

A revision of the *Brunsvigia radula*-group (Amaryllidaceae: Amaryllideae) of species in South Africa, including the description of *Brunsvigia gariepensis* a new species from Bushmanland in Northern Cape

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Received 4 November 2011; received in revised form 22 December 2011; accepted 30 December 2011

Abstract

The *Brunsvigia radula*-group of species, defined by their small size and capsules that dehisce readily along the septa, is revised. The new species *Brunsvigia gariepensis* Snijman, endemic to the Pellaberg and Ghaamsberg, is distinguished by its distinct perigone tube and biseriate stamens. The circumscriptions of *Brunsvigia comptonii* W.F.Barker and *Brunsvigia namaquana* D.Müll.-Doblies & U.Müll.-Doblies are amplified to accommodate recent range extensions into northern Bushmanland, and *B. radula* (Jacq.) W.T.Aiton is re-circumscribed as narrowly endemic to dolomite outcrops in the Knersvlakte, Western Cape. The species in the group are distinguished by the nature of the trichomes on the adaxial leaf surface (papillose or setose), the shape and relative position of the bristles (straight and pliable or curved and hard), the length of the perigone tube (4–5 vs. ≤ 0.5 mm long), and the relative lengths of the stamens (biseriate or variable in length). Complete descriptions, nomenclature and typification are given.

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Keywords: Amaryllidaceae; *Brunsvigia*; Nama-Karoo Biome; New species; South Africa; Succulent Karoo Biome; Taxonomy

1. Introduction

Brunsvigia Heist. is one of 11 genera in Amaryllidaceae (sensu APG II, 2003) endemic to southern Africa. The species are concentrated in two main centres of diversity: the richest within the Western Cape's northwest region (sensu Weimarck, 1941; Goldblatt and Manning, 2000), followed by the midlands of KwaZulu–Natal (Vorster, 1999). When *Brunsvigia* was last revised 17 species were recognized (Dyer, 1950, 1951). Since then three more species have been described (Barker, 1963; Müller-Doblies and Müller-Doblies, 1994; Snijman, 2001; Snijman and Linder Smith, 2001) and a further two species have been transferred to the genus (Goldblatt, 1972; Müller-Doblies and Müller-Doblies, 1994). When last assessed, seven species were included on southern Africa's Red List (Raimondo et al., 2009).

Currently, the mountains and inselbergs of northern Bushmanland, Northern Cape, rank among the few remaining

botanically underexplored areas in South Africa, with some of the first collections from these high-lying areas having been made by Oliver, Tölken and Venter as recently as 1977. The only published accounts on the region's flora are those of Van Jaarsveld (1985) on the trees of the Pellaberg Mountains and Desmet (2000) on the succulents of the quartzite-capped inselbergs. The Pellaberg lies within the Orange River Valley, and the chain of inselbergs that resembles an archipelago along the Valley's southern margin stretches from about 30 km east of Springbok to 10 km east of Pofadder.

Among several interesting discoveries made by Mr E.J. Van Jaarsveld during an expedition to the Pellaberg Mountains in 1982, was a flowering plant of an unknown *Brunsvigia*, which was later confirmed to be a new species following detailed study of further living collections at the Kirstenbosch National Botanical Garden. This account of the newly described *Brunsvigia gariepensis* includes a taxonomic reassessment of the closely allied species *B. comptonii* W.F.Barker and *B. namaquana* D.Müll.-Doblies & U.Müll.-Doblies, which have only recently

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been documented in Bushmanland, and the Namaqualand species *B. radula* (Jacq.) W.T.Aiton. The revised taxonomy incorporates new micromorphological features that serve to distinguish the species.

2. Materials and methods

This study was based on the collections of *Brunsvigia* in BOL, NBG, PRE, and SAM (acronyms as in Holmgren et al., 1990). Images of important specimens in European herbaria were studied using JSTOR Plant Science [<http://plants.jstor.org/>]. Field studies were complemented by the study of living collections at the Kirstenbosch National Botanic Garden. Leaf surfaces of all available material were examined using low magnification ($\times 12$ – 50) microscopy and six specimens, grown under identical conditions at Kirstenbosch, were studied in detail using scanning electron microscopy (Table 1). The leaf samples for SEM were prepared according to standard methods of dehydration, critical point drying and sputter coating. The distributions of the specimens were mapped according to the quarter degree reference system of Leistner and Morris (1976). Author abbreviations follow Brummitt and Powell (1992).

3. Results and discussion

B. gariepensis belongs to a small group of species of modest habit, comprising *B. comptonii*, *B. namaquana* and *B. radula*, all concentrated in the semi-arid north western parts of South Africa. All have small, prostrate leaves (mostly <four), a few-

flowered inflorescence, and characteristically small (8 – 15×7 – 13 mm), ovoid to cordiform, thin-walled capsules that dehisce readily down the septa for half or more of their length. Dehiscence in most other species of *Brunsvigia* is somewhat tardy and confined to the apex of the capsule, hampered below by heavy ribs that keep the septa closed for most of their length.

Alliances within the *Brunsvigia radula*-group are suggested primarily by the trichomes on the adaxial leaf surface. *B. gariepensis* and *B. comptonii* have micro- and macropapillae densely scattered over the leaf surface (Fig. 1), whereas *B. namaquana* and *B. radula* have pustules bearing conspicuous, pale- to straw-coloured bristles 2.5 – 5.5 mm long, either concentrated on the longitudinal veins or densely scattered over the adaxial surface. Each bristle is multicellular and densely to sparsely echinate along its length (Fig. 2A and C). The presence of bristles is unusual in *Brunsvigia* and is rare in Amaryllidaceae (Meerow and Snijman, 1998).

Herbarium collections of *Brunsvigia namaquana* and *B. radula* are often difficult to tell apart. *B. namaquana* was originally described from three specimens found on quartzite and granite outcrops near Steinkopf and Platbakkies in northern and eastern Namaqualand respectively (Müller-Doblies and Müller-Doblies, 1994). Plants of *B. radula* that match the iconotype of the species are represented in some South African herbaria from dolomite outcrops in the Knersvlakte, southern Namaqualand. Müller-Doblies and Müller-Doblies (1994), however, also included within this species plants from the quartz fields near Wallekraal on the coastal forelands of Namaqualand, although cautioning that the Wallekraal plants could possibly differ from *B. radula*.

Table 1

Key vegetative and floral characters in the setose-leaved specimens of *Brunsvigia* used in this study from NBG. Asterisks indicate specimens studied with SEM.

