

## A taxonomic revision of *Capnophyllum* (Apiaceae: Apioideae)

A.R. Magee<sup>a,\*</sup>, B.-E. van Wyk<sup>a</sup>, P.M. Tilney<sup>a</sup>, S.R. Downie<sup>b</sup>

<sup>a</sup> Department of Botany and Plant Biotechnology, University of Johannesburg, PO Box 524, Auckland Park 2006, South Africa

<sup>b</sup> Department of Plant Biology, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, USA

Received 11 April 2008; received in revised form 21 October 2008; accepted 5 February 2009

### Abstract

The Cape endemic genus *Capnophyllum* Gaertn. is revised. As a result of valuable recent collections and extensive fieldwork, this hitherto neglected genus was found to comprise four annual species, two of which are newly described, namely *C. lutzeyeri* Magee and B.-E. van Wyk, and *C. macrocarpum* Magee and B.-E. van Wyk. The four species are distinguished from one another by their fruit morphology (relative length of the styles, the shape and position of the stylopodium, fruit size, surface sculpturing, and the presence or absence of a sterile apical portion) and fruit anatomy (marginal wings slightly or prominently involute and secondary ribs present or absent). A comprehensive key to the species, their complete nomenclature and typification, together with complete descriptions and known geographical distributions for all the species are presented and illustrated.

© 2009 SAAB. Published by Elsevier B.V. All rights reserved.

**Keywords:** Cape endemic; Fruit anatomy; *Kruberia*; Morphology; New species; South Africa

### 1. Introduction

*Capnophyllum* Gaertn. is a genus of small annual herbs endemic to South Africa. The name is derived from the Greek (*kapnos*=smoke, but is also the Greek name for *Fumaria*; *phyllon*=leaf) and refers to the distinctly glaucous leaves that closely resemble those of the genus *Fumaria* L. (Sonder, 1862; Adamson, 1950). *Capnophyllum* is sometimes extended to include the Mediterranean *Kruberia peregrinum* Lowe (e.g. Tutin et al., 1968; Dyer, 1975; Downie et al., 1998). However, according to Meikle (1977), *Kruberia* Hoffm. can be distinguished from *Capnophyllum* by fruit and floral differences. Burt (1991) followed Meikle (1977) in considering *Capnophyllum* to be a South African endemic genus. Recently, Magee et al. (in press) using molecular and morphological data, provided strong support for the monophyly of *Capnophyllum* and for its placement within the *Lefebvrea* clade of the tribe Tordylieae, together with the Cape genera *Dasispermum*, *Sonderina* and *Stoibrax capense* (therein referred to as the *Cap-*

*nophyllum* group). In contrast, *Kruberia* was shown to be only distantly related, occupying a position somewhere between the tribes Apieae and Selineae (Downie et al., 1998, 2000; Winter et al., 2008; Magee et al., in press).

Until relatively recently, the genus in the strictest sense was considered to be monotypic, with two varieties of *C. africanum* (L.) Gaertn. recognised on the basis of fruit surface sculpturing. Goldblatt and Manning (2000), however, found that the two varieties were morphologically and geographically distinct and therefore raised *C. africanum* var. *leiocarpon* Sond. to the rank of species, as *C. leiocarpon* (Sond.) J.C. Manning and Goldblatt. As a result of valuable recent collections and extensive fieldwork, this hitherto neglected genus was found to comprise four species, two of which are as yet undescribed. We present here a detailed taxonomic treatment of the genus, including a key to the species, their complete nomenclature, typification, formal descriptions, as well as the known geographical distributions.

### 2. Materials and methods

The complete collections of *Capnophyllum* from the following herbaria were studied: BM, BOL, JRAU, K, NBG

\* Corresponding author.

E-mail address: [a.r.magee@hotmail.com](mailto:a.r.magee@hotmail.com) (A.R. Magee).

