting a relationship with the common Namaqualand shrub, *O. oppositifolium* (Aiton) T.Norl.

***Osteospermum norlindhianum* J.C.Manning & Goldblatt, sp. nov.**

TYPE.—WESTERN CAPE, 3219 (Wupperthal): Swartruggens, Knolfontein 60 km NE of Ceres, 32°50'49.7"S, 19°37'20.8"E, 1 260 m, (–DC), 26 Oct. 2011, I. Jardine 1729 (NBG, holo.; MO, S, iso.).

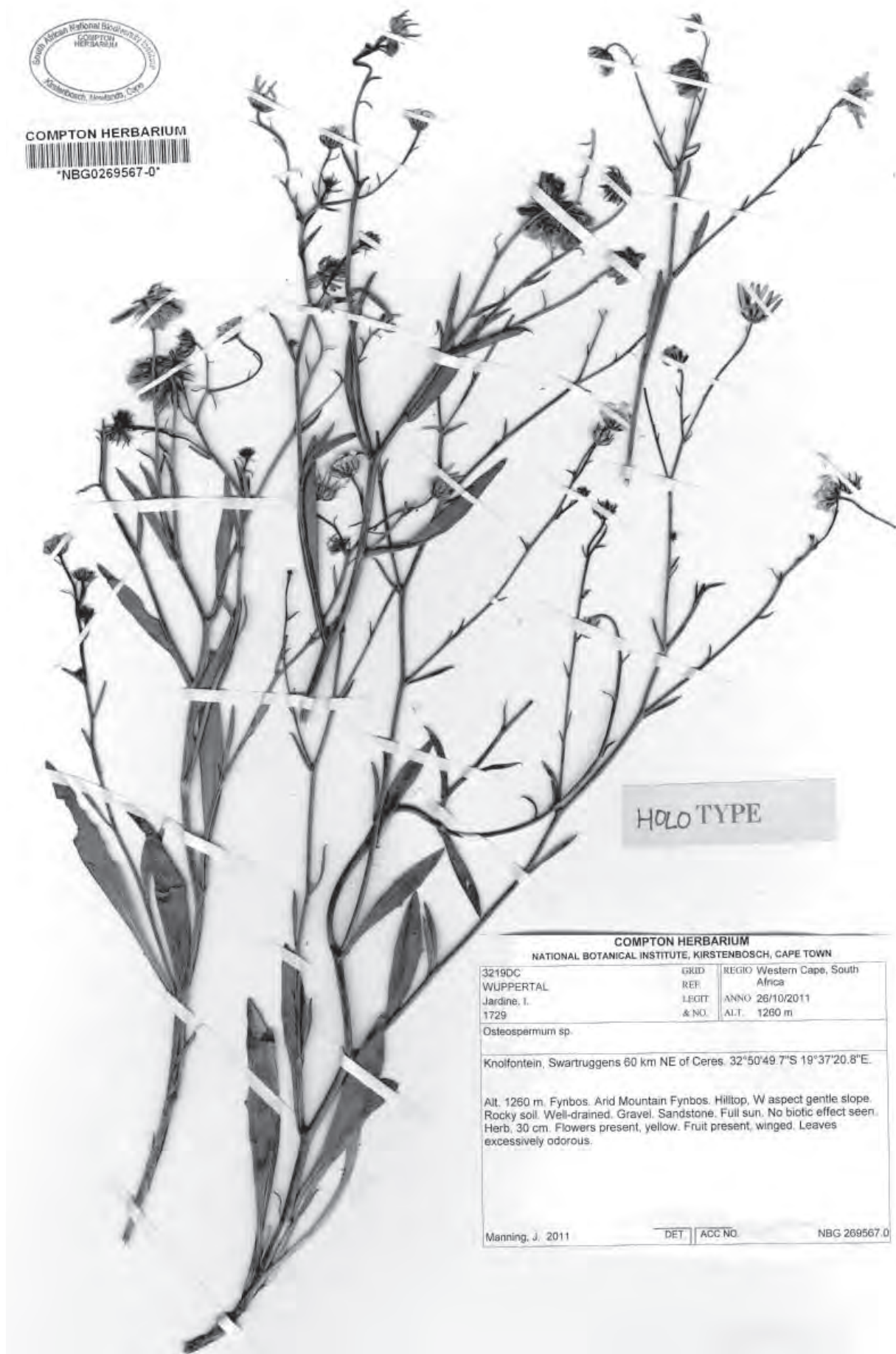
Tufted perennial from woody crown, 300–450 mm high, caudex producing a cluster of annual flowering stems; flowering stems suberect, laxly branched, 2–3 mm diam. at base, pubescent with mix of straggling, eglandular hairs and short, gland-tipped hairs, flushed purple at base. Leaves congested basally, lowermost subopposite with bases imbricate but not connate, becoming alternate distally as internodes lengthen, decreasing in size acropetally and ultimately grading into linear-subulate bracts, lower leaves oblanceolate, mostly 40–90 $\times$ 6–9 mm, leathery, sparsely to densely pubescent with mix of acute, eglandular hairs and gland-tipped hairs, adaxial surface $\pm$ asperulous, abaxial surface $\pm$ glandular-pubescent intermixed with scattered, straggling, eglandular hairs, these longer and denser along margins, blade tapering below into long, petiole-like base, midrib prominent abaxially, margins sparsely and weakly dentate, apiculate. Capitula heterogamous, radiate, ± 20 mm diam., on slender, branched peduncles forming lax, compound corymbs, nodding in fruit; involucre shallowly campanulate, 7–8 mm diam.; involucral bracts 12–15, sub-uniseriate, lanceolate, 3.5–4.0 $\times$ 1.0–1.5 mm, acute, densely glandular-pubescent, with scarious margins 0.25–0.50 mm wide; receptacle flat, glabrous. Ray florets female-fertile, 8–10; tube sparsely glandular-pubescent, ± 1 mm long; lamina spreading but recoiling in afternoon, narrowly elliptic, 4-veined, $\pm 3 \times$ as

