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A revision of *Lebeckia* sect. *Lebeckia*: The *L. pauciflora* and *L. wrightii* groups (Fabaceae, Crotalarieae)

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Abstract

All 14 species of the type section of the genus *Lebeckia* Thunb. are endemic to the Cape Floristic Region and are easily recognized by their phyllodinous, acicular (needle-shaped) leaves. Ten of the 14 species, comprising the *L. sepiaria* and *L. plukenetiana* groups, have already been revised. The last two groups are formally treated in this paper: 1. the *L. pauciflora* group (two virgate perennials with terete to semi-terete, stipitate fruits) and 2. the *L. wrightii* group (two trailing fireweeds with flat, sessile fruits). One of these, *L. uniflora* B-E.van Wyk and M.M.le Roux *sp. nov.*, is here described as new. The new species was previously confused with *L. wrightii* (Harv.) Bolus but differs in the single-flowered inflorescences, larger flowers and black seeds. The nomenclature, typification, morphological and diagnostic characters are presented as well as distribution maps. A comprehensive key to all 14 species of section *Lebeckia* is provided.

Keywords: Cape Floristic Region; Crotalarieae; Fabaceae; Fireweeds; *Lebeckia* section *Lebeckia*; *Lebeckia uniflora*; Revision

1. Introduction

Lebeckia Thunb. is the last remaining genus of the tribe Crotalarieae that has not been taxonomically revised in recent years (Harvey, 1862). The genus consists of some 33 species that are endemic to the western parts of southern Africa.

Recent molecular studies have shown that there are four major lineages within the tribe Crotalarieae (Benth.) Hutch. (Boatwright et al., in press). The genus *Lebeckia* is placed within the "Cape group", which includes the genera *Aspalathus* L., *Lebeckia*, *Rafnia* Thunb. and *Wiborgia* Thunb. *Lebeckia* is not monophyletic and is divided into several small groups. Combined molecular and morphological analyses showed the type section of the genus, *L.* sect. *Lebeckia*, to be monophyletic (Le Roux, 2006). This is supported by four apomorphies, namely the suffrutescent habit, acicular leaves that are often articulated near the middle, a 5+5 anther arrangement, and rugose seeds (Le Roux, 2006; Le Roux and Van Wyk, 2007).

Section *Lebeckia* includes 14 species that are nearly endemic to the Cape Floristic Region (Fynbos and Renosterveld Biomes) with only one species, *L. ambigua* E.Mey., also occurring in the Namaqualand coastal area (Le Roux and Van Wyk, 2008).

L. section *Lebeckia* is divided into four informal taxonomic groups, mainly based on fruit morphology and habit: 1. The *L. sepiaria* group – four species, all with sessile, terete or semi-terete fruits and a virgate habit; 2. The *L. plukenetiana* group – six species, all with stipitate, flat fruits and a prostrate habit; 3. The *L. pauciflora* group – both species have stipitate, semi-terete to terete fruits and a virgate habit; and 4. The *L. wrightii* group – two fireweeds, with sessile, flat fruits and stipules (Le Roux and Van Wyk, 2007; Le Roux and Van Wyk, 2008).

The *L. pauciflora* group and the *L. wrightii* group are revised here. One species from the *L. wrightii* group is described as new, namely *L. uniflora* B-E.van Wyk and M.M.le Roux *sp. nov.*

2. Materials and methods

Herbarium specimens obtained from BOL, JRAU, NBG, P, PRE, S and SAM were studied, as well as photographs of

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specimens from BM and K. Morphological variation was studied on several field trips. Illustrations were prepared using a WILD M3Z stereomicroscope with a *camera lucida* attachment. Specimens of those species that showed geographical variation were sorted into the following regional forms: *L. pauciflora*: Vanrhynsdorp or typical form, Montagu form (similar to typical form but habit smaller, inflorescences shorter), Langkloof form (habit small, leaves not articulated, inflorescences short); *L. wrightii*: Cape Town or typical form, Caledon form (similar to typical form).

3. Results and discussion

3.1. Morphology

With the exception of *L. uniflora* and *L. wrightii*, all species of *L.* section *Lebeckia* are perennial suffrutices. These two species are fireweeds – annuals or at most short-lived perennials that rapidly grow and mature only in the immediate post-fire phase of fynbos and disappear soon thereafter (Fig. 1c,d). *L. grandiflora* and *L. pauciflora* are virgate suffrutices with multiple stems spreading from a woody, persistent base and reach heights of up to 0.35 m and 0.8 m, respectively (Fig. 1a,b). Plants resprout and flower profusely after fire but the inflorescences often become sparse and few-flowered in the years following a fire. The Vanrhynsdorp or typical form of *L. pauciflora* may reach 1.0 m, but the Langkloof form is somewhat smaller (up to 0.6 m).

Stipules are commonly reduced in the Crotalarieae, and generally absent in section *Lebeckia* (Van Wyk and Schutte, 1988; Le Roux and Van Wyk, 2007), but they are uniquely present in *L. uniflora* and *L. wrightii* (Van Wyk and Schutte, 1989). The stipules are small, narrowly lanceolate and 2–5 mm long. Field observations have shown that stipules are absent from the lower leaves of seedlings, but gradually appear along the upper nodes, suggesting that the presence of stipules represents a reversal to an ancestral state in these two highly specialized species.

The leaves of the species in section *Lebeckia* are glaucous and glabrous in all the species except *L. uniflora* and *L. wrightii*, where they are minutely pubescent. Leaf length and density were studied in detail and was found to be inconclusive and of limited diagnostic value (Le Roux, 2006).

Fig. 1. Growth form (habit) and fruit shape in the four species of the *Lebeckia pauciflora* and *L. wrightii* groups: (a) *L. grandiflora* (Rooi Els or typical form), [*Esterhuysen 14102,* (P)]); (b) *L. pauciflora* (Vanrhynsdorp or typical form, photos taken at Algeria Forest Station); (c) *L. uniflora* (Caledon or typical form) [*Boucher 1878*, (NBG)]; (d) *L. wrightii* (Caledon form), photo taken in Kogelberg Nature Reserve; Photographers: B-E. van Wyk and J.S. Boatwright.

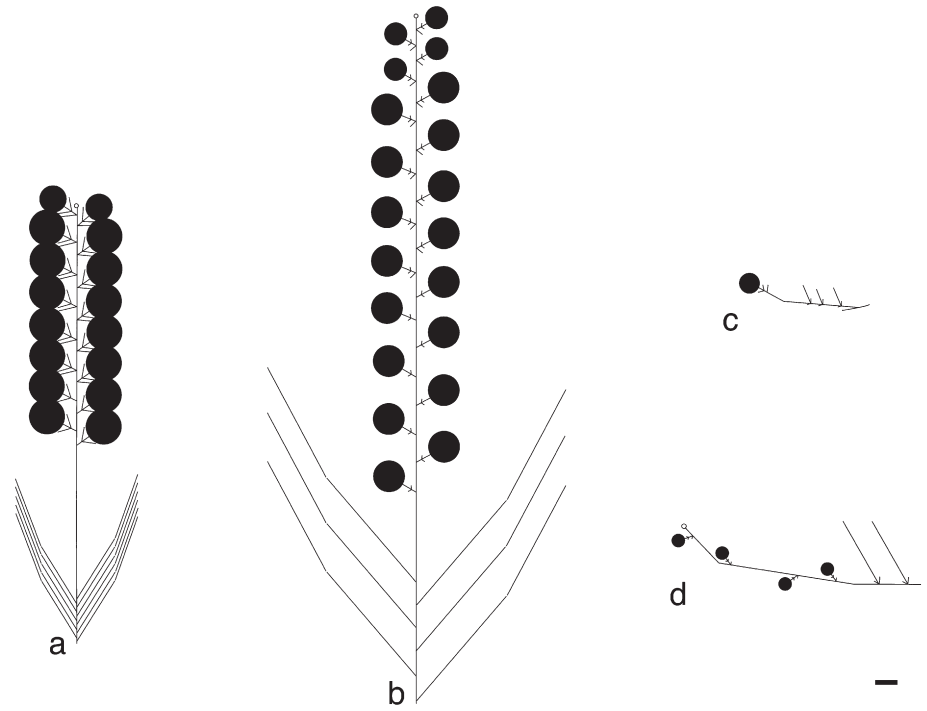

Fig. 2. Diagrams of inflorescence structure and relative flower size in the *Lebeckia pauciflora* and *L. wrightii* groups: (a) *L. grandiflora*; (b) *L. pauciflora*; (c) *L. uniflora*; (d) *L. wrightii.* Scale bar: 10 mm.

Some species in section *Lebeckia* have a joint or articulation near the middle of the leaf and its presence or absence is useful for diagnostic purposes. An articulation is invariably present in *L. grandiflora*; always absent in *L. uniflora* and *L. wrightii*; and either absent or present in *L. pauciflora*, depending on the location. Northern and southern populations of this species (Vanrhynsdorp or typical form) and Montagu form have the articulation present but not the eastern populations (Langkloof form) (see later). If the articulation is absent, the leaves are slightly shorter than when it is articulated.