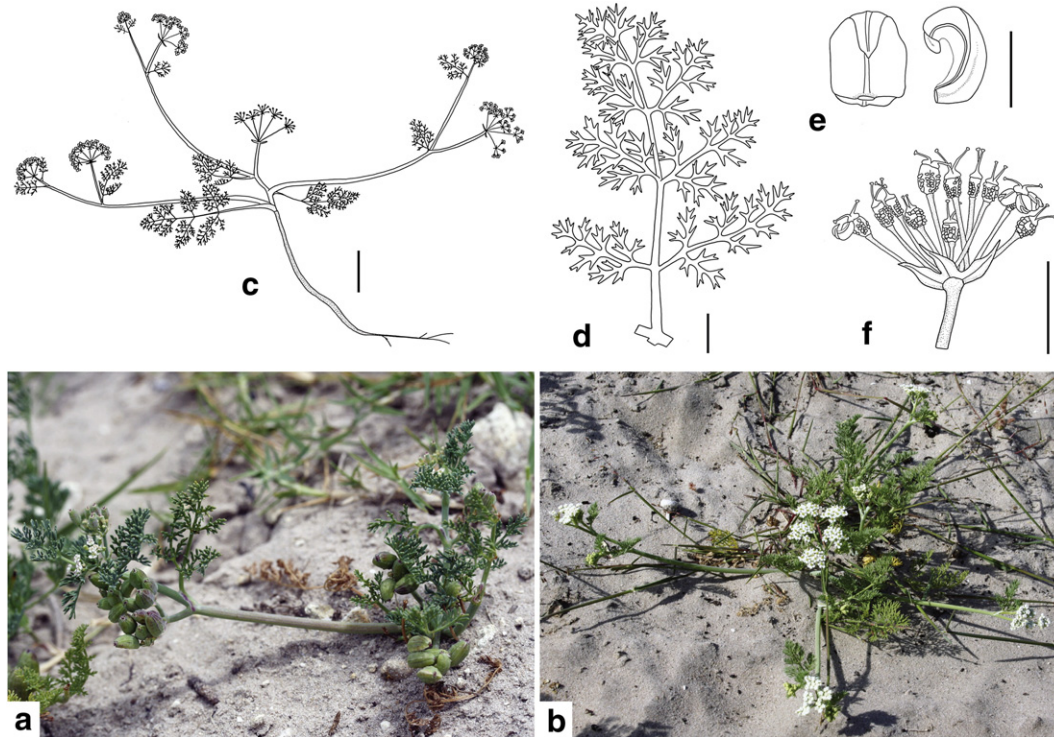


Fig. 1. General morphology of *Capnophyllum*. (a) *C. macrocarpum* in situ (photo by B–E. Van Wyk), showing the glaucous *Fumaria*-like leaves characteristic of the genus as well as the sparse compound umbels and small stature typical of this species; (b) *C. leiocarpon* in situ (photo by A.R. Magee), showing the distinctive decumbent branches; (c) typical sympodial growth form; (d) representative lower leaf pinnae; (e) typical petal in ventral and lateral view; (f) umbellule of *C. africanum* showing the distinct tubercles on the ovaries. Vouchers: (c) Magee et al. 125, JRAU; (d) Bester 6978, JRAU; (e) Williamson 3825, BOL; (f) Magee et al. 124, JRAU. Scale: c=25 mm, d and e=5 mm, f=1 mm.

(including SAM and STE), PRE and S (herbarium acronyms as in Holmgren et al., 1990). Extensive field work was undertaken to study all the taxa *in situ*, thus providing crucial additional insight into the species concepts proposed in this study. From this material, together with geographical information from Leistner and Morris (1976), the recorded distribution of the species was carefully verified and mapped. The line drawings (Figs. 1 and 2) were made by the first author with the aid of a camera lucida attachment on a Wild M3Z stereomicroscope.