Collector	Grid	Leaf			Bristles on adaxial leaf surface			Stamens		
		Number	Width (mm)	Margin	Shape when fresh	Length (mm)	Position when pressed	Position	Length relative to tepals	Filament appendages
Williamson 3430	2917BB	2, 3	11.5–17.0	Thin, micropapillate	Straight	4.0	Appressed	Spreading to deflexed	$\geq$ by 8 mm	Narrow wings
Mitchell 289	2917BB	2, 3	11.0–12.5	Thin, micropapillate	Straight	4.0	Appressed	Deflexed	>by 5 mm	Narrow wings
Smale s.n. (NBG 201410)	2918AA	2, 3	12–16	Thin, micropapillate	Straight	2.5	Appressed	Spreading	$\pm$ =	None
Van Berkel 332	2918AC	2–4	11–19	Thin, micropapillate	Straight	2.0–2.5	Appressed	Spreading	$\pm$ =	None
Van Jaarsveld 9489	2918AD	3	10–17	Thin, micropapillate	Straight	2.0–3.0	Appressed	Spreading to $\pm$ deflexed	>by up to 4 mm	None
*Desmet 2423	2918BB	2	14	Thin, smooth	Straight	1.5	Appressed	Spreading	$\pm$ =	None
Hall 4760	2918BC	2, 3	11–24	$\pm$ Thin, micropapillate	Straight	3.0–4.0	Appressed	Deflexed	>by ± 3 mm	None
*Goldblatt & Manning 9649a	2918CA	3, 4	13–24	Thin, micropapillate	Straight	2.0–3.0	Appressed	$\pm$ Deflexed	$\pm$ =	None
Lavranos & Bleck 22297	2918CB	3	16–17	Thin, micropapillate	Straight	3.5–4.0	Appressed	Spreading	>by up to 8 mm	Narrow wings
*Horak s.n. (NBG 198747)	3017AD	2, 3	28–32	Thin, micropapillate, with few, short, soft bristles	Straight	2.5	Appressed	Spreading	>by up to 7 mm	Narrow, pointed wings
Hall s.n. (NBG 66092)	3017BC	2	30–35	Thin, micropapillate	Straight	2.0	Appressed	Spreading	$\geq$ by ± 8 mm	Narrow wings
*Hall 5199	3118BC	2	26–34	Thick, with short, thick bristles	Strongly curved	2.0	Patent	Spreading	≥ 7 mm	None
Snijman 1254	3118BC	3	15–19	Thick, with short, thick bristles	Strongly curved	2.0–2.5	Patent	Spreading	$\pm$ =	None

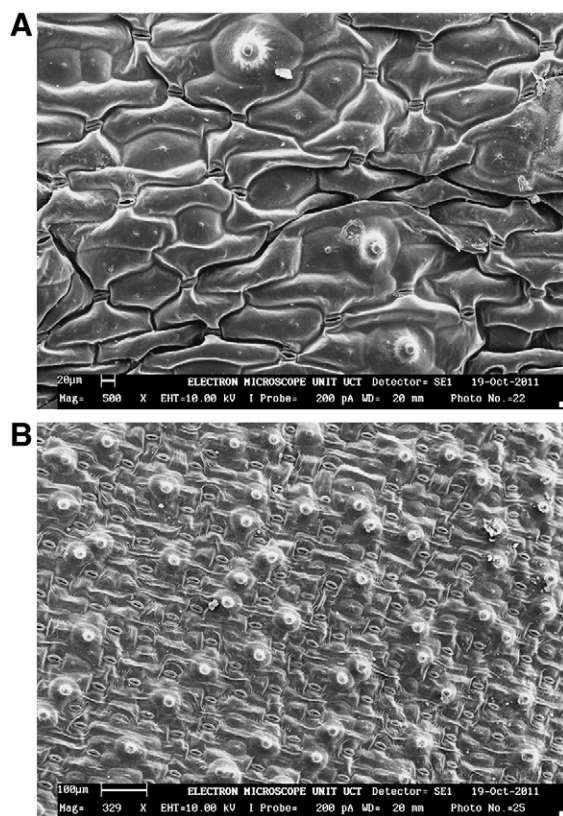


Fig. 1. Scanning electron micrographs showing scattered micro- and macropapillae on the adaxial leaf surfaces in: A, *Brunsvigia gariepensis* (Duncan 386, NBG); B, *B. comptonii* (Snijman s.n., NBG 882/82). Scale bars: A, 20 μm ; B, 100 μm .

According to Müller-Doblies and Müller-Doblies (1994), *B. namaquana* differs from *B. radula* in leaf number per season, (2)3 or 4 vs. 2 or (4), leaf width, (7–)10–12(–18) vs. (24–)36–45 mm, stamen orientation, $\pm$ declinate vs. spreading, and stamen length, 1.5 times longer than the tepals vs. slightly longer than the tepals. In addition, lateral appendages at the base of the filaments, when present, are narrowly winged in *B. namaquana*. Although the original description of *B. radula* does not mention appendages, the plants from Wallekraal have a pair of blunt teeth on the filaments.

To determine the identities of the many new collections belonging to either *B. namaquana* or *B. radula* from between Steinkopf and Aggeneys in north-western Bushmanland, and near Wallekraal on the Namaqualand coastal plain, and to assess the reliability of the key character states used so far to separate these two species, all available herbarium specimens having both leaves and flowers were compared in Table 1. The majority of the setose-leaved collections (i.e. all but Hall 5199 and Snijman 1254) have distinctive, soft, long bristles, widely scattered along the longitudinal veins of the adaxial surface. When pressed, these bristles lie flat on the leaf surface, often forming overlapping rows along the veins (Fig. 3). In addition, the leaves of all the specimens (except Hall 5199 and Snijman 1254) have margins mostly outlined with micropapillae and free of bristles, and the epidermis on the adaxial surface is comparatively thin (Fig. 2B). It is noteworthy that the soft, pliable, long bristles in specimens from the Wallekraal quartz fields (Horak s.n., NBG 198747) also match those in specimens from northern Namaqualand and Bushmanland (Goldblatt &