long as involucre, 9–10 $\times$ 3 mm, bright yellow, sometimes flushed reddish abaxially. Anthers vestigial, free, reduced to 4 subulate staminodes ± 0.8 mm long, yellow. Ovary obovoid, 3-angled, ± 2 mm long, densely glandular-puberulous; style terete, branching ± 0.5 mm above mouth of tube, branches narrowly elliptic-lanceolate, obtuse, ± 1 mm long, yellow, lateral margins stigmatic. Achenes heteromorphic in some capitula, 3-winged or unwinged: winged achenes 10–12 $\times$ 7–8 mm, body turbinate, ± 7 mm long, transversely ribbed and glandular-scabrid, with cylindrical, apical, trifenestrate airchamber, windows ovate, $\pm 2.5 \times 2.0$ mm, wings translucent, 2–3 mm wide but sometimes one or two only partially developed; unwinged achenes 0–3, fusiform-rostrate, 10–12 $\times$ 1.5 mm, glandular-pubescent, body purplish, rostrum and stipe greenish. Disc florets functionally male, numerous; corolla narrowly funnel-shaped, ± 3 mm long, yellow; tube glandular-hairy, ± 2 mm long; lobes suberect, triangular, ± 1 mm long. Anthers 2 mm long, yellow; base tailed, tails equalling filament collar; apical appendage ovate. Ovary $\pm$ terete, ± 1.5 mm long, glandular-pubescent; style terete, on short stylopodium, shortly bifid, lobes deltoid, acutely papillate with basal fringe of longer trichomes. Flowering time: Sept.–May. Figures 1; 3A–C.

Distribution and ecology: restricted to the drier, eastern edge of the Cedarberg and Cold Bokkeveld, where it has been recorded from Matjiesrivier in the southern Cedarberg and the Skurweberg and Swartruggens ranges in the Cold Bokkeveld (Figure 2) between 1 000 and 1 260 m. The species is a component of arid fynbos communities on the drier, hotter, northern slopes and the plants, like many species in the genus, are highly aromatic.

Diagnosis and relationships: *Osteospermum norlindhianum* belongs to the small group of species in sect. *Trifenestratae* that includes *O. dentatum* and *O. connatum* DC. and that is characterized by a tufted, perennial habit with the lower leaves congested and opposite or subopposite, and annual flowering stems developing lax, corymbose synflorescences of moderately-sized capitula with the tendency to produce dimorphic achenes. Most fruits develop three conspicuous wings but in some heads up to half of the achenes are unwinged and fusiform-rostrate, with reduced or obsolete apical windows. In this group, *O. connatum* from the Cedarberg is distinctive in its mostly subsessile, semi-amplexicaul or conspicuously auriculate leaves, and relatively small winged achenes, 5–6 mm long. Both *O. norlindhianum* and *O. dentatum* (Figure 4) from sandy coastal flats between Saldanha and Hermanus (Figure 2), in contrast, have leaves narrowed to a petiole-like base and larger achenes, 9–12 mm long, and the two are superficially very similar.