Inflorescences of the species in section *Lebeckia* are usually densely multi-flowered (up to 95 flowers), terminal racemes (Le Roux and Van Wyk, 2007), but those in the *L. pauciflora* and *L. wrightii* groups are fewer flowered (Fig. 2). *L. grandiflora* usually has up to 16 flowers per inflorescence and *L. pauciflora* up to 34 flowers. *L. wrightii* has shorter inflorescences with up to five flowers at most, while *L. uniflora* typically has a single flower (very rarely two or three) per inflorescence (Fig. 2). Lateral branches may rarely occur at the base of the inflorescences of *L. pauciflora* and *L. wrightii*, while the

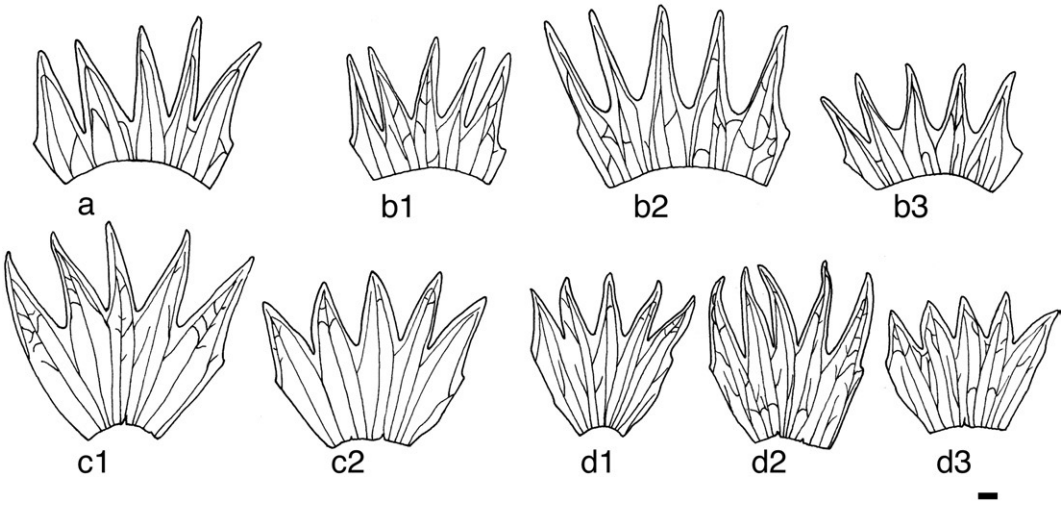

Fig. 3. Calyces of the *Lebeckia pauciflora* and *L. wrightii* groups (calyces are opened out with the upper lobes to the left): (a) *L. grandiflora*; (b) *L. pauciflora*; (c) *L. uniflora*; (d) *L. wrightii*. Vouchers: (a) from *Esterhuysen 14102* (P); (b1) *Fourcade 3117* (BOL); (b2) *Hanekom 3189* (NBG); (b3) *Fourcade 1707* (BOL); (c1) *Boucher 1878* (NBG); (c2) *Stokoe 964* (BOL); (d1) *Esterhuysen 31726* (BOL); (d2) *Boucher 1879* (NBG); (d3) *Compton s.n. sub. BOL 32416* (BOL). Scale bar: 1 mm. (c and d drawn by B-E. van Wyk). Scale bar: 1 mm.

inflorescences of *L. grandiflora* and *L. uniflora* are invariably unbranched.

Flower size is of some diagnostic value (Fig. 2). *L. wrightii* has small flowers (up to 8 mm long), whereas *L. grandiflora, L. pauciflora* and *L. uniflora* have larger flowers (up to 15 mm long).

The bracts and bracteoles are simple and sessile in all the species of section *Lebeckia*. *L. uniflora* and *L. wrightii* are unique in section *Lebeckia* in having minutely pubescent bracts and bracteoles. Bracts are attached at the base of the pedicel and usually have a median vein. They are usually caducous in *L. grandiflora* and *L. pauciflora*, but persist in *L. uniflora* and *L. wrightii* until the fruit has started developing (Fig. 7). The bracts are lanceolate to narrowly lanceolate, acute and usually small (1 to 3 mm long) but in *L. grandiflora* they can be relatively long (up to 7 mm). The paired bracteoles near the middle of the pedicel are usually narrowly lanceolate to triangular, acute and vary in length from 0.5 mm to 2.0 mm. The lanceolate bracteoles in *L. grandiflora* are diagnostically longer (±6 mm) and are almost as long as the bract (±7 mm).

The total length of the calyx is of diagnostic value in *L. grandiflora*, *L. pauciflora* and *L. uniflora,* as they have longer calyces than the rest of the section (7.5 mm to 12.5 mm long). In *L. wrightii* the calyx is 5.5 to 8.0 mm long and in *L. sepiaria* 4.0 to 6.5 mm long. The calyx lobes are usually shorter than or as long as the calyx tube in the section except in the four species treated here, where the lobes are characteristically longer than the tube (Fig. 3). The outer surface of the calyx in *L. uniflora* and *L. wrightii* is hairy but is completely glabrous in the other species of *L.* section *Lebeckia*.

The shape of the standard petal is usually ovate to orbicular but the apex may be obtuse (*L. pauciflora*) or emarginate (*L. grandiflora*, *L. uniflora* and *L. wrightii*). Claws of the petals are short in these species. The wing petals are distinct within these two groups in being obovate, with obtuse apices and numerous rows of lunate sculpturing. In *L. grandiflora* and *L. pauciflora* the wings are ± as long as the keel or slightly longer and the wings envelope the keel in *L. pauciflora*. In *L. uniflora* and *L. wrightii*, the wings are invariably longer than the keel (especially in *L. uniflora*). The keel petals are relatively uniform in structure and differ mainly in size, corresponding to flower size. A unique character within these two groups is the helically coiled keel, found in *L. pauciflora*, *L. uniflora* and *L. wrightii* (visible in Fig. 1). It would be worthwhile to examine fresh flowers of *L. grandiflora* for the possible presence of at least some degree of coiling in this seemingly close relative of *L. pauciflora*. Keel petals are usually rostrate (more so in *L. pauciflora*, *L. uniflora* and *L. wrightii* than in *L. grandiflora*), with ± obtuse apices.

The anthers in section *Lebeckia* are differentiated into five long, basifixed anthers alternating with five shorter, dorsifixed, versatile anthers (Le Roux and Van Wyk, 2007). The carinal anther resembles the long anthers in size and shape but it is attached a little higher up. Other sections in *Lebeckia* s.l. have 5+4+1 or 6+4 anther arrangements (Boatwright and Van Wyk, 2007), where the carinal anther is respectively intermediate in size or resemble the short anthers. It is invariably attached a little higher up than the basifixed anthers.

L. uniflora and *L. wrightii* are the only two species in the section with pubescent gynoecia. The ovary in section *Lebeckia* is usually many-ovuled (7 to 20 ovuled) but more so in *L. pauciflora* (17 to 37 ovuled). The gynoecium in *L. uniflora* and *L. wrightii* is ± sessile but subsessile in *L. grandiflora* and *L. pauciflora*.

L. pauciflora and *L. grandiflora* have semi-terete, markedly stipitate fruits that are much longer than in all other species – typically more than 60 mm long (Fig. 4). The fruits of *L. pauciflora* are thick-walled and spongy, while the fruit wall appears to be thin in *L. grandiflora*. In contrast, *L. uniflora* and *L. wrightii* have much smaller, pubescent, ± sessile and flat fruits (Fig. 4). *L. uniflora* seem to have slightly falcate and smaller fruits compared to those of *L. wrightii*.

The seeds of *L. pauciflora*, *L. uniflora* and *L. wrightii* are variable in shape (oblong-reniform to somewhat subtriangular or subrectangular) and markedly rugose (Fig. 5). *L. pauciflora* has characteristically larger seeds (up to 5.0×3.8 mm) than the other species (2.0–2.2×1.6–2.0 mm). Seed colour is of some diagnostic value: mottled light brown to dark brown in *L. pauciflora*, uniformly black in *L. uniflora,* or mottled black and white in *L. wrightii* (Fig. 5). Seeds of *L. pauciflora* have dark brown to black hilums and those of *L. uniflora* and *L. wrightii* black hilums. Seed characters seem useful to

Fig. 4. Fruit of the *Lebeckia pauciflora* and *L. wrightii* groups showing variation in size, shape and structure: (a) *L. grandiflora*; (b) *L. pauciflora*; (c) *L. uniflora*; (d) *L. wrightii*. Vouchers: (a1, a2) *Esterhuysen 3881* (BOL); (b1, b2) *Le Roux et al. 7* (JRAU); (b3) *Le Roux et al. 12* (JRAU); (b4) *Van Wyk 3024* (JRAU); (b5) *Van Wyk 3283* (JRAU); (b6) *Van Wyk 2983* (JRAU); (c1) *Snijman 80* (NBG); (c2, c3) *Boucher 1878* (NBG); (d1) *Bolus 4671* (BOL); (d2, d3) *Williams 3712* (NBG); (d4) *Kruger 114* (NBG). Scale bar: 10 mm.

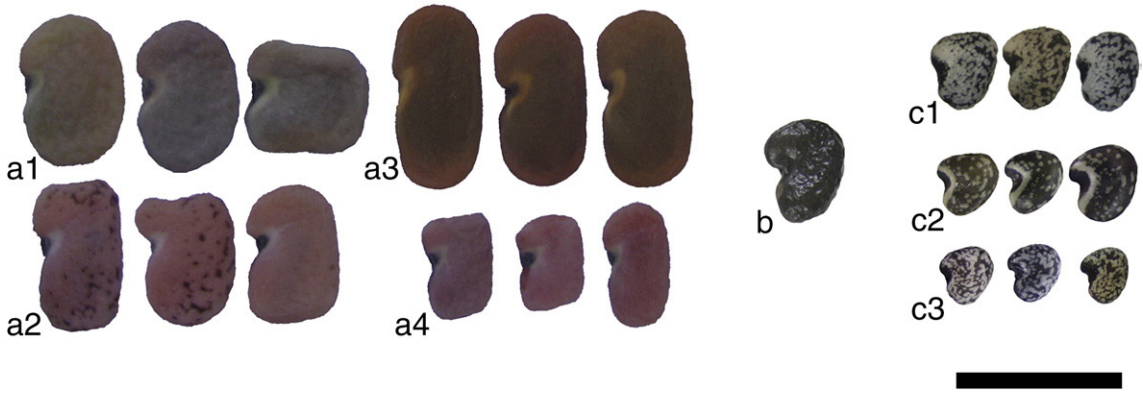

Fig. 5. Seeds of the *Lebeckia pauciflora* and *L. wrightii* groups: (a) *L. pauciflora;* (b) *L. uniflora;* (c) *L. wrightii.* Vouchers: (a1) *Le Roux et al., 12* (JRAU); (a2) *Van Wyk 3024* (JRAU); (a3) *Van Wyk 3283* (JRAU); (a4) *Le Roux et al. 7* (JRAU); (b) *Snijman 80;* (c1) *Drewe 448* (NBG); (c2) *Vlok et al., 11* (JRAU). Scale bar: 5 mm.

distinguish between some of the species, but a wider survey of the full range of variation in shape, size, colour and anatomical details is necessary to fully evaluate their diagnostic value. Unfortunately, no seeds of *L. grandiflora* were available for study and repeated attempts to locate the plant from known localities were unsuccessful.