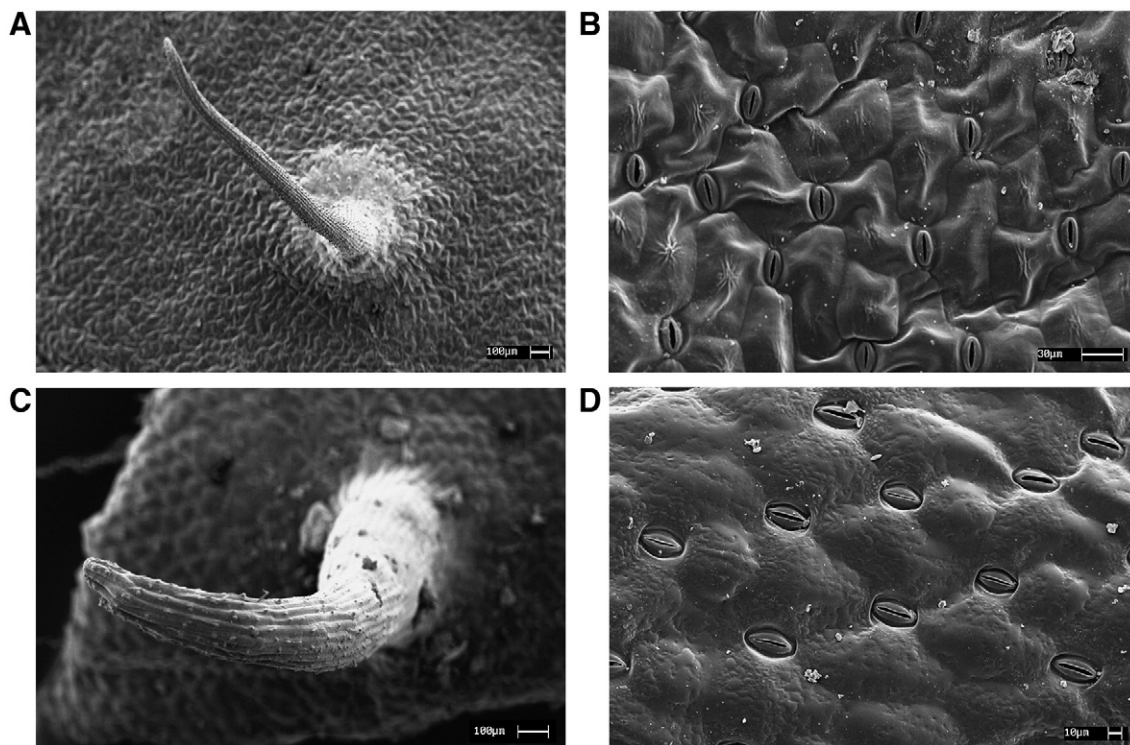


Fig. 2. Scanning electron micrographs showing the epidermis and multicellular, striate bristles on the adaxial leaf surfaces in: A and B, *Brunsvigia namaquana* (Goldblatt & Manning 9649a, NBG); C and D, *B. radula* (Hall 5199, NBG). Scale bars: A and C 100 μm ; B, 30 μm ; D, 10 μm .

Manning 9649a and Desmet 2423), despite being present on wider leaves (28–35 vs. 10–24 mm).

In contrast, the flowers of these somewhat softly setose-leaved plants are more variable than the leaves. Some collections from near Steinkopf (Hall 4760, NBG; Mitchell 289, NBG) have deflexed stamens, as in the original description of *B. namaquana*, but in others from the same locality (Williamson 3430, NBG) the stamens vary from deflexed to spreading (Fig. 3A), the latter state matching specimens from further east at Naip-se-Berg, northern Bushmanland (Van Jaarsveld 9489, NBG) (Fig. 3B). In general, the specimens from quartzite outcrops in the Steinkopf district are more dwarfed than those from elsewhere, but there is little else to distinguish them from the plants found on the quartzite-capped inselbergs in neighbouring northern Bushmanland and on the quartz fields of Wallekraal. This variability suggests that the presence of deflexed stamens can no longer be regarded as taxonomically reliable for *B. namaquana*. Instead, the data suggest that the texture and position of the trichomes on the leaves have more value as diagnostic characters.

The specimens Hall 5199 and Snijman 1254 (NBG), identified as *B. radula* from the dolomite outcrops on the Knersvlakte, southern Namaqualand, differ markedly from those of *B. namaquana* in having densely pustulose, thick-textured leaves covered with rigid, striate bristles on the adaxial surface (Fig. 4). These are proximally patent and apically curved (Fig. 2C), held stiffly above the leaf's thickened epidermis (Fig. 2D). The leaf edges are often sticky and covered with sand grains, and the margins are slightly inwardly-turned and fringed with short, thick, curved bristles. The bristles on the adaxial surface are so stiff that even when pressed they remain firmly patent.

4. Taxonomic treatment

4.1. Key to species of the *Brunsvigia radula*-group

- 1a. Upper surface of leaves densely covered with minute papillae, without bristles:
 - 2a. Pedicels 50–55 mm long; perigone tube 4–5 mm long; tepals 45–50 mm long*B. gariepensis*
 - 2b. Pedicels 10–25 mm long; perigone tube up to 0.5 mm long; tepals 20–27 mm long*B. comptonii*
- 1a. Upper surface of leaves pustulate and bristly:
 - 3a. Pustules widely scattered on upper surface; bristles straight and pliable, becoming appressed in herbarium specimens; leaf margin thin-textured, micropapillate and without bristles*B. namaquana*
 - 3b. Pustules densely arranged on upper surface; bristles curved and hard, remaining patent in herbarium specimens; leaf margin thick and tough, fringed with curved bristles*B. radula*

4.2. *Brunsvigia gariepensis* Snijman, sp. nov.

Quoad habitum et macropapillosam adaxialem paginam foliorum et valde septicaidem dehiscentiam ad Brunsvigiam comptonii, sed ab differt inflorescentia magniore, pedicellis



Fig. 3. Pressed specimens of *Brunsvigia namaquana* showing the adaxial surface of leaves sparsely covered with appressed bristles, and inflorescences with declinate to spreading stamens of variable length: A, Williamson 3430 (NBG); B, Van Jaarsveld 9489 (NBG). Scale bars: in cm.



Fig. 4. Pressed specimen of *Brunsvigia radula* (Hall 5199 (NBG)) showing the adaxial surface of leaves densely covered with rigid, curved bristles and an inflorescence with spreading stamens. Scale bar: in cm.

longioribus (50–55 mm), *tepals longioribus* (45–50 mm), *tubo perigonii* 4–5 mm longo, *et staminibus biseriatis*.

Type: South Africa. Northern Cape, Pofadder (2919): Pella se Berge, NW of Pella, S slope, amongst quartz and micaschist rocks, 420 m (–AA), 26 Mar 1985, *E.J. Van Jaarsveld & J.D. Kritzing* 8082 (NBG 135575, holo.; NBG 148082, iso.).

Deciduous bulbous herb, 110–200 mm tall when flowering. *Bulb* solitary, hypogeal, $\pm$ ovoid, 50–70 $\times$ 30–37 mm, sometimes extended into a neck up to 50 $\times$ 20 mm, inner tunics fleshy to papery, cream-coloured, outer tunics brittle, tan-coloured. *Leaves* 2 or 3(4), absent or emerging at flowering, prostrate, upper 2 $\pm$ opposite, lowermost 1 (when present) curved sideways, $\pm$ elliptical or strap-shaped, tapering apically, 50–140 $\times$ 22–50 mm, pale green, adaxial surface covered with micropapillae and conical macropapillae, abaxial surface smooth, margin outlined by narrow, $\pm$ impressed, smooth, cartilaginous rim. *Inflorescence* 6–17-flowered, a little less than hemispherical at anthesis, 80–140 mm diam., enlarging slightly in fruit up to $\pm$ 200 mm diam.; scape erect, up to 120 mm long, compressed–elliptical in transverse section, $\pm$ 10 $\times$ 4 mm, olive green, flushed reddish green basally; spathe valves 2, oblong–lanceolate, 35 $\times$ 15 mm, membranous, delicate pink, soon reflexed; bracteoles filiform; pedicels of outer flowers straight, those of inner flowers curved abruptly outwards immediately below ovary, 50–55 $\times$ 3–4 mm, trigonous, olive green. *Perigone* zygomorphic, pure white or white suffused with delicate pink, olive green to lime green in throat, dull-scented; tube 4–5 $\times$ 5 mm; tepals spreading, recurved near apex, 5 placed above horizontal plane, 1 spreading slightly downward and widely separated from others, narrowly oblong–lanceolate, 45–50 $\times$ 7–8 mm but

narrowing to 3.5–4.5 mm near base, margin plane; stamens biseriate, deflexed to $\pm$ 30° below horizontal plane at anthesis, upturned distally; filaments shortly fused basally, tightly clustered in lower half, without appendages near base, white but green towards base, outer $\pm$ 30 mm long, inner $\pm$ 50 mm long; anthers oblong, $\pm$ 5 mm long before dehiscence, maroon; pollen cream-coloured. *Ovary* $\pm$ 3-angled, $\pm$ 5 $\times$ 4 mm, olive green, with 3 or 4 ovules per locule; style slender, up to 55 mm long, included in stamen cluster for $\pm$ half its length, upturned in distal quarter, extending beyond inner stamens, white; stigma shortly trifid, papillate. *Capsule* cordiform, $\pm$ 10 $\times$ 9 mm, septa not strongly ribbed, dehiscing $\pm$ half way from apex, walls $\pm$ papery, $\pm$ translucent, without thickened cross-veining. *Seeds* subglobose, $\pm$ 3 mm diam., fleshy. *Flowering time*: late Feb–Mar. Fig. 5.