Apart from their eco-geographical separation, the two species are distinguished by details of their foliage and fruits. The leaves of *O. norlindhianum* are oblanceolate without basal auricles, mostly 6–9 mm wide and obscurely toothed, with scattered, relatively long, straggling eglandular hairs on the underside and also along the margins, rendering them $\pm$ ciliate; the involucral bracts are glandular-puberulous with scarious margins 0.25–0.50 mm wide (Figure 3A); and the seed body in

FIGURE 1.—*Osteospermum norlindhianum*, Swartruggens, Jardine 1729 (NBG).

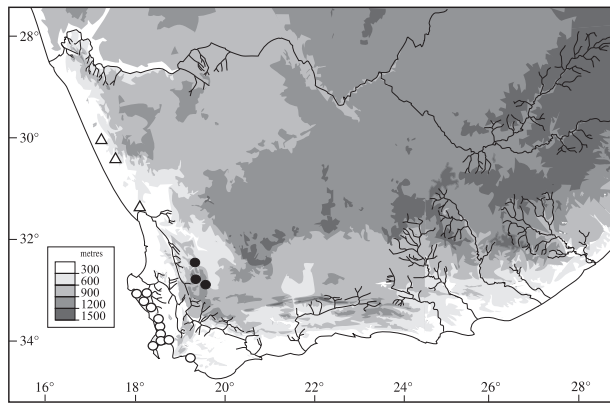


FIGURE 2.—Distribution of *Osteospermum dentatum*, ○; *O. norlindhianum*, ●; *O. nordenstamii*, △.

the winged achenes is conspicuously glandular-scabrid and $\pm$ turbinate, with a broadly cylindrical distal third containing the air chamber, a broadly ovoid and transversely ribbed central section with a median longitudinal sulcus, and an abruptly narrowed slender basal third (Figure 3B). The leaves of *O. dentatum* are oblong to obovate and generally broader, 10–20 mm wide, mostly with basal auricles, and usually more coarsely toothed or lacerate, with both surfaces and the margins scabridulous with short, stiff eglandular hairs; the involucre bracts are scabridulous with narrow scarious margins 0.10–0.25 mm wide (Figure 3D); and the fruit body is smoothly ellipsoid and subglabrous, with a median longitudinal sulcus through the entire distal two thirds (Figure 3E).

Hilliard & Burt (1985) commented on the spatial/altitudinal separation within species pairs in *Calenduleae* in *O. attenuatum* Hilliard & Burt ($\pm$ 1 675 to 2 300 m) and *O. grandidentatum* DC. (sea level to $\pm$ 1 500 m); and in *Dimorphotheca fruticosa* (L.) B.Nord. (near sea level) and *D. caulescens* (Harv.) Harv. ($\pm$ 1 650 m). The new *O. norlindhianum* ($\pm$ 1 000 to 1 260 m) and *O. dentatum* (near sea level) constitute a third example of this.

Etymology: named for Tycho Norlindh, whose monograph on the sub-Saharan members of the tribe (Norlindh 1943) remains current. Norlindh also correctly annotated the flowering collection *Esterhuysen 12709* (BOL) as representing an unnamed species related to *O. dentatum* but was prevented from formally describing and naming it by the lack of fruits. The species was recently re-collected, in flower and in fruit, by Ivor and Cora Jardine during their survey of their property in the Swartruggens.

Additional specimens seen

WESTERN CAPE.—3219 (Wuppertal): Cedarberg, Matjiesrivier Nature Reserve, above Easter Cave, 950 m, 32°28'38"S, 19°22'43"E, (–AD), 24 Apr. 1996, *Lechmere-Oertel 15* (NBG); Matjiesrivier Nature reserve, W of Zuurfontein west gate, 1 000 m, 32°27'S, 19°24'E (–AD), 5 Oct. 1997, *Lechmere-Oertel 873* (NBG); rocky ridge above Winkelhaaks River, E of Bokkeveld Sneeuwkop, (–CD), 20 Apr. 1946, *Esterhuysen 12709* (BOL); Swartruggens, Knollfontein, 60 km NE of Ceres, 1 259 m, 32°50'58.2"S, 19°37'25.4"E, (–DC), 11 Feb. 2009, *Jardine & Jardine 1093* (NBG).

***Osteospermum nordenstamii* J.C.Manning & Goldblatt, sp. nov.**

TYPE.—Northern Cape, 3017 (Hondeklipbaai): Riethuis quartz fields, 100 m E of road to Kommagas from Riethuis, 30°04'52.5"S, 17°26'08.7"E, 170 m, (–AB), 24 Aug. 2011, *Helme 7342* (NBG, holo.).