4. Discussion

Two of the four species treated in this paper (*L. uniflora* and *L. wrightii*), show some unusual features, including an annual habit, pubescent leaves and calyces, minute but distinct stipules and spirally twisted keels. The latter feature is also present in the perennial *L. pauciflora*. Coiled keel petals are common in many Fabaceae (e.g. in *Bolusia* – see Van Wyk, 2003).

The variability of the leaf articulation (present or absent) and the long, slender fruits, together with the wide geographical distribution (across the entire Cape Floristic Region) are unique features of *L. pauciflora*. *L. grandiflora* is a poorly known and highly localized species, represented by only a few, relatively old herbarium collections. The general morphology (especially the petals and seeds) and conservation status of this plant should be the focus of future field studies.

4.1. Key to the 14 species of L. section Lebeckia

This paper represents the last part of a revision of the section *Lebeckia* and a key to the species is presented. Critical characters to consider are the presence or absence of a distinct joint or articulation near the middle of the leaf, the relative length of the wing petals (shorter, as long as, or longer than the keel petals), the relative length of the calyx lobes (in relation to the tube), the presence and length of the fruit stipe and the size and shape of the fruit.

1a. Leaves not acicular (linear to broadly obovate or variously digitate); anther arrangement 5+4+1 or 6+4 ..... *Lebeckia* (other sections)
1b. Leaves acicular (needle-shaped, terete); anther arrangement 5+5 ..... *Lebeckia* section *Lebeckia*:
2a. Calyx teeth longer than the tube; keel spirally twisted (except in *L. grandiflora*):
3a. Fruit subsessile, up to 50 mm long; short-lived fireweeds; flowers up to 5 per inflorescence; leaves and calyx pubescent:
4a. Flowers 3 to 5 per inflorescence, 5–8 mm long; wings 6.5–9.5 mm long ..... *L. wrightii*
4b. Flowers usually 1 per inflorescence, 8–12 mm long; wings 11.5–15.0 mm long ..... *L. uniflora*
3b. Fruit markedly stipitate, 70–165 mm long; perennial suffrutices; flowers more than 5 per inflorescence leaves and calyx glabrous:
5a. Keel spirally twisted; fruit 70–165 mm long, terete ..... *L. pauciflora*
5b. Keel not twisted; fruit 60–77 mm long, semi-terete ..... *L. grandiflora*
2b. Calyx teeth as long as or shorter than the tube; keel never spirally twisted:
6a. Leaves articulated near the middle:
7a. Fruit stipe 5–20 mm long; flowers widely spaced on rachis (2 or 3 flowers per 10 mm length of rachis) ..... *L. contaminata*
7b. Fruit sessile or stipe less than 5 mm long, flowers usually densely spaced on rachis (3 to 7 flowers per 10 mm length of rachis, except in *L. meyeriana*):
8a. Fruit ovoid (up to 13 mm long) .... *L. brevicarpa*
8b. Fruit oblong to linear (more than 15 mm long):
9a. Decumbent habit; fruit oblong (up to 6× longer than wide), flat, upper suture with distinct margin or wing ..... *L. meyeriana*
9b. Erect or sub-erect habit; fruit linear (more than 7× longer than wide), terete or semi-terete, upper suture without a margin or wing:
10a. Flowers usually up to 8 mm long; lateral sinus of calyx ± as wide as upper and lower sinuses; southern coastal distribution from Bredasdorp to Port Elizabeth ..... *L. gracilis*
10b. Flowers more than 9 mm long; lateral sinus of calyx much wider than upper and lower sinuses; western coastal distribution

from Namaqualand and inland to the Cedarberg and eastwards to Heidelberg:

11a. Fruit dehiscent, fruit wall thin and membranous, terete to semi-terete, ±2 mm wide, sometimes falcate; flowers 7–10 mm long, wings longer or shorter than keel ..... *L. ambigua*

11b. Fruit indehiscent, fruit wall thick and spongy, terete, 3–4 mm wide, straight, often somewhat torulose; flowers 12–18 mm long, wings invariably shorter than the keel ..... *L. sepiaria*

6b. Leaves not articulated:

12a. Fruit stipe 12 mm or longer; wings shorter than the keel ..... *L. longipes*

12b. Fruit sessile or stipe up to 5 mm long; wings as long as or longer than the keel:

13a. Wings as long as the keel, standard orbicular:

14a. Fruit elliptic, 40–45 mm long; flowers 6–8 mm long; Southern Cape (from Grootvadersbosch to the Outeniqua Mountains) .... *L. brevipes*

14b. Fruit oblong, up to ±12 mm long; flowers up to ±4 mm long; Western Cape (Klipfontein, Swartland) ..... *L. zeyheri*

13b. Wings longer than the keel, standard ovate .... *L. plukenetiana*

5. Revision of the *L. pauciflora* and *L. wrightii* groups

5.1. L. grandiflora Benth. in Hook., Lond. J. Bot. 3: 357 (1844); Harv. in Harv. and Sond., Fl. Cap. 2: 85 (1862), *pro parte majore*. Type: South Africa, [Western Cape] Cape Colony [exact locality not traced], *Bowie s.n.* (K!, specimen in the middle, lecto., designated here) [Note: The specimen was part of Bentham's herbarium and is therefore chosen as lecto. *Sarcophyllum grandiflorum* E.Mey. is actually *L. pauciflora*: Jakkalsriver, Olifantsriver, *Drège s.n.* ("*III, A, d*"), Giftberg, *Drège s.n.* ("*III, A, c*") (P!), Ezelsfontein, *Drège s.n.* ("*III, A, a*") (P!).]

Sub-erect to decumbent, glabrous suffrutex, up to 0.35 m in height. *Leaves* phyllodinous, acicular, articulated near middle; leaf density 7–8 per 10 mm length of stem; stipules absent. *Inflorescences* terminal, 110–200 mm long; rachis ± furrowed; flowers relatively numerous (up to 16 flowers per inflorescence), lax (±2 per 10 mm length of rachis), 13–16 mm long; pedicel 3–7 mm long. *Bract* lanceolate, acuminate, ±6.5 mm long. *Bracteoles* narrowly lanceolate, acuminate, ±5.5 mm long. *Calyx* 7.0–12.5 mm long, tube 2.5–5.5 mm long, lobes 5–7 mm long; subequally lobed but upper lateral sinuses much wider than medial and lower lateral sinuses; lobes deltoid, tips minutely pubescent inside. *Standard* obovate, ±12.5×±12.0 mm; apex retuse; claw ±2 mm long. *Wings* oblong to obovate, ± as long as keel, ±15.5×±6.0 mm, with ±11 rows of sculpturing; apex obtuse; claws ±3.5 mm long.

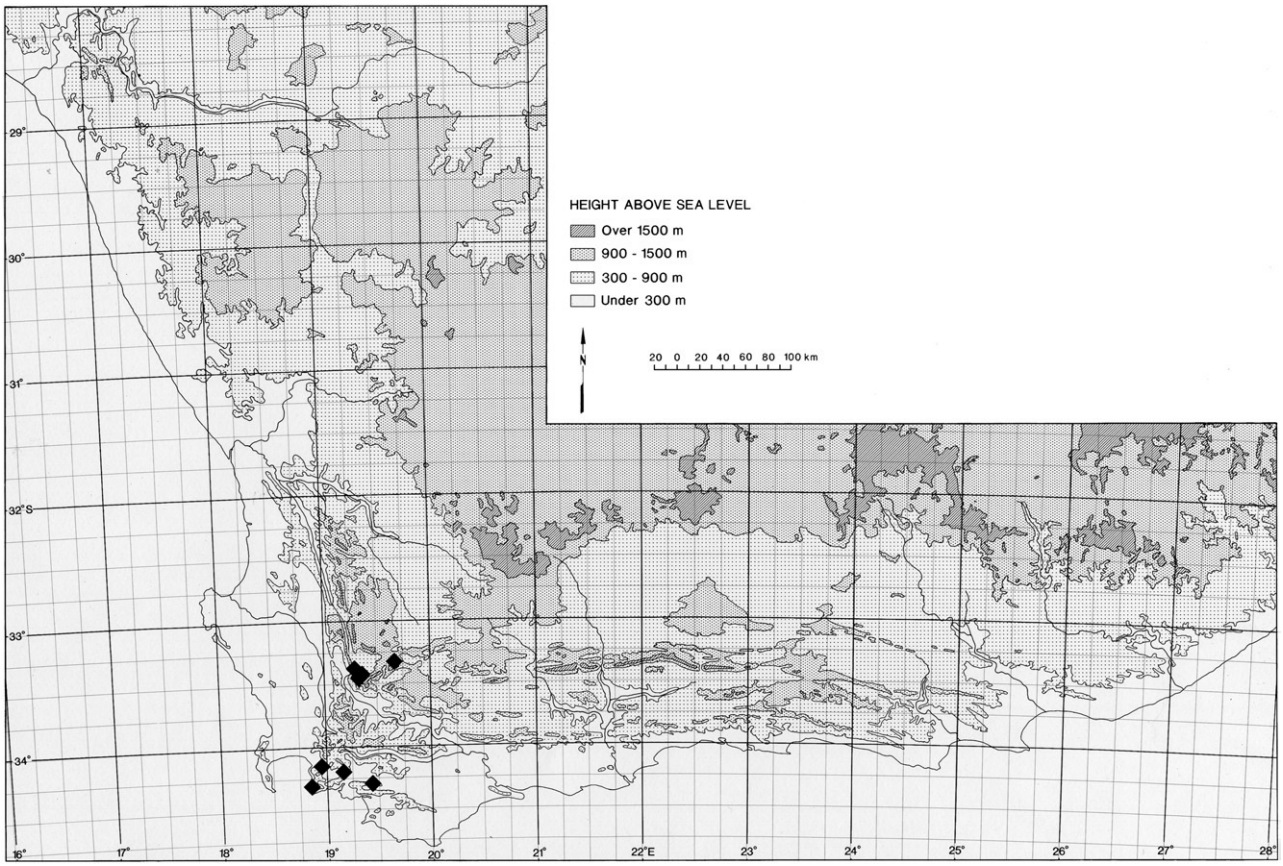

Fig. 6. Known distribution of *Lebeckia grandiflora*.