4.2.1. Distribution and habitat

B. gariensis has been well documented from the Pellaberg, located south of the Orange River between Aggeneys and Pofadder, Northern Cape, in the sandy plains of northern Bushmanland (Fig. 6). Other populations occur approximately 35 km southwest of Pellaberg on the comparatively cooler Ghaamsberg and Namiesberg inselbergs, situated on the border between the winter and summer rainfall systems within the Eastern Gariiep floristic area of endemism (Jürgens, 1991). The identity of the Namiesberg specimen (Kirstenbosch Expedition NBG 916/49) still remains tentative as it consists only of an inflorescence. On Pellaberg the plants occupy south-facing slopes, typically amongst jumbled, quartzitic and micaschist rocks, whereas on Ghaamsberg they favour northeast facing slopes on small hills dotting the mountain's central plateau. The vegetation at both localities is classified as Bushmanland Inselberg Shrubland (Mucina et al., 2006b) and includes a mixture of succulent and non-succulent elements. Thunder showers provide erratic, low amounts of rainfall from February to April and are a pre-requisite for flowering, whereas the hysteranthous leaves depend on precipitation generated by cold fronts that occasionally extend into the interior in winter. Currently the Ghaamsberg populations are threatened by the proposed mining of this floristically important site for zinc.

4.2.2. Diagnostic features

B. gariensis differs from the closely allied *B. comptonii*, which has similar papillate leaf upper surfaces, in having a consistently larger inflorescence in which the flowers have longer pedicels (50–55 vs. 10–25 mm at anthesis), longer tepals (45–50 vs. 20–27 mm) and a longer perigone tube (4–5 vs. $\leq$ 0.5 mm), and the stamens are distinctly biseriate, the outer whorl being $\pm$ two thirds as long as the inner. Although lateral appendages at the base of the filaments are sometimes present in *B. comptonii* they are absent in *B. gariensis*. This feature is nevertheless regarded as taxonomically unreliable in *Brunsvigia*, being variable in *B. namaquana* (Müller-Doblies and Müller-Doblies 1994) and *Brunsvigia bosmaniae* F.M.Leight (Manning et al., 2002). Other species from the semi-arid western parts of Northern Cape that have flowers with distinctly biseriate stamens are *B. bosmaniae*, *Brunsvigia herrei* F.M.Leight ex W.F.Barker and *Brunsvigia pulchra*

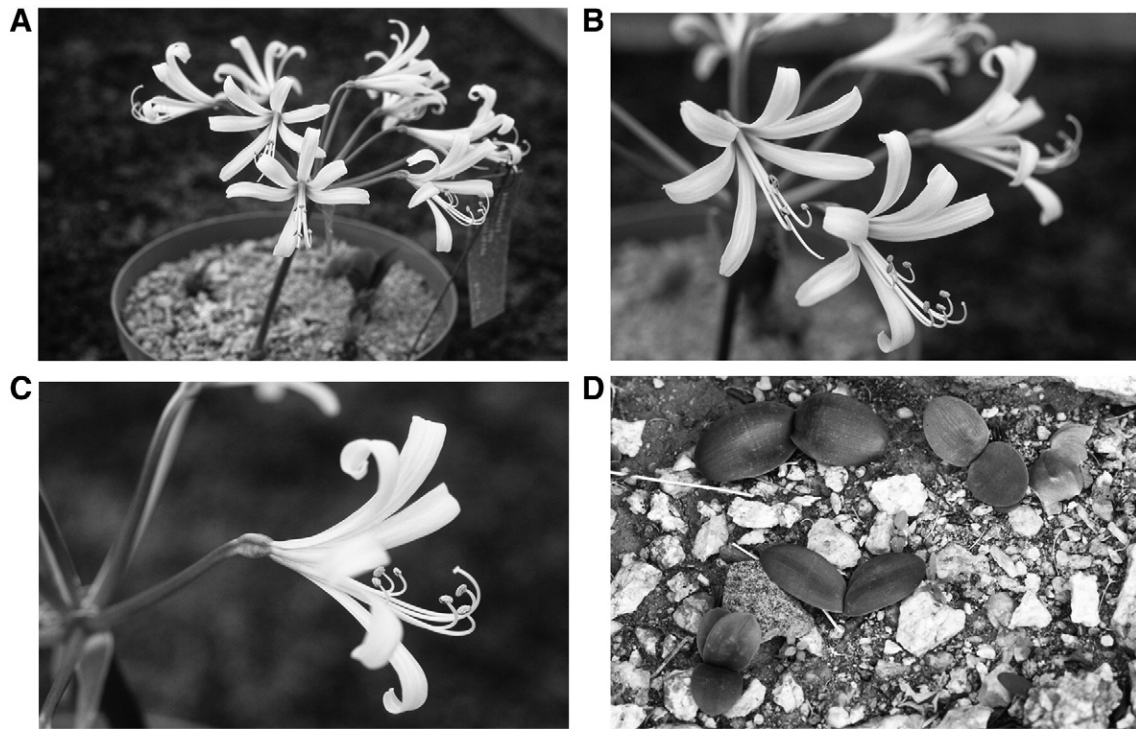


Fig. 5. *Brunsvigia gariepensis*: A, few-flowered inflorescence; B, partial inflorescence showing tightly clustered filaments and style; C, flower in lateral view showing short perigone tube and biseriate stamens; D, prostrate leaves in habitat amongst white quartzite stones and rocks. Photographs: A–C, J.C. Paterson-Jones (*Duncan 386*, NBG), in cultivation at Kirstenbosch National Botanic Garden; D, E.J. Van Jaarsveld (*Van Jaarsveld 8082*, NBG).

(W.F.Barker) D.Müll.-Doblies & U.Müll.-Doblies. They are all easily distinguished from *B. gariepensis* by their large habit and heavily ribbed fruiting capsules.

4.2.3. Etymology

The name *B. gariepensis* refers to the eastern Gariep floristic centre in northern Bushmanland (sensu Jürgens, 1991), where the species is endemic.

4.2.4. Additional specimens examined

South Africa. NORTHERN CAPE: **2918 (Gamoep)**: Aggen-
eys district, Ghaamsberg, centre of crater, lily hill (–BD), 31 Mar

1999, A. Van Heerden & T.A. Anderson 838 (KMG). **2919 (Pofadder)**: Groot Pellaberg (–AA), 10 Aug 1982, E.J. Van Jaarsveld 6653 (NBG, PRE); Groot Pellaberg (–AA), 20 Nov 1996, G. Duncan 386 (NBG, PRE).