Gnarled, dwarf shrublet to 100 mm high, flowering on densely leafy short-shoots; vegetative shoots prostrate and laxly leafy with internodes 10–15 mm long, stems smooth and weakly compressed when young and flushed reddish, $\pm$ 2 mm diam., glabrescent with thinly scattered, eglandular hairs, developing a pale brownish, corky bark, greyish and rectangularly fissured when old, 3–4 mm diam. *Leaves* opposite, decussate, suberect, oblanceolate, (9–)15–30(–35) $\times$ (3–)4–8 mm, sessile, connate for up to 3 mm and shortly sheathing at base of short shoots, obtuse or rarely apiculate, leathery or sub-succulent, pubescent when young with mix of straggling, eglandular hairs and short, gland-tipped hairs, especially along margins but subglabrous when fully expanded, densely woolly in axils, adaxial surface flat or shallowly concave, margins yellowish-translucent and horny, prominent when dry, abaxial midrib prominent basally and decurrent on stem. *Capitula* heterogamous, radiate, $\pm$ 25 mm diam., shortly pedunculate, solitary and terminal on short shoots, rarely a second capitulum developing from an axillary shoot near apex, nodding in fruit; peduncles 15–25 mm long and 0.5–0.8 mm diam. but up to 1.0 mm diam. in fruit, leafless but with 1 or 2 scattered, linear-subulate bracts 3–5 mm long, thinly pubescent with a mix of straggling, eglandular hairs and short, gland-tipped hairs, flushed purple; *involucre* shallowly campanulate, $\pm$ 10 mm diam.; *involucre bracts* 15–17, sub-uniseriate or biseriate, lanceolate, 5–6 $\times$ 1.5–2.0 mm, acute, $\pm$ glabrous or thinly puberulous with scattered gland-tipped hairs, with scarious margins 0.3–0.5 mm wide; *receptacle* flat, glabrous. *Ray florets* female-fertile, 20 to 22, tube glandular-pubescent, $\pm$ 1 mm long, lamina spreading but recoiling in afternoon, narrowly elliptic, 4-veined, $\pm$ twice as long as involucre, 11–12 $\times$ 4 mm, dull yellow; *anthers* vestigial, free, reduced to 4 subulate staminodes, yellow; *style* terete, branching $\pm$ 1 mm above mouth of tube, branches narrowly elliptic-lanceolate, obtuse, $\pm$ 1.5 mm long, yellow, lateral margins stigmatic; *ovary* obovoid, 3-angled, $\pm$ 2 mm long, glandular-pubescent; *achenes* homomorphic, 3-winged, 10–12 $\times$ 8–10 mm, body narrowly turbinate, $\pm$ 7 mm long, subglabrous or sparsely glandular-pubescent, with apical, trifenestrate airchamber, windows subrotund, $\pm$ 1 mm diam., wings translucent, flushed purple, 3–4 mm wide. *Disc florets* functionally male, numerous; corolla narrowly funnel-shaped, $\pm$ 4 mm long, yellow tipped blackish; tube glandular-pubescent, $\pm$ 3 mm long; lobes suberect, triangular, $\pm$ 1 mm long; *anthers* 2 mm long, dark purple with yellow filaments; base tailed, tails equalling filament collar; apical appendage ovate. *Ovary* compressed-ovoid with lateral ribs, $\pm$ 1 mm long, glabrous; style terete, bifid, lobes deltoid, acutely papillate with basal fringe of longer trichomes. *Flowering time:* July–Sept. Figures 3F, G; 5; 6.

Distribution and ecology: restricted to the coastal plain of southern Namaqualand, where it has been collected northeast and southeast of Riethuis in Northern Cape, and near Koekenaap and Vredendal in Western Cape (Figure 2). *Osteospermum nordenstamii* is