Keel rostrate, not twisted, ±15×±5 mm, usually with pockets; claws ±4.5 mm long. *Carpel* subsessile, ovary ±9.0×±1.5 mm, linear; ovules up to 16; style ±7 mm long; curved upwards. *Pods* linear, straight or slightly falcate, semi-terete, not narrowly winged on the upper suture, up to 77×4–5 mm; stipe 13–20 mm long; dehiscent; fruit wall thin, membranous. *Seeds* unknown.

5.1.1. Distribution, habitat and flowering time

L. grandiflora has a restricted distribution on mountain peaks near Worcester and southwards to Rooi Els and Caledon (Fig. 6). This species is very rare and occurs at high altitudes (1100–1700 m), probably flowering only after fire. Flowering specimens were collected during October.

5.1.2. Diagnostic characters

L. grandiflora (Fig. 7) is similar to *L. pauciflora* in the long calyx lobes, obovate wing petals, stipitate fruit and habit, but differs in the invariably articulated leaves, the straight keel, and the shorter, thin-walled, membranous fruits, 60 to 77 mm long. In *L. pauciflora,* western populations have articulated leaves and eastern populations have unarticulated leaves, the keel is twisted, and the spongy fruit is 70 to 165 mm long.

5.1.3. Specimens examined

– **3319** (Worcester): Lower N slopes of Schurfteberg (–AD), *Esterhuysen 21866* (BOL); Schurfteberg (–AD), *Lewis 907* (NBG); Waaihoek Mountain (–AD), *Esterhuysen 8328* (BOL); Witsenberg (–AD), *Zeyher s.n.* (S); "Valsch Gat Kloof" (–BC), *Esterhuysen 3881* (BOL).

– **3418** (Simonstown): Palmiet River Mountains (–BB), *Guthrie 4164* (NBG); Sir Lowry's Pass (–BB), *Levyns 2530* (BOL); W of Steenbras (–BB), *Lamb 2602* (SAM); mountain slopes at Rooi Els (–BD), *Esterhuysen 14102* (BOL, K, P); mountains near Rooi Els and Hangklip (–BD), *Stokoe s.n.* (NBG).

–3419 (Caledon): Houwhoek (–AA), *Bolus 9875* (BOL, K); Houwhoekberg (–AA), *Schlechter 5464* (BOL); between Caledon and Elim (–AD), *Bolus 6791* (BOL).

Precise locality unknown

Cape Colony, *Bowie s.n.* (K).

5.2. L. pauciflora Eckl. and Zeyh., Enum. 2: 192 (Jan., 1836); Benth. in Hook., Lond. J. Bot. 3: 356 (1844) *pro parte majore*; Harv., in Harv. and Sond., Fl. Cap. 2: 85 (1862) *pro parte majore*; Schutte-Vlok in Goldblatt and Manning, Cape Plants, Strelitzia 9: 493 (2000). Type: South Africa, [Western Cape] in "Hauhoek [Houwhoek] (Caledon) [3419 AA], in Langekloof (George) [3323 CB]", *Ecklon* and *Zeyher 1337* (S!, specimen on the left hand side of the herbarium sheet, lecto., designated here; S!, SAM!, isolecto.). [Note: The specimen in S is chosen as lecto. because it bears the characteristic label of the Enumeratio. The specimens collected by *Ecklon and Zeyher 1337* is clearly a mixed collection of plants from two very different localities. As noted elsewhere, western populations usually have articulated

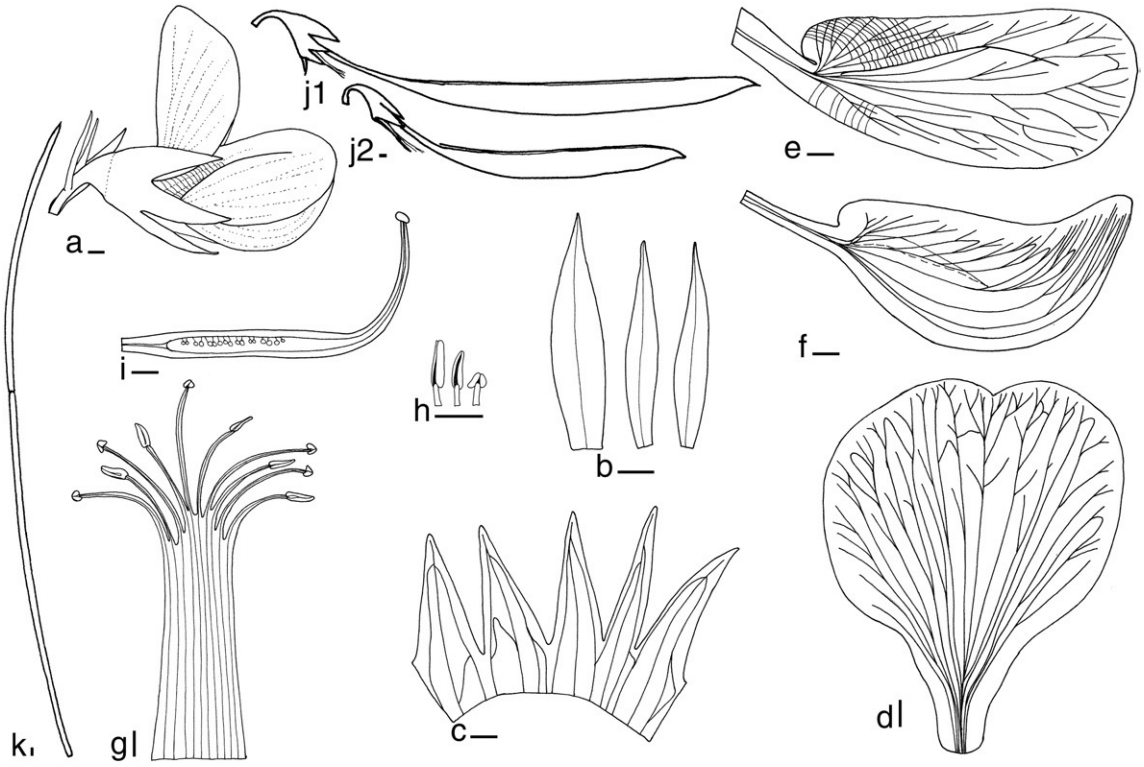

Fig. 7. Morphology of *Lebeckia grandiflora:* (a) lateral view of flower; (b) abaxial view of bract (furthest left) and bracteoles; (c) abaxial view of calyx with the upper lobes to the left; (d) standard petal; (e) wing petal; (f) keel petal; (g) androecium; (h) long, basifixed anther (left), long, carinal anther (centre) and short, dorsifixed anther (right); (i) carpel; (j) lateral view of pod; (l) leaf. Vouchers: (a–j1) *Esterhuysen 14102* (P); (j2) *Esterhuysen 14102* (BOL); (k) *Levyns 2530* (BOL). Scale bars: 1 mm.

leaves, while the eastern populations lack leaf articulations. It is therefore likely that the specimen on the right-hand side of the herbarium sheet is from "Langekloof" and the specimen on the left-hand side from "Hauhoek".]

Sarcophyllum grandiflorum E.Mey., Comm. 1: 32 (Feb., 1836), *syn. nov.* Paratypes: South Africa, [Western Cape] "in collibus arenosis inter Jakkalsrivier et Olifantrivier" [3218 BB], *Drège s.n.* ("*III, A, d*"), [Western Cape] "in monte Giftberg" [3118 BC], *Drège s.n.* ("*III, A, c*") (P!), [Northern Cape] "Ezelsfontein" [3218 DA], *Drège s.n.* ("*III, A, a*") (P!).

Sub-erect to decumbent, glabrous suffrutex, up to 1.0 m in height. *Leaves* phyllodinous, acicular, sometimes articulated near middle; leaf density 1–3 per 10 mm length of stem; stipules absent. *Inflorescences* terminal, 115–290 mm long; rachis smooth; flowers relatively numerous (up to 34 flowers per inflorescence), lax (1–2 per 10 mm length of rachis), 9–14 mm long; pedicel 3–10 mm long. *Bract* lanceolate, acute, 2.0–4.2 mm long. *Bracteoles* triangular, acute, 1.0–2.5 mm long. *Calyx* 6.5–11.5 mm long, tube 2.5–5.5 mm long, lobes 3.5–6.5 mm long; subequally lobed but upper lateral sinuses much wider than medial and lower lateral sinuses; lobes deltoid, tips minutely pubescent inside. *Standard* broadly ovate to orbicular, 10.5–15.5 × 10.5–15.5 mm; apex obtuse; claw 2.5–4.0 mm long. *Wings* obovate, ± as long as the keel, 12–16 × 5.5–9.0 mm, with 5–10 rows of sculpturing; apex obtuse; claws 2–4 mm long. *Keel* rostrate, twisted, 9.5–16.0 × 4.0–5.5 mm, always with pockets; claws 3.0–5.5 mm long. *Carpel* stipe short; ovary 8.0–13.5 × 0.6–1.2 mm, linear; ovules many (17–37); style 5–7 mm long, curved upwards. *Pods* narrowly linear, straight or slightly falcate, semi-terete, not narrowly winged on upper suture, up to 165 × 2–5 mm; stipe 14–37 mm long; dehiscent; fruit wall thin, membranous. *Seeds* oblong-reniform, 5.0 × 3.8 mm, rugose, light to reddish brown, mottled brown; hilum brown to black.

5.2.1. Distribution, habitat and flowering time

L. pauciflora has the widest distribution of all species in the section *Lebeckia*. It occurs at altitudes between 200 and 1200 m from the Kamiesberg southwards to the mountains surrounding Montagu and eastwards to Steytlerville (Fig. 8). *L. pauciflora* grows in Fynbos vegetation on sandy soil or in Renosterveld vegetation in well-drained, rocky, loam soil. This species flowers between August and January.