4.3. *Brunsvigia comptonii* W.F.Barker in J. S. African Bot. 14: 29 (1948)

Type: South Africa. Western Cape, Montagu (3320): Laingsburg District, Whitehill, crevices in Dwyka shale, 2700 ft [823 m] (BA/BC), 5 Mar 1948, R.H. Compton 20483 (NBG, holo!; BOL!, K — image!, PRE — image!, iso.).

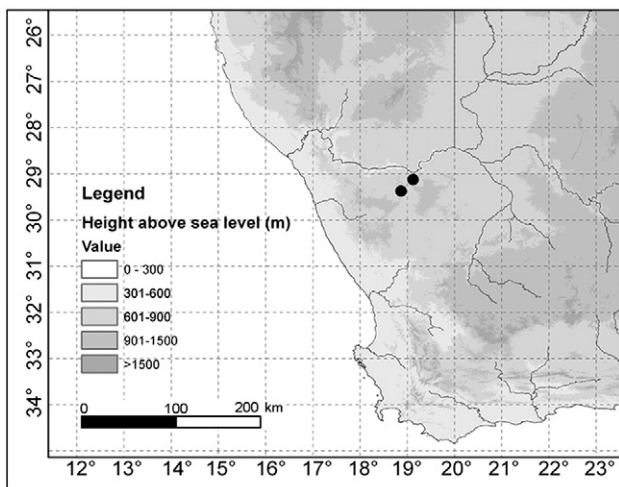


Fig. 6. Distribution of *Brunsvigia gariepensis*.

Deciduous bulbous herb, up to 110 mm tall when flowering. *Bulb* solitary, hypogeal, ±ovoid, 20–40×20–40 mm, usually extended into a neck up to 50(–70)×20 mm, inner tunics fleshy to papery, cream-coloured, outer tunics brittle, tan-coloured. *Leaves* 2–4(5), absent or emerging at flowering, adpressed to ground, upper 2±opposite at first, later deflected sideways, narrowly to broadly ovate, subacute or obtuse, 45–80×10–30 mm, adaxial surface covered with micropapillae and conical macropapillae, abaxial surface smooth, margin plain. *Inflorescence* 4–13(–20)-flowered, a little less than hemispherical at anthesis, 45–80 mm diam., enlarging slightly in fruit up to 50–120 mm diam.; scape erect, up to 75 mm long, compressed–elliptical in transverse section, ±4–8 mm wide, reddish brown; spathe valves 2, oblong–lanceolate, 18–30×3–6 mm, membranous, reddish brown, soon reflexed and papery; bracteoles filiform; pedicels of outer flowers straight, those of inner flowers often geniculate immediately below ovary, 10–25×±2 mm, trigonous, reddish brown,

lengthening up to 32 mm in fruit. *Perigone* zygomorphic, pale pink with a distinct darker midrib or deep pink with 3 darker central veins, greenish at base; tube up to 0.5 mm long; tepals recurved, either all curving towards upper half of flower or 1 spreading slightly downwards and widely separated from others, narrowly oblong–lanceolate, $15\text{--}27 \times 2.5\text{--}5.0$ mm, margin sometimes undulate; stamens of various lengths, $\pm 3/4$ as long as tepals to slightly longer, deflexed slightly below horizontal plane at anthesis or markedly so in flowers with pedicels geniculate below ovary, upturned distally; filaments shortly fused near base and tightly clustered in lower half, pale to dark pink, often darker towards base, with or without lateral appendages near base, appendages either minute or forming a tapering or apically pointed wing up to 5 mm long; anthers oblong, ± 4 mm long before dehiscence, maroon; pollen cream-coloured. *Ovary* ± 3 -angled, $\pm 3\text{--}4$ mm diam., reddish brown, with 3 or 4 ovules per locule; style slender, up to ± 35 mm long, included in stamen cluster for $\pm$ half its length, strongly upturned in distal quarter, extending well beyond stamens, pale pink; stigma shortly trifid, papillate. *Capsule* cordiform, $10\text{--}15 \times 10\text{--}13$ mm, septa without ribbing, dehiscing for $\pm$ two thirds or more below apex, walls $\pm$ papery, $\pm$ translucent, without conspicuous cross-veining. *Seeds* subglobose, ± 3 mm diam., fleshy. *Flowering time*: Dec–Apr. See <http://plants.jstor.org/specimen/nbg0066095-1>.

4.3.1. Distribution and habitat

B. comptonii was originally known only from near Laingsburg, Western Cape, but has now also been recorded in the Tanqua and Moordenaars Karoo, and the Klein Roggeveld, extending northwards to around Loeriesfontein and beyond to between Aggeneys and Pofadder, and Aughrabies Falls in Northern Cape (Fig. 7). The species favours loamy or shaley soils on plains and plateaus, occurring in open patches of shallow soil, along seasonal watercourses and floodplains, and rarely on scree belts. Populations vary from less than 100 plants in small, open patches to several thousands of plants along seasonal floodplains. In the Nama-Karoo Biome the species is

found in alluvial vegetation and outlying areas of succulent vegetation, whereas in the Succulent Karoo Biome it is found in the Rainshadow Valley Karoo Bioregion (Mucina et al., 2006a). The associated vegetation in the Nama-Karoo is dominated by grasses, unlike the Succulent Karoo shrublands of the south. Nevertheless, parts of the Tanqua Karoo and Moordenaars Karoo are grass-rich. The plants flower opportunistically in response to occasional autumn rains. Vegetative growth is confined to late autumn and winter.

4.3.2. Diagnostic features

B. comptonii is distinguished by the densely macropapillate upper surface of its few, small leaves (Fig. 1B), its small inflorescence with short pedicels, 10–25 mm, obsolete perigone tube, <0.5 mm long, and upwardly flared tepals, 15–27 mm long.

Other features of the flower are variable. Plants from the inselbergs between Ghaamsberg and Pofadder have filaments that are more markedly declinate than elsewhere. Plants from northern Bushmanland (Van Jaarsveld s.n., NBG167590; Desmet 2372, 2381, NBG) and central Bushmanland (Snijman 1846, NBG) also occasionally have translucent, lateral wings (up to 5 mm long) near the base of both filament whorls. These may be apically pointed or $\pm$ smoothly tapering towards the apex. In southern Bushmanland (Bruyns 7867, NBG), near Langberg (Summerfield s.n., NBG), in the Tanqua Karoo (Bayer 1848, NBG) and near Matjiesfontein (Barker, 1948), appendages are occasionally present near the base of the filaments as minute, lateral thickenings.