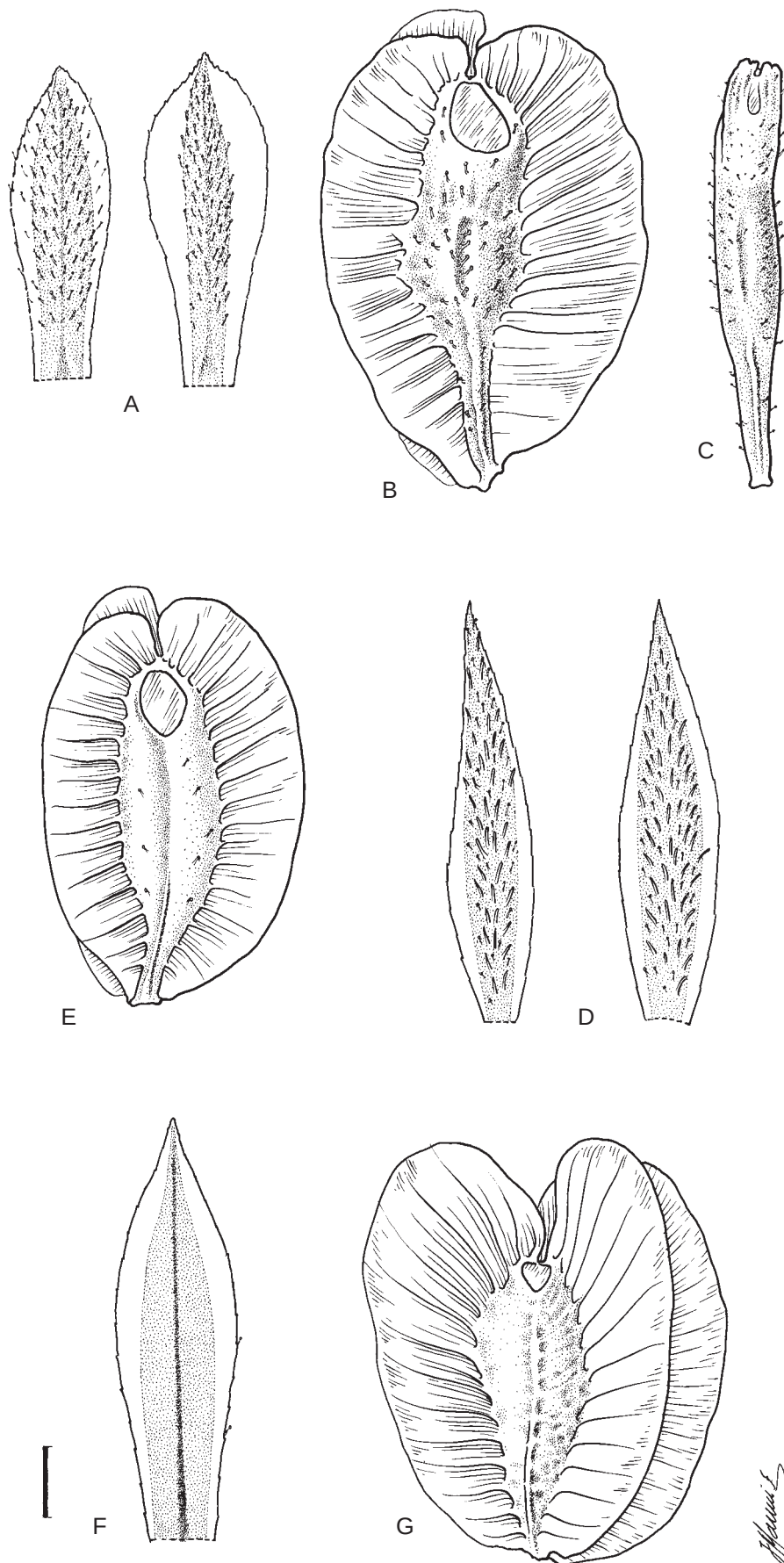


FIGURE 3.—Achenes and involucral bracts. A–C, *Osteospermum norlindhianum*, Jardine 1729 (NBG); A, involucral bracts; B, winged achene; C, wingless achene; D, E, *O. dentatum*; D, involucral bracts [Langebaan, Bosenberg & Rutherford 89 (NBG)]; E, winged achene [Wildevöel-vlei, O’Callaghan 704 (NBG)]; F, G, *O. nordens-tamii*, Helme 7342 (NBG)]; F, involucral bract; G, winged achene. Scale bar: A, D, F, 1 mm; B, C, E, G, 2 mm. Artist: J.C. Manning.

locally common among white quartz pebbles, mainly on north-facing slopes, and is yet another highly localized endemic of the Namqualand lowland quartz fields

(Schmiedel & Jürgens 1999). The two known areas of occurrence at Koekenaap and Riethuis are some 175 km apart with very little suitable quartz patch habi-



FIGURE 5.—Flowering plant of *Osteospermum nordenstamii* at the type locality near Riethuis. Photographer: N.A. Helme.



FIGURE 6.—Fruiting plant of *Osteospermum nordenstamii* at the type locality near Riethuis. Photographer: N.A. Helme.

tat between them. Low rainfall at both places is supplemented by substantial precipitation from coastal fog, especially in autumn and winter.