FAA and herbarium material were used to study fruit anatomy. The herbarium material was first rehydrated and then placed in FAA for a minimum of 24 h. The material was subsequently treated according to a modification of the method of Feder and O'Brien (1968) for embedding in glycol methacrylate (GMA). This modification involves a final infiltration of the material in GMA for five days. Staining was done according to the periodic acid Schiff/toluidine blue (PAS/TB) staining method (Feder and O'Brien, 1968). The terminology used to describe the fruit anatomy follows that proposed by Kljuykov et al. (2004). Voucher specimens for the fruit anatomical study are listed below.

*Capnophyllum africanum*: Van der Merwe 1767 (NBG); Winter 110 (JRAU); Anon. sub. NBG 754111. *Capnophyllum leiocarpon*: Stirton & Zantovska 11430 (NBG); Taylor 12003 (PRE); Williamson 3825 (PRE). *Capnophyllum lutzeyeri*: Magee et al. 106 (JRAU). *Capnophyllum macrocarpum*: Magee

et al. 133 (JRAU). *Kruberav peregrinum*: Lippert 22969 (PRE); Sandwith 6215 (K).

To study the three-dimensional structure of the vittae (oil canals), mature fruit were softened by soaking them in boiling water for 24 h. The exocarp was then peeled off while keeping the fruit submerged in water to prevent desiccation.

### 3. Results and discussion

#### 3.1. Vegetative morphology

The four species of *Capnophyllum* are all annual herbs which exhibit a sympodial growth pattern similar to that found in the closely related genus *Sonderina* H. Wolff (Magee et al., in press). In both these genera, the stem consists of a series of sympodial segments each ending in a terminal umbel which becomes laterally displaced by continued growth from the axillary bud of the uppermost leaf, which takes over as the main growth axis (Burt, 1991). In *Capnophyllum* the plants are all well-branched sprawling herbs in which the branches become prostrate or decumbent (Fig. 1a–c). As the generic name implies, the leaves are always characteristically glaucous. They are pinnate to bi-pinnate and mostly cauline (Fig. 1), with the ultimate leaflet segments flat or subterete and less than 1 mm broad (Fig. 1d). All the species are relatively small in stature (ranging from 50–500 mm in height). *Capnophyllum lutzeyeri*