4.3.3. Additional specimens examined

South Africa. NORTHERN CAPE: **2820 (Kakamas)**: Kenhardt Division, Aughrabies Falls, Orange River (–CB), Apr 1936, C.F.L. Leipoldt 4381 (BOL). **2918 (Gamoep)**: Ghaamsberg, between Aggeneys and Pofadder, on S-facing side of mountain (–BD), date unknown, E.J. Van Jaarsveld s.n. (NBG167590). **2919 (Pofadder)**: Pofadder (–AB), 16 Feb 1962, H.A. Horn s.n. (NBG66099); Aggeneys, Volstruishoek (Namies), S-facing slope of Namiesberg, 1050 m (–AC), 4 Dec 2000, P. Desmet 2372 (NBG, PRE); Aggeneys, Volstruishoek (Namies), plateau of Namiesberg, 1120 m (–AC), 4 Dec 2000, P. Desmet 2381 (NBG); Farm Middeldevrlei, 50 km S of Pofadder (–CB), date unknown, G. Louw s.n. (NBG184567); Farm Middeldevrlei, 50 km S of Pofadder (–CB), 11 Sep 2001, D. Snijman 1846 (NBG). **3019 (Loeriesfontein)**: Brakfontein, 650 m (–CB), 13 Jun 1999, P.V. Bruyns 7867 (NBG); Farm Brandkraal, between Langberg and Kubiskouberg, NW of Loeriesfontein (–CC), date unknown, G. Summerfield s.n. (NBG190474). **3119 (Calvinia)**: Farm Hamburg, between Nieuwoudtville and Loeriesfontein (–AA), 19 Apr 2001, D. Snijman 1794 (NBG); 17.6 km along Rondekop road off R27 at Soetlandsfontein River (–AC), 6 Jun 2005, J.C. Manning 2949 (NBG). **3120 (Williston)**: 16 km from Middelpoos towards Sutherland, between Muldersfontein and Oupos (–CD), 25 Mar 1983, D. Snijman 1166 (NBG). **3219 (Wuppertal)**: 52 km N of Tulpfontein (–BA/BC), 24 Jul 1979, M.B. Bayer 1847 (NBG); Tanqua Karoo, 106 km N of turnoff to Sutherland towards Calvinia

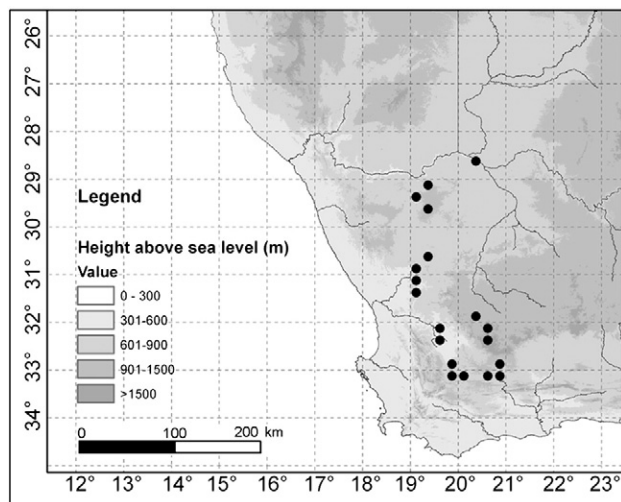


Fig. 7. Distribution of *Brunsvigia comptonii*.

(–BC), 23 Mar 1988, *D. Snijman 1156* (NBG); Rietfontein/Droogelaagte, boundary SSE [of] Rietfontein farmhouse (–DD), 5 Aug 1992, *M.B. Bayer 6226* (NBG); Ceres Karoo, 130 km N of Ceres on Calvinia road (–DD), 24 Mar 1978, *C.E. Labuschagne s.n.* (NBG 115736). **3220 (Sutherland)**: 33 km N of Sutherland (–BA), 16 Feb 1987, *M.B. Bayer 5315* (NBG); Sutherland (–BC), Feb 1907, *R. du Toit* sub *H. Bolus: Austro-Africanæ Flora 12538* (BOL); ± 48 miles SW of Sutherland on Ceres road (–BC), 29 Apr 1971, *M. Thomas s.n.* (NBG 94935). WESTERN CAPE: **3220 (Sutherland)**: 44 km along Moordenaars Karoo road, NE of Laingsburg (–DD), 17 Mar 1980, *D. Snijman 205* (NBG). **3319 (Worcester)**: Platfontein near Karooport (–BB), Mar 1929, *C.H. Wicht s.n.* (NBG167278). **3320 (Montagu)**: 5 km E of Patatsrivier turnoff, from Karooport/Sutherland road towards Matjiesfontein (–AA), 20 Apr 1977, *M.B. Bayer 512* (NBG); Whitehill Karoo, Laingsburg District (–BA), 2 Mar 1942, *R.H. Compton 13043* (NBG); Whitehill Karoo, Laingsburg District (–BA), 25 Feb 1943, *R.H. Compton 14410* (NBG); Whitehill, Laingsburg District (–BA), 5 Mar 1948, *R.H. Compton 20483* (NBG); 13 km north of Laingsburg towards Komsberg (–BB), 19 Mar 1988, *P. Bruyns 3053* (NBG); 5 km W of Laingsburg on Laingsburg/Matjiesfontein road (–BB), 16 Mar 1980, *D. Snijman 201* (NBG); 2 km S of Laingsburg (–BB), 16 Mar 1980, *D. Snijman s.n.* (NBG 151858).

4.4. *Brunsvigia namaquana* D.Müll.-Doblies & U.Müll.-Doblies in Feddes Repert. 105: 347 (1994)

Type: South Africa. Northern Cape, Springbok (2917): about 35 km south of Vioolsdrif, near Animub, north of Jakkalswater just east of N7 road near pegmatite ridge (–BB), 27 Sep 1978, *A.R. Mitchell 289* (NBG 122546, neo.!, here designated; NBG!, PRE, iso.).

Deciduous bulbous herb, 25–100 mm tall when flowering, sometimes up to 150 mm in cultivation. *Bulb* solitary, hypogaeal, $\pm$ ovoid, 20–35 $\times$ 15–28 mm, sometimes extended into a neck up to 50 $\times$ 10 mm, inner tunics fleshy to papery, cream-coloured, outer tunics brittle, tan-coloured. *Leaves* 2 or 3(4), absent or emerging at flowering, prostrate, upper 2 $\pm$ opposite, lowermost 1 (when present) curved sideways, $\pm$ strap-shaped to narrowly elliptical, tapering apically, 14–100 $\times$ 10–28(–35) mm, pale green, often $\pm$ flaccid, adaxial surface bearing widely-spaced pustules on longitudinal veins, each with a straight, erect, straw-coloured bristle 1.6–4.0(5.5) mm long, abaxial surface smooth, margin narrowly cartilaginous, with a single row of micropapillae. *Inflorescence* 4–8(–11)-flowered, loosely spreading at anthesis, 30–120 mm diam., enlarging slightly in fruit; scape erect, 15–60 mm long, up to 100 mm in cultivation, compressed–elliptical in transverse section, ± 3 –6 mm wide, pinkish brown; spathe valves 2, oblong–lanceolate, 13–30 $\times$ 5–8 mm, membranous, delicate pink, soon reflexed; bracteoles filiform; pedicels of outer flowers straight, those of inner flowers sometimes geniculate immediately below ovary, 10–30(–55) $\times$ ± 2 mm, trigonous, pinkish brown. *Perigone* zygomorphic, pale to dark pink, with darker pink veins, pale green to cream-coloured near base, occasionally

slightly scented; tube inconspicuous, up to 1.5 mm long; tepals recurved, either all curved upwards above horizontal plane, or 1 spreading slightly downward and widely separated from others, narrowly oblong–lanceolate, 11–24 $\times$ 2.5–4.5 mm, margin plane or $\pm$ crisp; stamens of various lengths, $\pm$ as long as or up to 8 mm longer than tepals, deflexed slightly below horizontal plane at anthesis or markedly so in flowers with pedicels geniculate below ovary, upturned distally; filaments fused basally for up to 2 mm long, tightly clustered in lower half, with or without narrow wings near base of up to 2 mm long, wings sometimes tipped with a delicate tooth up to 1 mm long, pink with pale lime-green towards base; anthers oblong, 2.5–4.3 mm long before dehiscence, maroon; pollen cream-coloured. *Ovary* ± 3 -angled, ± 2 –4 mm diam., brownish pink to greenish pink, with 3 or 4 ovules per locule; style included in stamen cluster for $\pm$ half its length, upturned in distal quarter, slender, up to 21–32 mm long, extending well beyond stamens, white to pale pink; stigma shortly trifid, papillate. *Capsule* cordiform, ± 7 mm diam., septa without ribbing, dehiscing for up to three quarters below apex, walls $\pm$ papery, $\pm$ translucent, without conspicuous cross-veining. *Seeds* subglobose, ± 3 mm diam., fleshy. *Flowering time*: Dec–Apr. Fig. 3.