At the type locality near Riethuis the species grows with the locally endemic succulents *Drosanthemopsis vaginata*, *Meyerophytum meyeri*, *Conophytum concavum* and *Monilaria globosa* (Aizoaceae), and with the more widespread *Hirpicium alienatum* (Asteraceae) and *Cheiridopsis robusta* (Aizoaceae). An undescribed species each of *Othonna* (Asteraceae) and of *Eriospermum* (Ruscaceae) were also recorded in the area. The two southern localities fall within the Knersvlakte centre of endemism (Van Wyk & Smith 2001).

Diagnosis and relationships: *Osteospermum nordenstamii* is readily distinguished from all other species by its dwarf habit (Figures 5 & 6), forming small, gnarled, ± creeping shrublets less than 10 cm high, with decussate, oblanceolate leaves with entire margins, mostly obtuse apices, and distinctly woolly axils. Plants produce prostrate or spreading, relatively distantly leafy vegetative shoots but flower only from closely leafy short-shoots, which produce solitary, dull-yellow capitula on short, terminal peduncles. The leaves have distinctive translucent, horny margins especially evident in dried herbarium material.

The opposite, entire, subglabrous leaves of *Osteospermum nordenstamii* are otherwise found only in *O. oppositifolium* among the species of sect. *Trifenes-tratae*, and suggest that its relationships lie here. The two species are readily separated by their habit and also by bark, foliage and inflorescence. *O. oppositifolium* is common throughout western Namaqualand as far south as Clanwilliam, forming colonies on stony and rocky slopes. It is a rounded shrub, mostly 0.5–1.0 m high but occasionally as low as 30 cm, with linear to oblanceolate, mostly acute leaves, 20–60 × 2–10(–12) mm, with the margin only weakly thickened and without woolly axils (rarely a few sparse hairs are present). The stems develop relatively thin, longitudinally striate bark quite unlike the corky, quadrately fissured bark of *O. nordenstamii*, and the capitula are typically borne in lax corymbs at the ends of the branches, not on short shoots. They are mostly larger than in *O. nordenstamii*, 25–35

mm diam., and the ray florets vary in colour from rich golden yellow in Namaqualand to pale yellow in the Olifants River Valley. Both species have been recorded at the same locality north of Koekenaap (Nordenstam 907).

Etymology: named for Bertil Nordenstam, who has published extensively on Asteraceae in general and on the tribe Calendulae in particular, and who first collected the species in 1962.

Other specimens seen

NORTHERN CAPE.—3017 (Hondeklipbaai): Riethuis/Oubees, 30°7'49"S, 17°25'20"E, quartz patch, 150 m, (–AB), 24 Aug. 1999, Desmet 244 (NBG); S of Riethuis on track to Taaibosduin, quartzite koppie, (–AB), 13 Aug. 2006, Koekemoer 3342 (PRE); along road to Soebatsfontein from Wallekraal/Hondeklipbaai road, 161 m, (–BC), 16 Sept. 2000, Koekemoer & Funk 1957 (PRE).

WESTERN CAPE.—3118 (Vanrhynsdorp): 3 miles [4.8 km] NE of Koekenaap, (–AD), 15 July 1962, Nordenstam 581 (S); Moedverloor, 4 miles [6.4 km] N of Holrivier Bridge, quartzite fields and patches, (–AD), 10 Aug. 1962, Nordenstam 907 (S); 4 miles [6.4 km] N of Koekenaap, quartzite kopje W of road, (–AD), 25 Aug. 1962, Nordenstam 1022 (S); 4 km N of Koekenaap, quartzite outcrop, (–AD), 6 Sept. 1974, Nordenstam & Lundgren 1686 (S); Koekenaap, 31.46°S, 18.31°E, (–AD), without date, Desmet 3636 (NBG); Koekenaap, portion of old Farm 630, 50 m, (–CB), 16 Aug. 1997, Desmet & Ellis 1243 (NBG).

ACKNOWLEDGMENTS

Material was collected under permits from the conservation authorities of Northern and Western Cape. BOL, NBG, PRE and SAM, the main herbaria with good representation of collections of Cape species, were consulted for records of the two new species (herbarium acronyms after Holmgren *et al.* 1990). We thank curators of these herbaria for allowing access to their collections, and the referees for their constructive comments.

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OBITUARY

EDUARDO JOSÉ DOS SANTOS MOREIRA MENDES (1924–2011)

On 24 September 2011, Eduardo Mendes (Figure 1) passed away at his home in Lisbon, Portugal, at the grand old age of 86—just 2 months short of his 87th birthday—following a stroke. He was one of the last of a generation of colonial plant taxonomists who had expertise on the flora of Angola and some of the other former African colonies of Portugal, and his passing signifies the end of an era.