5.2.2. Diagnostic characters

L. pauciflora (Fig. 9) is similar to *L. wrightii* in both having a twisted keel, calyx lobes that are longer than the calyx tube and obovate wings, but differs in the erect, perennial habit, absence of stipules, absence of hair (except on the inside of the calyx tips) and long, terete fruit (70–165 mm long). *L. wrightii* is a hairy, decumbent annual or short-lived fireweed, with stipulate leaves and sessile, flat fruit (23–35 mm long). *L. pauciflora* is also similar to *L. grandiflora* as both species have long calyx lobes, obovate wing petals, stipitate fruit and a sub-erect

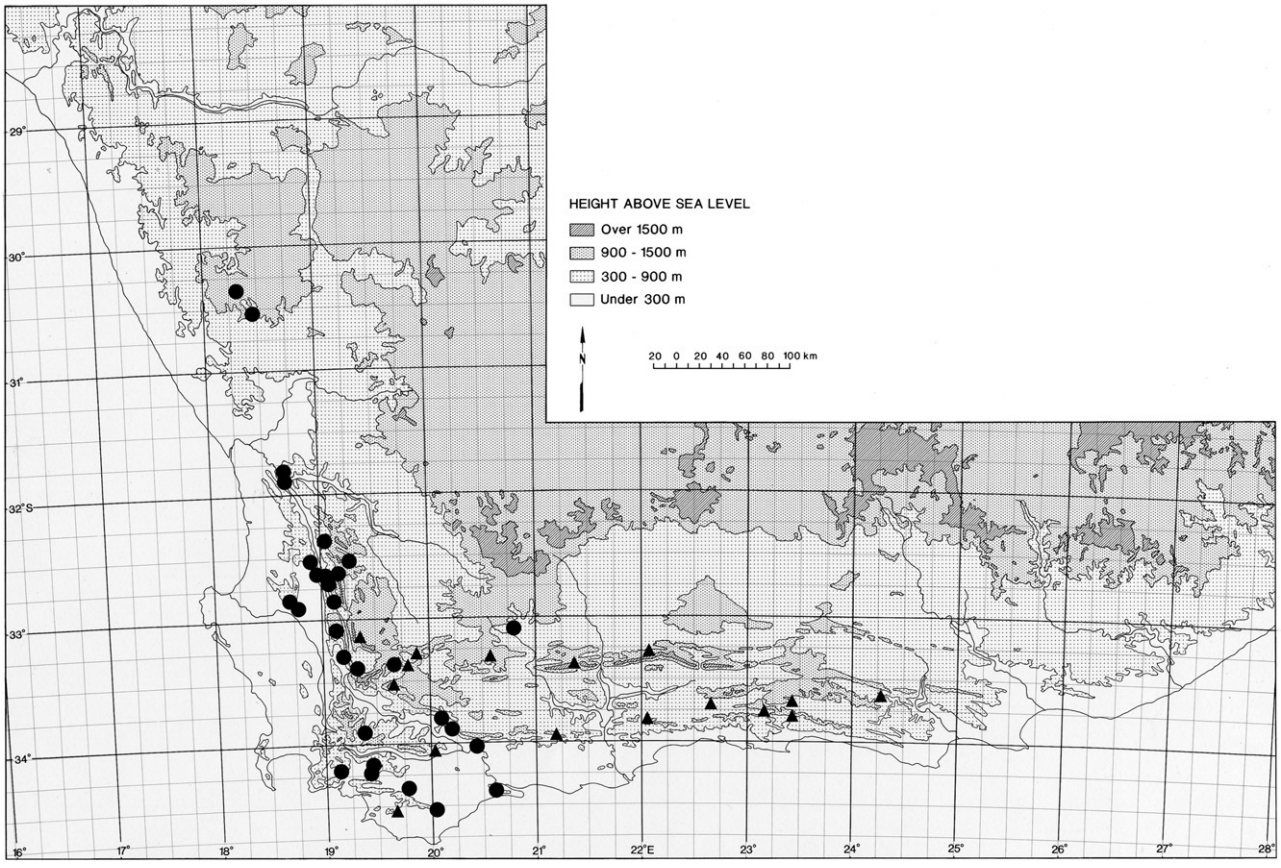

Fig. 8. Known distribution of *Lebeckia pauciflora* (populations with articulated leaves indicated by circles; those without articulations by triangles).

to decumbent habit, but differs in details of the leaf, fruit and keel.

5.2.3. Regional variation

L. pauciflora is the only species in which the leaves may be articulated or not. The Montagu form is similar to the Vanrhynsdorp or typical form but is slightly smaller in its habit and has somewhat shorter inflorescences. Both have articulated leaves. The Lange Kloof form has shorter leaves with no articulations and is generally a smaller plant with shorter inflorescences.

5.2.4. Specimens examined

– **3018** (Kamiesberg): "Ezelsfontein" (–AC), *Drège s.n.* ("*III, A, a*") (P); "Giftberg" (–CB), *Drège s.n.* ("*III, A, c*") (P).

– **3118** (Vanrhynsdorp): Gifberg Pass near the bottom end (–DC), *Van Wyk 3283* (JRAU); Nardouw Kloof (–DC), *Stokoe s.n.* (NBG).

– **3119** (Calvinia): Hotbergfontein, Oorlogskloof, Nieuwoudtville (–AC), *Le Roux et al. 32* (JRAU).

– **3218** (Clanwilliam): Citrusdal, Maanskloof (–DB), *Hanekom 3189* (NBG, PRE); Piekenierskloof Pass near Piquetberg (–DB), *Van Wyk 2899* (JRAU); W slope of Piekenierskloof Pass (–DB), *Van Wyk 3024* (JRAU); Piquetberg Mountain (–DC), *Barker 7576* (NBG); top of Piquetberg Mountains (–DC), *Barker 10257* (NBG); 8 km from Piquetberg in Versveld Pass (–DC), *Grobbelaar 2806* (PRE); De Hoek (–DD), *Barker 9754* (NBG).

– **3219** (Wuppertal): Above ranger's house, Algeria (–AC), *Low 2970* (NBG); Cedarberg, Algeria (–AC), *Le Roux et al. 7* (JRAU); in vicinity of Algeria camping area (–AC), *Hugo 640* (NBG, PRE); Elandskloof, N slopes above main river (–CA), *Oliver 4021* (NBG, PRE); roadside near Warm Bath, Oliphant's River Valley (–CA), *Stephens 7019* (BOL, K); summit of Oliphant's River Mountains behind Warm Bath (–CA), *Stephens 7036* (K); 13 km from Citrusdal along the road to The Baths (–CA), *Strid 37317* (NBG); 20 km S of The Baths, Citrusdal (–CA), *Le Roux et al. 12* (JRAU); Cedarberg, NW facing slope, SE of campsite (–CB), *Low 696* (NBG); Keerom, sandy hills along Oliphant's River Valley (–CC), *Esterhuysen 17854* (BOL).

– **3319** (Worcester): Dasklip Pass, Great Winterhoek Mountains (–AA), *Van Wyk 3134* (JRAU); between Elandskloof and Gydo (–AB), *Isaac s.n.* (BOL, PRE); Gydo (–AB), *Compton 18769* (NBG); S Cold Bokkeveld (–AB), *Compton 12489* (NBG); Schurfteberg, Gydo (–AB), *Bolus 7549* (BOL, K); between Witzenberg and Schurteberg (–AC), *Zeyher 377* (BM,

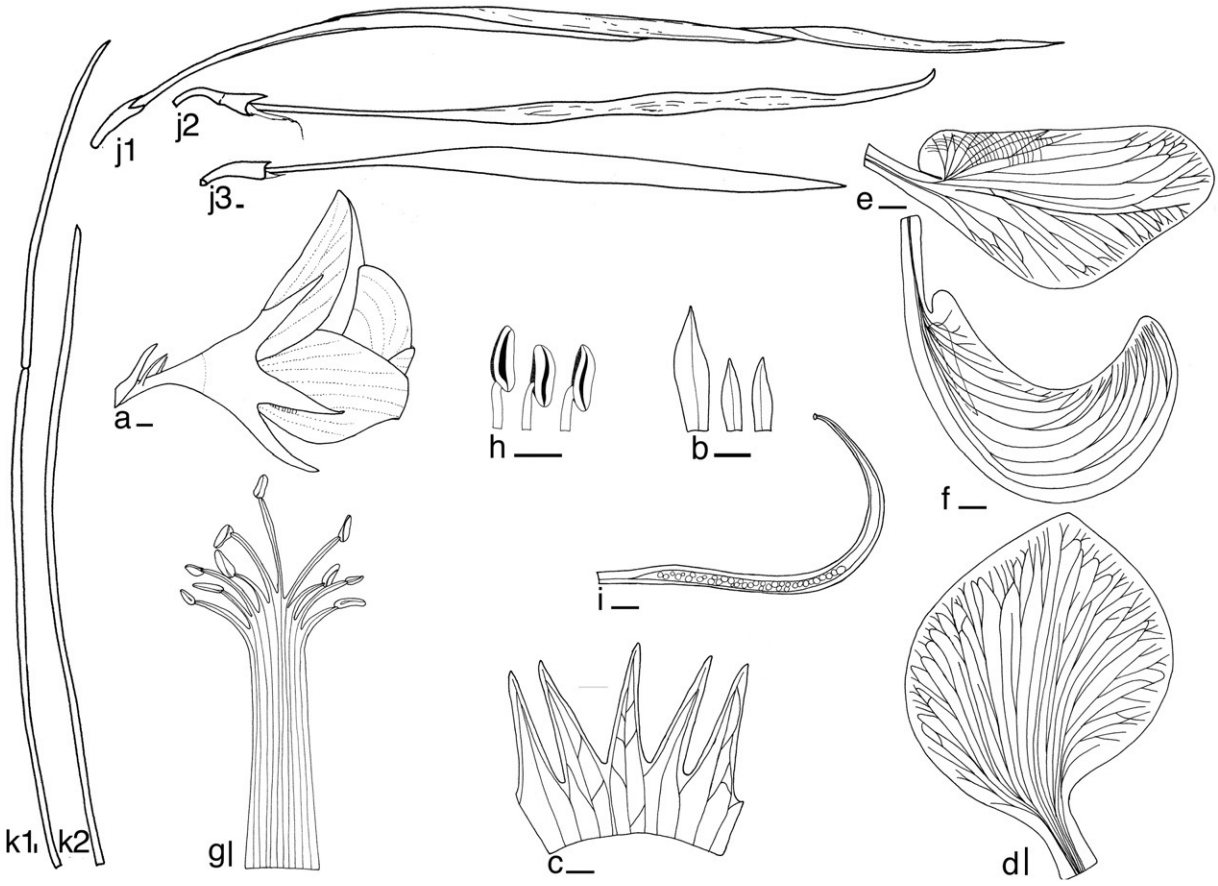

Fig. 9. Morphology of *Lebeckia pauciflora:* (a) lateral view of flower; (b) abaxial view of bract (furthest left) and bracteoles; (c) abaxial view of calyx with the upper lobes to the left; (d) standard petal; (e) wing petal; (f) keel petal; (g) androecium; (h) long, basifixed anther (left), long, carinal anther (centre) and short, dorsifixed anther (right); (i) carpel; (j) lateral view of pod; (k) leaf. Vouchers: (a) *Van Wyk 3134* (JRAU); (b, d–f, h) *Hanekom 3189* (NBG); (c) *Fourcade 3117* (BOL); (g, i) *Bolus 5038* (BOL); (j1–j2) *Le Roux et al. 7*; (j3) *Le Roux et al. 12*; (k1) *Esterhuysen 11068* (BOL); (k2) *Walters 310* (NBG). Scale bars: 1 mm.