4.4.1. Distribution and habitat

B. namaquana was first collected by the Rev. G. Meyer near Steinkopf in northern Namaqualand as early as 1927 but the species has only recently been recorded beyond this district. In the extreme northeast *B. namaquana* is found at Oonab Noord, a quartzite-capped inselberg lying northwest of Aggeney, northern Bushmanland. Populations are also known from the Riethuis-Wallekraal Quartz Vygieveld (*Mucina et al., 2006a*) in the southwest, and from near the Kubiskou Mountains on the border between Namaqualand and Bushmanland in the southeast (Fig. 8). Plants favour south-facing quartzite scree slopes and grit pockets on quartzite or low granite outcrops, on elevated plateaus and low-lying plains. Although the inselbergs of northern Bushmanland are embedded in the Nama-Karoo Biome they differ from the surrounding grassy

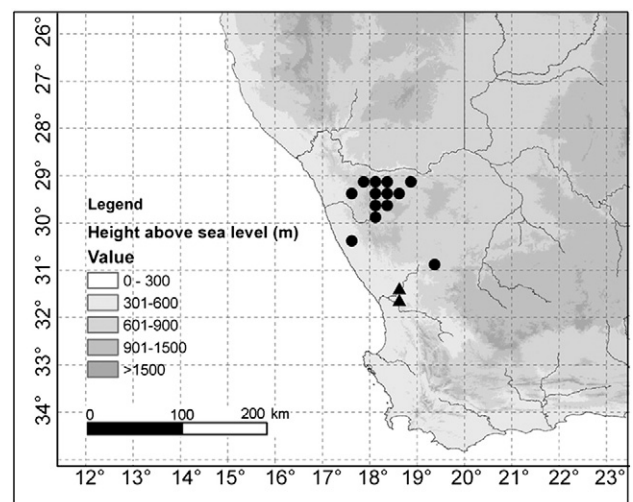


Fig. 8. Distribution of *Brunsvigia namaquana* ● and *B. radula* ▲.

plains by having succulent shrublands, similar to those in the Succulent Karoo Biome. Several specimens having leaves that resemble *B. namaquana* are known from mountains north and south of the Orange River in the Warmbad District (Giess & Müller 12258, WIND; Van Jaarsveld 19157, NBG), but as yet these collections are too fragmentary to be sure of their identity.

4.4.2. Typification and diagnostic features

B. namaquana was originally described from three collections (Müller-Doblies and Müller-Doblies, 1994) but none has been deposited in any herbarium to date. In the absence of any original material, the specimen A.R. Mitchell 289 (NBG 122546) is designated here as a neotype. In all respects it is a good match of the illustrations originally provided (Müller-Doblies and Müller-Doblies 1994, Figs. 13e–g, 14a).

The species is most easily recognised by its (2)3(4) leaves with long (1.5–5.5 mm), pliable, straw-coloured bristles arising from widely scattered pustules on the longitudinal veins of the adaxial surface (Fig. 2A). In herbarium specimens the bristles become appressed to the leaf surface, often in overlapping ranks along the veins (Fig. 3). The leaf margins are thin-textured and mostly outlined with a row of micropapillae without bristles. As re-circumscribed here, the species is more variable florally than was previously known. Although long (± 1.5 times as long as the tepals), declinate stamens were treated as diagnostic of the species, these characters are confined to just a few plants in populations that otherwise have filaments spreading only slightly below the horizontal plane (Fig. 3). The stamens vary in length at anthesis, even in an individual flower, with the shortest $\pm$ equal to the tepals and the longest exerted by up to ± 8 mm. Also variable are the lateral appendages, which are occasionally present as wings or teeth near the base of the filaments.

4.4.3. Additional specimens examined

South Africa. NORTHERN CAPE: **2917 (Springbok)**: Kinderle, Steinkopf (–BB), 7 Jun 1956, *H. Hall s.n.* (NBG 66093); near Animub, N of Jakkalswater (–BB), 27 Sep 1978, *A.R. Mitchell* 289 (NBG); summit overlooking Kabinaberg, N of Steinkopf (–BB), 6 Apr 1985, *G. & F. Williamson* 3430 (NBG); near Steinkopf (–BC), Apr 1927, *G. Meyer* sub *R. Marloth* 134171 (PRE); near Steinkopf (–BC), Jul 1928, *G. Meyer* sub *R. Marloth* 136021 (PRE); on the Spitskop near Steinkopf (–BC), 4 Apr 1929, *G. Meyer* sub *R. Marloth* 13671 (PRE). **2918 (Gamoep)**: Pofadderkop, 37 km N of Concordia (–AA), 25 Mar 1988, *T. Smale s.n.* (NBG 201410); Aggeneys, Farm Amam, S slope of main peak of Amam-se-Kop (–AB), 16 Apr 2000, *P. Desmet* 2429 (NBG); Latitude 29° 15.16' S, Longitude 18° 13.06' E (–AC), 1 May 1981, *N. Van Berkel* 332 (NBG); Steinkopf 22, base of slope on N side of Kouriespoort (–AC), 7 Apr 2001, *P. Desmet & T. Smale* 3264 (NBG); Naip-se-Berg (–AD), 11 Nov 1978, *E. Van Jaarsveld* 9489 (NBG, PRE); Aggeneys, Farm Oonab Noord (–BB), 15 Apr 2000, *P. Desmet* 2423 (NBG); Steinkopf District, Umduas (–BC), 19 Oct 1977, *H. Hall* 4760 (NBG); ± 24 km E of Springbok towards Pofadder, next to granite rocks (–CA), 24 Aug 1993, *P. Goldblatt & J. Manning* 9649a

(NBG, PRE); Kouberge, 30 km NE of Gamoep (–CB), ex hort. 15 Jan 1987, *J. Lavranos & M. Bleck* 22297 (NBG); Rietfontein (–CC), Sep 1995, *S. Hammer & G. Williamson* 5705 (NBG). **3017 (Hondeklipbaai)**: 5 miles N of Wallekraal (–BC), date unknown, *H. Hall s.n.* (NBG 66092); ± 14 km N of turnoff to Soebatsfontein from Wallekraal/Hondeklipbaai road via Gembokvlei (–BC), 8 Dec 2003, *B. Horak s.n.* (NBG 198747). **3019 (Loeriesfontein)**: Kubiskow Mountain (–CD), 7 Sep 1926, *R. Marloth* 12858 (BOL, PRE). INEXACT LOCALITIES: Kamiesberg area, *Unknown donor*, Jun 1982, (NBG 198018); NW of Loeriesfontein, Jul 1989, *J. Lavranos* 27602A (NBG).