Eduardo José dos Santos Moreira Mendes was born in Lisbon on 26 November 1924. He studied in Lisbon and obtained his first degree in biological sciences in 1946 at the University of Lisbon where he studied under the tutelage of, among others, the renowned cytogeneticist, Prof. Flávio Resende, who had a special interest in southern African petaloid monocots, including aloes and their kin (Smith & Figueiredo 2011a). Mendes was a botany lecturer at the University of Lisbon from 1946 to 1954, where he taught courses in the Faculties of Sciences, Pharmaceutical Sciences, and Medicine. During that period he developed a research programme on cryptogams, and published several papers on this group. In 1954 he was employed as assistant to the project ‘Missão Botânica de Angola e Moçambique’ and in 1956 became a researcher at the Junta de Investigações do Ultramar, later superseded by the Instituto de Investigação Científica Tropical (IICT). From 1974 to 1986, Mendes was Director of the Centro de Botânica of the IICT, in Lisbon, Portugal. While Director of the Centro, he used an interesting way of summoning staff to his office: a switch on his desk was connected to a bell that

rang in the Instituto’s corridors and each staff member had a Morse code-style code that, when sounded, meant that he or she must immediately go to the Director’s office (Martins 1994).

Throughout his career Mendes maintained an interest in the floras of Angola and Mozambique, and did considerable work on these. He revised several families for the *Conspectus florum angolensis*; publishing a series of papers under the title ‘Additiones et Adnotationes Florae Angolensis’ that continued until 1973. He further revised several families for the *Flora zambesiaca* in a set of papers under the series entitled ‘Additiones et Adnotationes Florae Mozambicanae’. During his career he published over 70 papers and was editor or co-editor of *Conspectus florum angolensis*, *Flora zambesiaca*, *Flora de Moçambique*, and *Garcia de Orta, Série Botânica*.

Mendes participated in two botanical expeditions to Angola, during which he collected several thousand herbarium accessions (Figure 2). The first expedition that Mendes undertook to Angola took place from September 1955 to March 1956 and focused mostly on the southwestern parts of the country, where he collected 1 750 numbers (Figure 3). The second expedition took place between December 1959 and May 1960, mostly in the southeastern region, between Cuvango and Cuito-Cuanavale, and resulted in the numbers 1 800 to 4 064 in Mendes’s African collection (Mendes 1980; Martins 1994).



FIGURE 1.—Eduardo Mendes (26 November 1924–24 September 2011) at his home in Lisbon, Portugal. Photograph: Gideon F. Smith, 23 September 2010.



FIGURE 2.—A young, mustachioed Eduardo Mendes photographed in Angola during the first of the two expeditions he undertook to the country. Photographer unknown. Reproduced courtesy of the Mendes family, Lisbon, Portugal.



FIGURE 3.—A series of tents pitched around the field collecting vehicle served as shelter during the first of the expeditions that Mendes undertook to Angola. Photograph: Eduardo Mendes. Reproduced with the permission of the Instituto de Investigação Científica Tropical, Lisbon, Portugal.

After his retirement from the Centro de Botânica, Mendes disappeared from the botanical landscape. Two of the authors (GFS and EF) visited him at his home on 23 September 2010 to obtain information on the provenance of the material on which the name *Aloe mendesii* Reynolds (Asphodelaceae), a cliff-dwelling species from Angola, was based. He was very helpful and vividly remembered the material, including when and where it was collected and what happened to it—quite remarkably—over 55 years ago! However, Mendes sadly passed away one week before the resulting paper appeared in print (Smith & Figueiredo 2011b).

The work and collections of Mendes remain little known in South Africa as he never collected in the country as far as we could ascertain, and was therefore not included in Gunn & Codd's (1981) benchmark work on the botanical exploration of southern Africa, and was only briefly mentioned in Figueiredo & Smith (2008). However, his collecting activities in Angola contributed significantly to the primary botanical knowledge of that country, and some of the specimens that he collected

decades ago are still being used as the types of new plant names. Sousa *et al.* (2010), for example, recently described *Cyphostemma mendesii* F.Sousa in the Vitaceae based on some of Mendes's Angolan material. Thirteen further taxa were described from, and named for, Eduardo Mendes from collections he made in Angola. Eleven are currently accepted, including the distinctive succulent tree *Euphorbia eduardoi* L.C.Leach, *Uvaria mendesii* Paiva, *Ceropegia mendesii* Stopp, *Phyllanthus mendesii* Brunel ex Radcl.-Sm., *Adenodolichos mendesii* Torre, *Crotalaria mendesii* Torre, *Indigofera mendesii* Torre, *Vigna mendesii* Torre, *Rothea mendesii* (R.Fern.) R.Fern., and *Aloe mendesii* Reynolds.