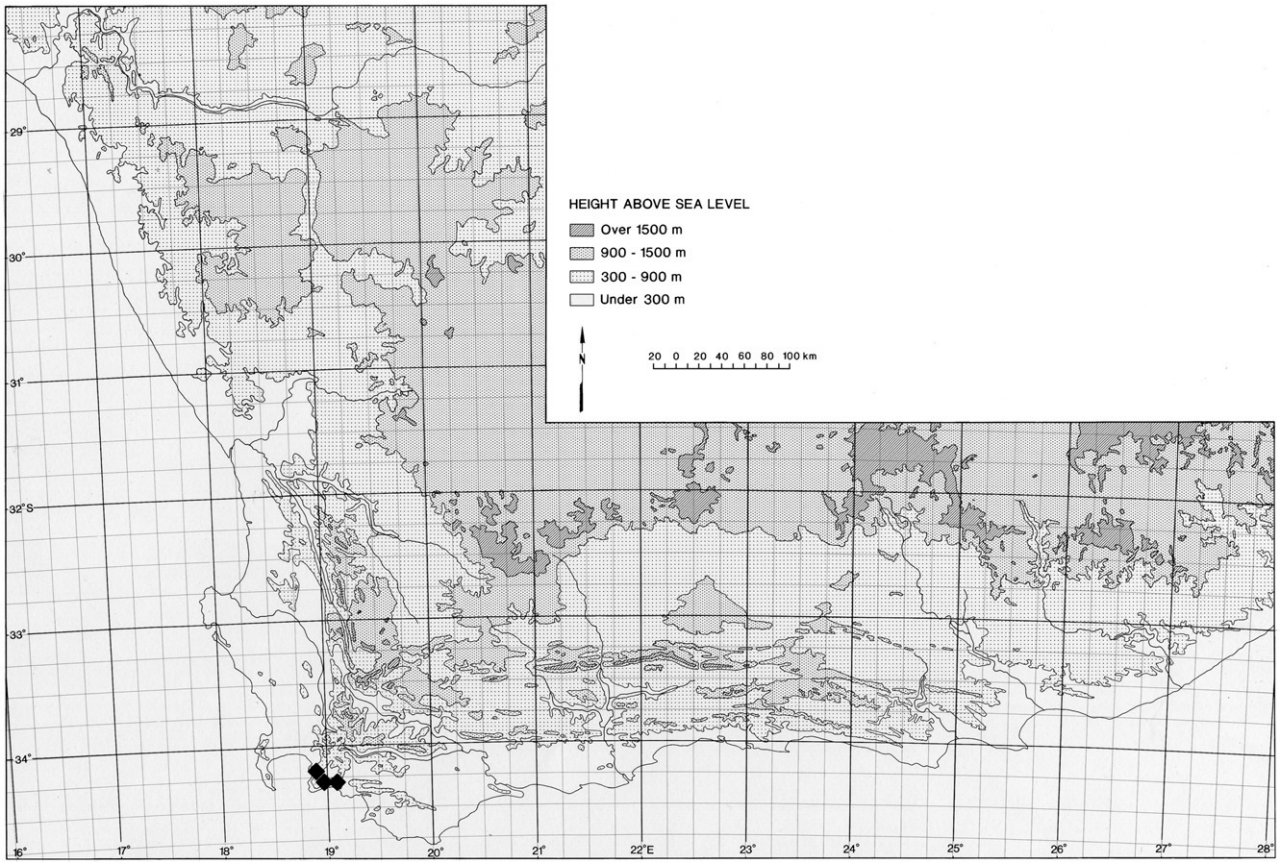

Fig. 10. Known distribution of *Lebeckia uniflora.*

K, SAM); Witzenberg (–AC), *Zeyher s.n.* (K, SAM); Witzenberg and Schurfteberg (–AD), *Zeyher s.n.* (S); Bokkeveld, Martinsburg (–BC), *Phillips 1940* (NBG); area around camping site at Vermeer VLSI (–BD), *Boise 70* (NBG); Hex River Pass (–BD), *Barker 7457* (NBG); on the summit of the ridge at Bundaberg, Eikenbosch Hoek (–BD), *Esterhuysen 3769* (–BOL); lower slopes of Stettynsberg (–CD), *Esterhuysen 11068* (BOL); Hex River Valley (–DA), *Tyson 679* (PRE, SAM); Sandhills, above national road (–DA), *Walters 310* (NBG).

– **3320** (Montagu): Heuningberg (–BB), *Van Wyk 2983* (JRAU); Witteberg, S slopes at Bantams (–BC), *Esterhuysen 30505* (BOL); Klipheuwel, 14 km E of Montagu (–CC), *Manning 2193* (NBG); Langeberg near Montagu (–CC), *Esterhuysen 23830* (BOL, K).

– **3321** (Ladismith): Klein Swartberge, S of Seweweekspoort Peak (–AD), *Vlok 147* (NBG, PRE); N slopes of Seweweekspoort Mountains, ridge peak (–AD), *Andreae 1246* (BOL, PRE), *Primos 46* (PRE); between Garcia's Pass and Muis Kraal (–CC), *Bolus s.n.* (BOL).

– **3322** (Oudtshoorn); Prince Albert, Zwartberg Pass (–AC), *Bolus 11467* (BOL, PRE); Klein Moerasrivier Spruiten (–CC), *Barker 7708* (NBG); Langkloof (–DA), *Fourcade 1701* (BOL).

– **3323** (Willowmore): Ongeleë, 33 km from Joubertina to George (–CB), *Stirton 6332* (K, PRE); N slopes of Tsitsikamma Mountains, 3 km W of De Vlugt (–CC), *Vlok 1679* (BM, PRE); Uniondale district, Misgund Hills (–CD), *Esterhuysen 6964* (PRE).

– **3324** (Steytlerville): Kouga, between Zievefontein and Joubertskraal (–CB), *Fourcade 3117* (BOL, K, NBG, PRE).

– **3419** (Caledon): Houwhoek (–AA), *Guthrie 3634* (NBG), *Schlechter 7359* (BM), *Schlechter 9433* (BM, BOL, K, PRE); Houwhoek in Langekloof (–AA), *Ecklon and Zeyher 1337* (S, SAM); Houwhoek Pass (–AA), *Bolus 5038* (BM, BOL, K, PRE), *Salter 4051* (BM, K); 6 km N of Caledon on Zwart River 241, at Diepdrift SE of main road (–AB), *Helme 2295* (NBG); ±6 km from Elim to Die Dam (–BD), *Grobbelaar 2723* (PRE); lower slopes of Koudeberg (–DA), *Lewis 5694* (NBG).

– **3420** (Bredasdorp): Hessekwas Poort (–AA), *Acocks 22707* (PRE, K); Hessekwas Poort, ca. 8 miles E of Stormsvlei (–AA), *Taylor 3978* (NBG); Bontebok Park (–AB), *Grobler 587* (NBG); De Hoop, Potberg Nature Reserve, 1.5 km SE of Boskloof (–BC), *Burgers 1702* (NBG); Bredasdorp (–CA), *Galpin 11249* (K, PRE).

5.3. L. uniflora B-E.van Wyk & M.M.le Roux *sp. nov. valde L. wrightii similis sed inflorescentiis unifloris, floribus valde maioribus, leguminibus nonnihil minoribus et seminibus nigris parce albomaculosis differt*. Type: South Africa, [Western Cape] Caledon district, Highlands State Reserve, Paardeberg