4.5. *Brunsvigia radula* (Jacq.) W.T. Aiton, *Hortus Kew.*, ed. 2, 2: 230 (1811)

Amaryllis radula Jacq., Pl. Hort. Schoenbr. 1: 35 (1797). *Coburgia radula* (Jacq.) Herb. ex Steud., *Nomencl. Bot.*, ed. 2, 1: 390 (1840). Type: South Africa. [Illustration in] Jacq., Pl. Hort. Schoenbr. 1: t. 68 (1797), lecto!, here designated; ‘Africa australis’ *Masson s.n.* (BM 000911876 epi., — image!, here designated).

Deciduous bulbous herb, 50–80 mm tall when flowering. *Bulb* solitary, hypogaeal, $\pm$ ovoid, 30–35 $\times$ 30–35 mm, sometimes extended into a neck up to 30 $\times$ 15 mm, inner tunics fleshy to papery, cream-coloured, outer tunics brittle, tan-coloured. *Leaves* 2, absent at flowering, prostrate, opposite, elliptical, 30–45 $\times$ 15–35 mm, rarely up to 55 mm long in cultivation, shiny green, thick-textured, adaxial surface covered with pustules, each bearing a short, hard, apically curved bristle, abaxial surface smooth, margin horny, fringed with short, hard bristles. *Inflorescence* 3–8-flowered, loosely spreading at anthesis, 50–70 mm diam., enlarging slightly in fruit; scape erect, up to 60 mm long, compressed–elliptical in transverse section, ± 5 –8 mm diam., brownish pink; spathe valves 2, oblong–lanceolate, $\pm 20 \times 9$ mm, membranous, delicate pink, soon reflexed; bracteoles filiform; pedicels straight or sometimes slightly geniculate immediately below ovary, 15–25 $\times$ 1–2 mm, trigonous, brownish pink. *Perigone* zygomorphic, rose-pink, pale greenish cream in throat; tube up to 1 mm long; tepals all flared upwards above horizontal plane, or 1 spreading slightly downward and widely separated from others, narrowly oblong–lanceolate, 18–22 $\times$ 3–4 mm, margin plane or slightly undulate; stamens of various lengths, $\pm$ as long as to 7 mm longer than tepals, spreading horizontally or deflexed to $\pm 30^\circ$ below horizontal plane at anthesis, upturned distally; filaments shortly fused for ± 1.5 mm at base, remaining tightly clustered in lower half, without appendages near base, white to pale pink; anthers oblong, ± 3.5 mm long before dehiscence, maroon; pollen cream-coloured. *Ovary* ± 3 -angled, ± 2 –4 mm diam., brownish pink, with 3 or 4 ovules per locule; style slender, included in stamen cluster for $\pm$ half its length, upturned in distal quarter, exerted up to 5 mm beyond stamens, white to pale pink; stigma shortly trifid, papillate. *Capsule* cordiform, ± 8 –10 mm diam., septa not ribbed, dehiscing for at least three quarters below apex, walls $\pm$ papery, $\pm$ translucent, with a few cross-veins. *Seeds* subglobose, ± 3 mm diam., fleshy. *Flowering time*: Mar–May. Fig. 4.

4.5.1. Distribution and habitat

The first record of the species is a painting by Francis Masson (BM), dated 1790 and annotated 'Loc. nat. in collibus aridissimis Karo prope Elephants river'. Masson would have collected the bulbs during his journey to the Roggeveld, between 26 September 1774 and 20 December 1774, via what is today known as Vanrhynsdorp (Bradlow, 1994). The species was rediscovered by Mr H. Hall as recently as 1981, on dolomite outcrops in the low-lying Knersvlakte, just north of Vanrhynsdorp. Currently, the species is known from less than five sites on most of the major limestone outcrops of the Knersvlakte: near the Graafwater River, north and south of the Sout River, and north and south of the Vars River, in quarter degree grids 3118BC and 3118DA (N.A. Helme, pers. comm.) (Fig. 8). The bulbs often grow tightly packed together in rock crevices or in shallow soils overlying rocks. Other species narrowly endemic to these dolomite outcrops are *Eriospermum arachnoideum* P.L.Perry (Ruscaceae), *Babiana carminea* J.C.Manning & Goldblatt and *Ixia acualis* Goldblatt & J.C.Manning (Iridaceae). Growing together with these species is *Massonia echinata* L.f. (Hyacinthaceae), which has setose leaves that superficially resemble those of *B. radula*. These highly localised populations, of about a hundred or less plants each, are presently threatened by the proposed mining of the dolomite outcrops in the area.

4.5.2. Typification and diagnostic features

The illustration in Jacquin (1797), designated above as a lectotype, depicts a plant with two inflorescences and three dissimilar leaves: the upper two covered with pustules and short, hard trichomes, the lowermost small and smooth. Since a plant with two inflorescences is atypical of any species in *Brunsvigia*, an epitype (Masson s.n., [<http://plants.jstor.org/specimen/bm000911876>]) consisting of two leaves and one inflorescence has been designated here. This specimen, collected by Masson, was the first to have been positively identified by Baker (1888, 1896) as *B. radula*.

Jacquin (1797) explicitly stated that *B. radula* has a pair of thick-textured leaves, which are rough with short, hard trichomes on the adaxial surface. Inserted on large pustules and densely covering the adaxial surface, the ± 2 mm long, ivory-coloured trichomes remain remarkably rigid and upright, even in pressed specimens (Figs. 2 and 4). The leaf margins are thick and tough and fringed with similarly hard, short, curved bristles. Florally *B. radula* is difficult to separate from *B. comptonii* and *B. namaquana*, as all three species have similar, small, pink, few-flowered inflorescences. Although flowering specimens of *B. radula* have not often been collected, the flowers are not known to have appendages at the base of the filaments. In the wild only a small number of plants seem to flower each season (R. Saunders, pers. comm.).

4.5.3. Additional specimens examined

South Africa. WESTERN CAPE: **3118 (Vanrhynsdorp)**: Quaggaskop, Knersvlakte (–BC), 6 Aug 1981, H. Hall 5080 (NBG); Farm Kwaggaskop, Knersvlakte (–BC), 2 Mar 1982, H. Hall 5199 (NBG); Farm Rooiberg, Knersvlakte (–BC), 19 May 1992, D. Snijman 1254 (NBG).

Acknowledgements

Phillip Desmet and Ernst Van Jaarsveld kindly provided many valuable collections from Bushmanland. Greta Louw was generous with her hospitality while working in Bushmanland. Graham Duncan provided plants for study from the Kirstenbosch National Botanic Garden. Robert Archer and Lufuno Makwarela supplied images from the National Herbarium, Pretoria. JSTOR Plant Science gave access to images from European herbaria. Miranda Waldron of the Electron Microscope Unit, University of Cape Town, generated the electron micrographs, and Michelle Smith and Bronwynne Busch helped prepare the figures. Colin Paterson-Jones provided invaluable help with photography. The Nature Conservation Board, Western Cape, and the Department of Tourism, Environment and Conservation, Northern Cape, granted permits to collect plants for study.

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