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OBITUARY

KATHLEEN DIXON GORDON-GRAY (NEÉ HUNTLEY) (1918–2012)

Kathleen Gordon-Gray passed away peacefully on 13 January 2012, eleven days before her 94th birthday. She is survived by her only daughter Celia.

Gordon-Gray was no ordinary person; she was in fact a most extraordinary and generous woman. Not only was she the South African expert in Cyperaceae and several other plant families occurring in KwaZulu-Natal (KZN) (see scholar.google.co.za for a list of some of her publications), but she was a wife, mother, and an excellent lecturer in the then Botany Department at the University of Natal (now UKZN) on the Pietermaritzburg campus. Gordon-Gray was also a much sought after confidant and friend to students and colleagues alike. It was her gentle and caring manner, ability to listen and her almost infinite patience and desire for perfection that were her enduring qualities. I never heard her speak ill of anyone and, if she had a fault, it was that she accepted her lowly academic status in the Department—as women often did in those days; foregoing promotion to realize her professional calling. Even to the last, wracked with arthritis, she was alert and working on Cyperaceae with Jane Browning and another of her close co-workers C.J. (Roddy) Ward, a well-known KZN plant collector and field ecologist (and ex-student from her earliest days as a Junior Lecturer).

Kath Gordon-Gray was born in Pietermaritzburg and graduated with a B.Sc. and M.Sc. (1939). Her Ph.D. was awarded in 1959 (all degrees from Natal University, now UKZN). After teaching at Girls Collegiate School (1940–1945), she was appointed in the Botany Department as a Junior Lecturer to teach mainly ex-service men; later as Lecturer (1951–1966 (Gunn & Codd 1981)) under Professor A.W.J. Bayer who was Head of Department at the time; as Senior Lecturer (1967–1976, after Professor Bayer retired); and finally as Associate Professor (1977–1978). She was, sadly, required by the regulations of the time, to retire at the age of 60 in 1978 (Glen & Germishuizen, 2010); but continued to work on her beloved KZN plants and the Cyperaceae in particular.

Gordon-Gray was essentially a ‘home’ girl, collecting some 4 000 specimens mainly from KZN. My fondest memories of her date back to the 1960s when the then Botany Department in Pietermaritzburg was arguably in its heyday. From the late 1950s to the early 1970s, a remarkable number of botanists passed through the Department (Moll 1987) and many undergraduates and postgraduates came under the spell of Doc G-G, as she was fondly known. Personally, if it had not been for Gordon-Gray, I would have become a zoologist and I know of many others who pursued a career in botany because of her influence. Thus, almost single-handedly, she recruited many people into botany who later became



FIGURE 1.—Three keen botanists sorting through live material of *Aca-cia robusta* in the herbarium that had been collected for leaf and pod measurements as part of a study to quantify the difference between the two subspecies of *A. robusta* subsp. *clavigera* and *robusta*. Left to right Eugene Moll, Kath Gordon-Gray, and Ken Tinley (Photographer: J.H. Ross).

well known in their particular fields, and who then went on themselves to recruit other botanists and ecologists. Some noteworthy students and colleagues until the 1980s were Don Killick, Roddy Ward, Denzil Edwards, Mike Wells, Clare Archer (Reid), Jim Ross, Fiona Getliffe, Roger Ellis, Charles Stirton, Esmé Hennessy, Ken Tinley, Brian Downing, Brian Huntley, Ed Granger, and Trevor Arnold.

One thing that she is well known for is her annotations on herbarium sheets, that are often accompanied by her meticulous drawings and notes of what she believed to be diagnostic features (for example see Goetghebeur & Coudijzer, 1985: 245), and on JSTOR some sheets such as the Type of *Fimbristylis bequaertii* De Willd. [Family Cyperaceae]; BR0000008639400, have illustrations by Gordon-Gray attached (J. Browning pers. comm. January 2012).

When she died, Gordon-Gray was still working on Cyperaceae with Jane Browning who compiled a comprehensive list of notes on her co-worker that she kindly shared with me. It was typical of Gordon-Gray to shun the lime-light. She was however belatedly awarded the South African Association of Botanists' Silver Medal in 1998, though she certainly deserved greater recognition earlier in her career. As she disliked being photographed, pictures of her are rare and she shunned National and International Meetings; preferring to work alone and in close collaboration with those she knew and trusted. Yet, through her teaching and supervision, she was inspirational and provided sound theoretical and practical training in the fundamentals of taxonomy, anatomy, breed-

ing systems and the ecology of her beloved sedges and grasses.

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