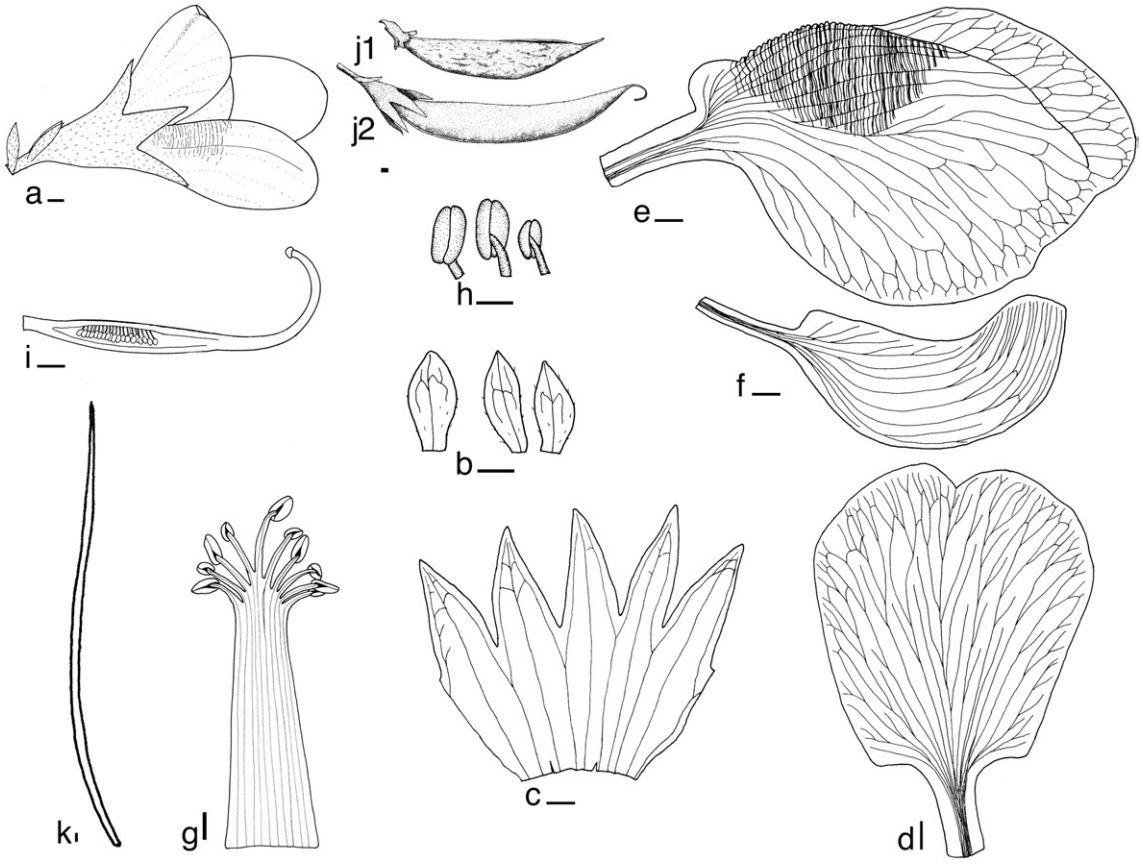

Fig. 11. Morphology of *Lebeckia uniflora:* (a) lateral view of flower; (b) abaxial view of bract (furthest left) and bracteoles; (c) abaxial view of calyx with the upper lobes to the left; (d) standard petal; (e) wing petal; (f) keel petal; (g) androecium; (h) long, basifixed anther (left), long, carinal anther (centre) and short, dorsifixed anther (right); (i) carpel; (j) lateral view of pod; (k) leaf. Vouchers: (a, c) *Stokoe 964* (PRE); (b) *Boucher 2175* (NBG); (d–f, h–i) *Boucher 1878* (NBG); (g, k) *Boucher 1878* (NBG); (j1) *Snijman 80* (NBG); (j2) *Boucher 1878* (NBG). Scale bars: 1 mm. (b–f, h–j drawn by B-E. van Wyk.)

Mountains, Mimetes stokoei locality [3419AC], *Boucher 1878* (NBG!, holo.; PRE!, iso.)

Decumbent, pubescent suffrutex, up to 0.4 m in height. *Leaves* phyllodinous, acicular, unarticulated; leaf density up to 1 per 10 mm length of stem; stipules 3–5 mm long. *Inflorescences* terminal, 25–37 mm long; rachis furrowed; flowers solitary, (rarely up to 3 flowers) 8–12 mm long; pedicel 3–6 mm long. *Bract* lanceolate, acute, 2.5–3.5 mm long. *Bracteoles* lanceolate, acute, 2.5–3.5 mm long. *Calyx* 7–10 mm long, tube 3–4 mm long, lobes 4–6 mm long; subequally lobed but upper lateral sinuses much wider than medial and lower lateral sinuses; lobes deltoid, tips minutely pubescent inside. *Standard* ovate, ±11 × 9.5–10.0 mm; apex emarginate; claw 3–5 mm long. *Wings* oblong to obovate, longer than keel, 11.5–15.0 × 9.0–10.5 mm, with 9–11 rows of sculpturing; apex obtuse; claws 4.0–4.5 mm long. *Keel* rostrate, twisted, 8–10 × 3.5–4.0 mm, always with pockets; claws ±4 mm long. *Carpel* subsessile; ovary 5.0–5.5 × 0.8–1.2 mm, linear; ovules many (13–15); style 6–8 mm long, curved upwards. *Pods* narrowly oblong, straight, flat, not narrowly winged on upper suture, up to 27–36 × 4.5–6.0 mm; stipe 1–3 mm long; dehiscent; fruit wall thin, membranous. *Seeds* broadly oblong-reniform, ±2.2 × 2.0 mm, rugose, black; hilum black.

5.3.1. Distribution, habitat and flowering time

L. uniflora has a localised distribution and is endemic to the Kogelberg and Palmiet River Mountains near Caledon (Fig. 10). It grows at altitudes between 500 and 1250 m in Fynbos vegetation. This species is an obligate pyrophyte.

5.3.2. Diagnostic characters

L. uniflora (Fig. 11) is closely related to *L. wrightii*, which it resembles in its annual habit, and pubescent leaves and calyx, but differs in the single-flowered inflorescence, the larger flowers (8–11 mm long), the wings that are much longer than the keel (2.5–5.0 mm longer) and the black seeds. *L. wrightii* has 3 to 5 smaller flowers (5–8 mm long) per inflorescence, the wings are longer than the keel (1–3 mm longer) and the seeds are black with mottled white.

5.3.3. Specimens examined

– **3418** (Simonstown): Palmiet River Mountains, track to Kogelberg from Steenbras (–BB), *Stokoe 964* (BOL, PRE); Kogelberg State Forest, Elgin Basin side of Dwars River Mountains (–BD), *Boucher 2175* (NBG).

– **3419** (Caledon): Highlands State Reserve, Paardeberg Mountains, *Mimetes stokoei* locality (–AC), *Boucher 1878* (NBG, PRE); Highlands Forest Reserve, off track towards

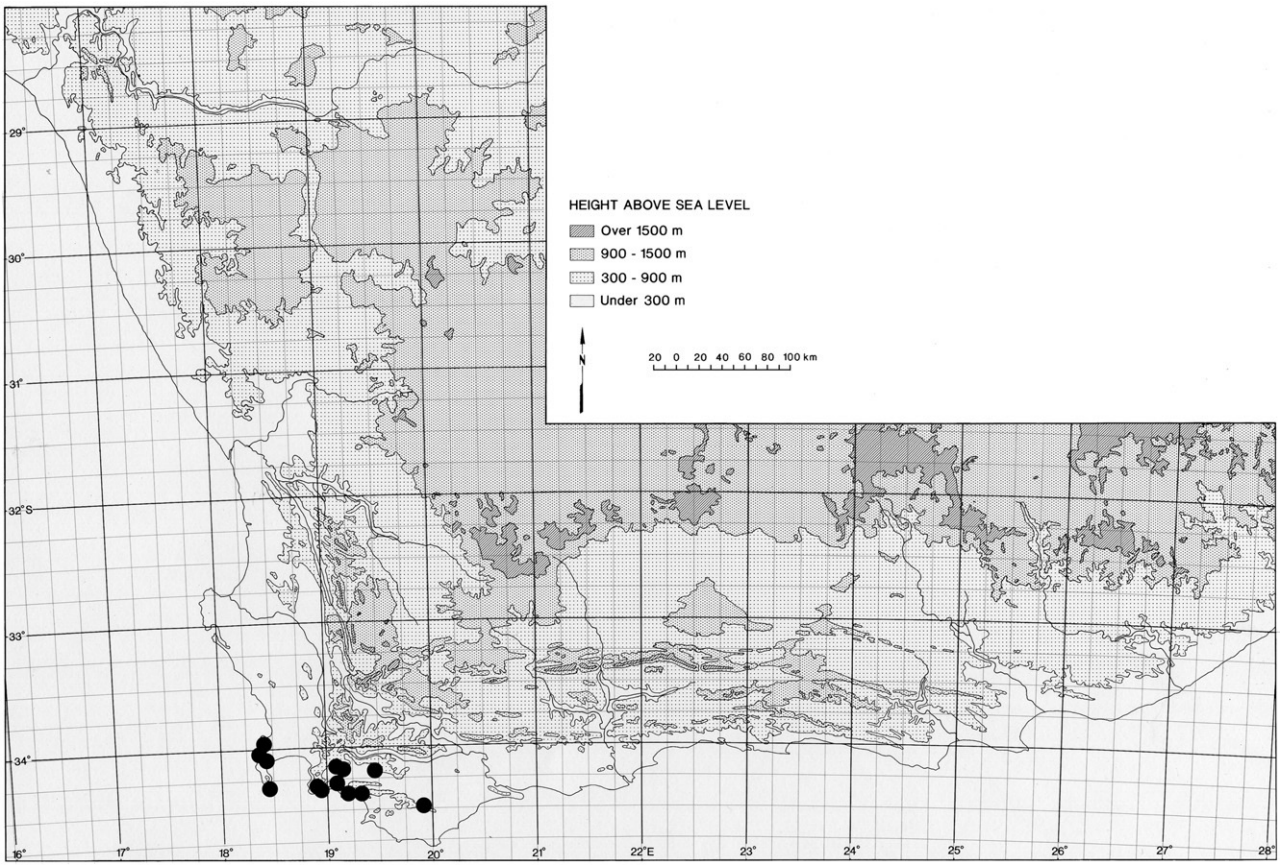

Fig. 12. Known distribution of *Lebeckia wrightii*.

Lebanon along western border of Middelmans farm (–AC), *Snijman 80* (NBG, PRE).

5.4. L. wrightii (Harv.) Bolus in Hook. Icon. pl. 16, sub tab. 1552 (1887); Salter in Salter and Adamson, Flora of the Cape Peninsula: 471 (1950); Schutte-Vlok in Goldblatt and Manning, Cape Plants, Strelitzia 9: 493 (2000). *Lotononis wrightii* Harv. in Harv. and Sond., Fl. Cap. 2: 594 (1862). Type: South Africa, [Western Cape] mountain sides near Simonstown [3318CB], *C. Wright s.n.* (TCD, holo. photo in K!)

Decumbent, pubescent suffrutex, up to 0.3 m in height. *Leaves* phyllodinous, acicular, unarticulated; leaf density up to 1 per 10 mm length of stem; stipules present, 2.0–3.5 mm long. *Inflorescences* terminal, 80–130 mm long; rachis ± furrowed; flowers few (up to 5 flowers per inflorescence), lax (up to 1 flower per 10 mm length of rachis), 5–8 mm long; pedicel 3–5 mm long. *Bract* narrowly lanceolate, acute, 2.0–3.5 mm long. *Bracteoles* narrowly lanceolate, acute, 2.0–3.5 mm long. *Calyx* 5.5–8.0 mm long, tube 2.5–3.5 mm long, lobes 2.5–4.5 mm long; subequally lobed but upper lateral sinuses much wider than medial and lower lateral sinuses; lobes deltoid, tips minutely pubescent inside. *Standard* ovate, 6.5–9.0×5–7 mm; apex emarginate; claw 2–3 mm long. *Wings* oblong to obovate, longer than keel, 6.5–9.5×5–8 mm, with 6–7 rows of sculpturing; apex obtuse; claws 3.5–4.0 mm long. *Keel* rostrate, twisted, 5.5–6.5× 2.0–2.5 mm, always with pockets; claws 2.5–3.0 mm long. *Carpel* subsessile; ovary 3.5–4.0×±1 mm, linear; ovules many (15–18); style 5.0–5.5 mm long, curved upwards. *Pods* narrowly oblong, straight, flat, not narrowly winged on upper suture, up to 23–35×4.0–5.5 mm; stipe 1–2 mm long; dehiscent; fruit wall thin, membranous. *Seeds* broadly oblong-reniform, ±2.0×1.6–1.9 mm, rugose, black, mottled white; hilum black.

5.4.1. Distribution, habitat and flowering time

L. wrightii is distributed in the Cape Peninsula, Kogelberg and Palmiet River Mountains near Caledon (Fig. 12). It grows at altitudes between 60 and 750 m in Fynbos vegetation. This species is an annual fireweed that only grows after fire and then disappears until the area burns again. Field studies are needed to determine whether *L. uniflora* and *L. wrightii* grow together at Kogelberg.

5.4.2. Diagnostic characters

L. wrightii (Fig. 13) is closely allied to *L. uniflora*, and both are annual pyrophytes with pubescent leaves and calyces, but differs in the few-flowered inflorescences (up to five flowers per inflorescence), and smaller flowers (5–8 mm long) with shorter wings (6.5–9.0 mm long). *L. uniflora* has single-flowered inflorescences, and larger flowers (8–12 mm long) with wings 11.5–15.0 mm long. *L. wrightii* is also similar to *L. pauciflora* in the wing and keel petal structure, but differs in the few-flowered inflorescence, decumbent habit (annual fireweed) the

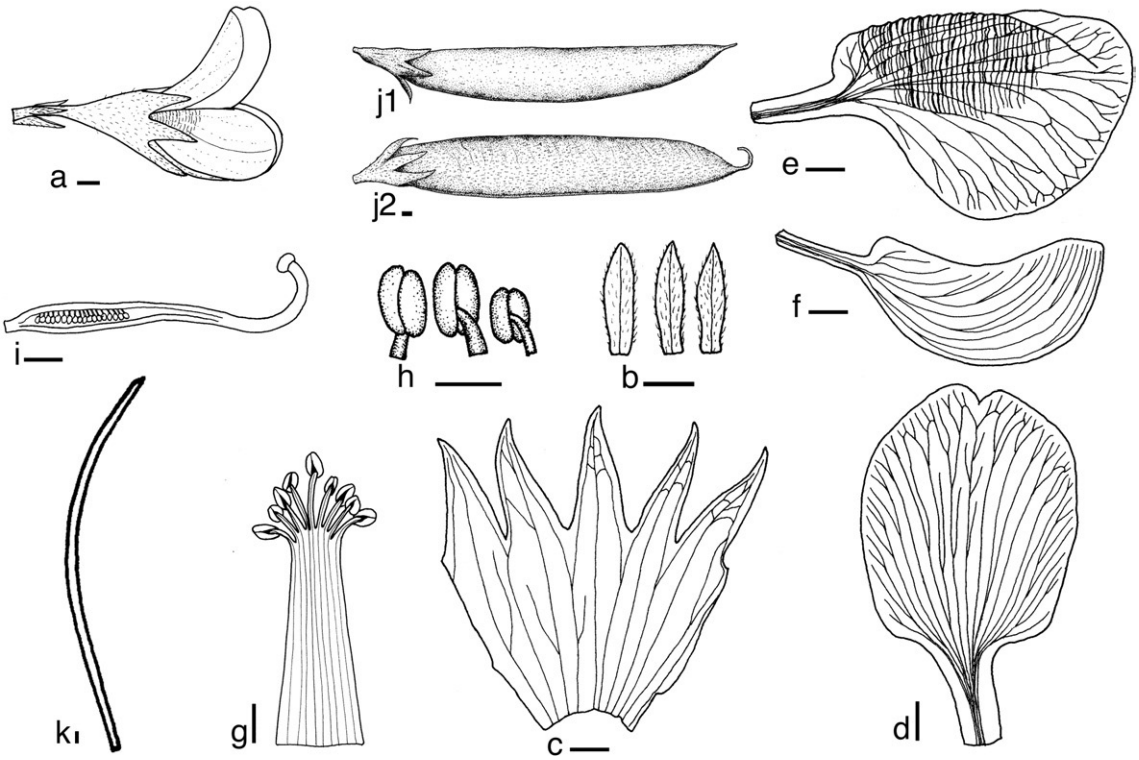

Fig. 13. Morphology of *Lebeckia wrightii:* (a) lateral view of flower; (b) abaxial view of bract (furthest left) and bracteoles; (c) abaxial view of calyx with the upper lobes to the left; (d) standard petal; (e) wing petal; (f) keel petal; (g) androecium; (h) long, basifixed anther (left), long, carinal anther (centre) and short, dorsifixed anther (right); (i) carpel; (j) lateral view of pod; (k) leaf. Vouchers: (a) *Esterhuysen 22398* (BOL); (b–i) *Esterhuysen 31726* (BOL); (ji) *Taylor 7012* (NBG); (j2) *Levyns sub. Salter 7862* (BOL); (k) *Bolus 4671* (BOL). Scale bars: 1 mm. (b–f, h–j drawn by B-E. van Wyk.).

emarginate apex of the standard petal, the short, sessile, pubescent fruit, and the small, mottled black and white seeds. *L. pauciflora* is many-flowered, it is a virgate, suffrutex, the standard petal has an obtuse apex, the fruit is long, stipitate and glabrous and the seeds are large, pink-brown and mottled dark brown.

5.4.3. Specimens examined

– **3318** (Cape Town): Kirstenbosch, mountain slopes (–CD), *Compton s.n. sub BOL 32414* (BOL); Kirstenbosch, Nursery Gorge (–CD), *Esterhuysen 7617* (BOL); Kirstenbosch, between Skeleton and Window Gorge (–CD), *Leighton 729* (PRE); Table mountain above Kirstenbosch (–CD), *H. Bolus 4671* (BOL); Table Mountain, near Klassenbosch (–CD), *H. Bolus 4671* (K); Table Mountain, top of Corridor Butress (–CD), *Compton 20235* (BOL, NBG); Table Mountain, top of Skeleton Gorge (–CD), *Compton s.n. sub BOL 32416* (BOL); Table Mountain, above Kirstenbosch (–CD), *Esterhuysen 22398* (BOL, PRE); Table Mountain, slopes between Skeleton and Window Gorge (–CD), 1944, *Esterhuysen 11223* (BOL, K); Table Mountain, above Window Gorge (–CD), *Esterhuysen 11035* (BOL); Table Mountain, in Groene Kloof (–CD), *Galpin 3924* (PRE); Table Mountain, lower plateau between Skeleton and Window Gorges (–CD), *Goldblatt 6723* (PRE).

– **3418** (Simonstown): Kalk Bay Mountains, Cave Peak (–AB), *Compton 18602* (NBG); Constantiaberg (–AB), *Esterhuysen 32730* (BOL); Muizenberg Mountain (–AB), *Levyns s.n. sub Salter 7862* (BOL); hills W of the Muizenberg (–AB), *Pillans 3464* (PRE); Retreat (–AB), *Rogers 4711* (BOL); Silvermine (–AB), *Compton 14283* (NBG); between Swartkops Peak and Smitswinkel Peak (–AD), *Esterhuysen 36403* (BOL); Cape Peninsula, between Buffelsfontein and Cape Point (–AD), *L. Bolus s.n. sub BOL 32415* (BOL); Cape Peninsula, W of Smith's Farm (–AD), *Salter 1868* (BM, BOL, K); Cape Point, circular drive near S entrance of the drive (–AD), *Van Wyk 3354* (JRAU); Paulsberg, S. Ridge (–AD), *Taylor 7012* (BOL, K, NBG, PRE); W slope of Paulsberg (–AD), *Salter 252/7* (BM); Betties Bay (–BD), *Van der Merwe 1163* (NBG, PRE); mountains near Palmiet River Mouth (–BD), *Esterhuysen 13670* (BOL); Kogelberg Forest Reserve (–BD), *Vlok et al. 11* (JRAU); Kogelberg Forest Reserve, Platberg, easterly ascent (–BD), *Boucher 381* (K, NBG, PRE); Kogelberg State Forest, 60 m on left side of the road turning right along stream branching off from road to second dwelling (–BD), *Kruger 114* (NBG).

– **3419** (Caledon): Houwhoek Mountain (–AA), *Esterhuysen 31726* (BOL, K, 2 sheets); Lebanon State Forest, Jakkalsrivier Catchment (–AA), *Kruger 1117* (NBG), *Kruger 1613* (NBG); Zwarteberg (–AB), *H. Bolus 32424* (BOL), *Borkin s.n. sub BOL 6792* (BOL); Highlands State Forest, Paardeberg, Mimetes stokoei locality (–AC), *Boucher 1879* (NBG); Hermanus, Fernkloof Nature Reserve (–AC), *Drewe 448* (HER, K); Hermanus, Vogelgat (–AD), *Stirton 11166* (K), *Williams 3712* (K, NBG, PRE); Bredasdorp Mountains, 5 km WSW of Napier: Farm 139 (–BD), *Cupido 114* (NBG).

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