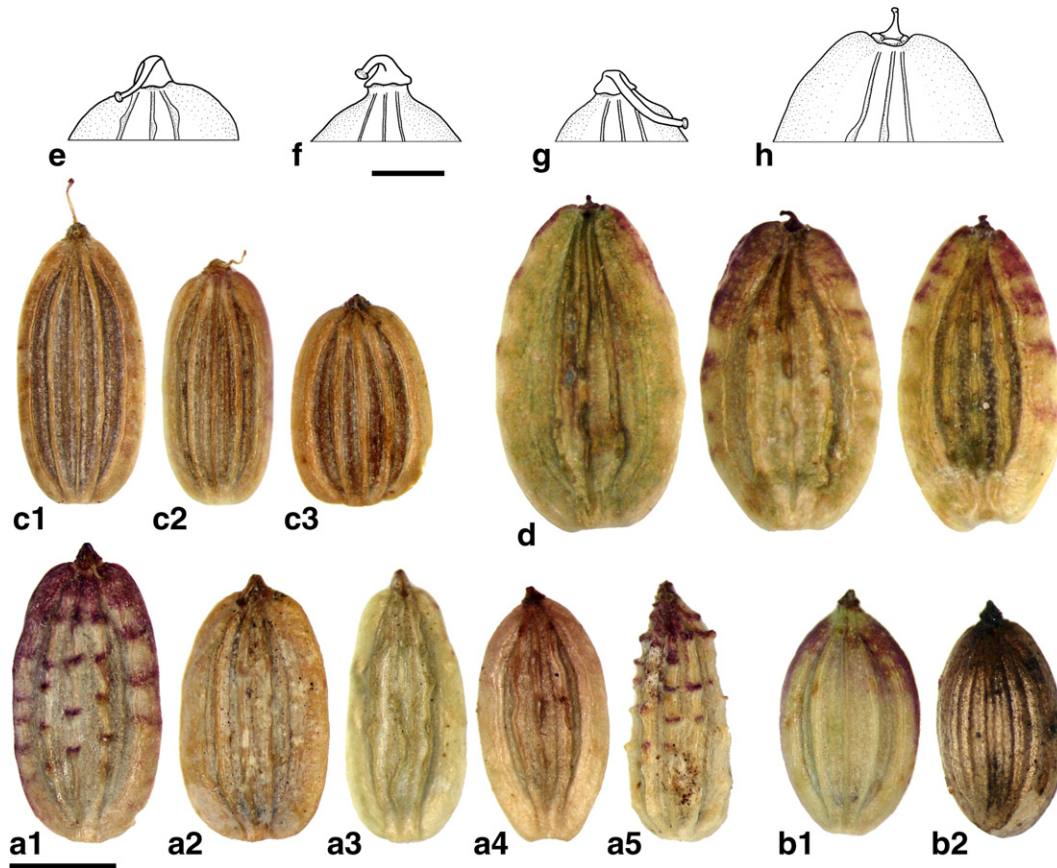


Fig. 2. Variation in fruit morphology (a–d) of *Capnophyllum* species with drawings of the stylopodia (e–h): (a, e) *C. africanum*; (b, f) *C. lutzeyeri*; (c, g) *C. leiocarpon*; (d, h) *C. macrocarpum*. Vouchers: (a1) *Bachmann s.n.*, BOL; (a2) *Bolus 2793*, BOL; (a3) *Winter 110*, JRAU; (a4) *Adamson 3081*, BOL; (a5) *Van der Merwe 1767*, NBG; (b1) *Lutzeyer 7A*, JRAU; (b2) *Magee et al. 106*, JRAU; (c1) *Williamson 3825*, BOL; (c2) *Stirton & Zantovska 11432*, NBG; (c3) *Pillans 7899*, BOL; (d, three fruit) *Magee et al. 133*, JRAU; (e) *Winter 110*, JRAU; (f) *Lutzeyer 7A*, JRAU; (g) *Stirton & Zantovska 11430*, NBG; (h) *Magee 133*, JRAU. Scale: a–d=3 mm, e–h=1 mm.

appears to be more robust than the other species, while *C. macrocarpum* (Fig. 1a) is generally much smaller at maturity. However, as both these species are known from only a single locality, the size of the plants may eventually prove to be of limited diagnostic value.

### 3.2. Reproductive morphology

The relatively small compound umbels appear to be laterally borne along the stems but are in fact terminal and become leaf-opposed due to continued growth from the axillary shoots. The bracts of the involucre and involucler may be either free or connate at their bases, and the rays and raylets are invariably glabrous (Fig. 1f). The umbels of *C. macrocarpum* are always very sparse with only two or three rays consistently present (Fig. 1a). The other species usually have at least four rays, although two or three may rarely be present in *C. leiocarpon* and *C. lutzeyeri*.

The hermaphroditic flowers are pentamerous, with indistinct sepals and white, oblong to obovate, papillose petals with acuminate inflexed tips (Fig. 1e). The ovaries of *C. africanum* (Fig. 1f) and *C. macrocarpum* are distinctive in that they are prominently tubercled, while in the other species they are smooth.

The shape and position of the stylopodia in mature fruit were found to be useful diagnostic characters (Fig. 2). The stylopodia are either conical and raised above the fruit apex as in *C. africanum* (Fig. 2a and e), *C. leiocarpon* (Fig. 2c and g) and *C. lutzeyeri* (Fig. 2b and f), or very shortly conical to flattish and diagnostically sunken below the fruit apex in *C. macrocarpum* (Fig. 2d and h). The styles are at first erect and relatively short, but may lengthen as the fruit mature. Their relative length is an important diagnostic character. In *C. macrocarpum* (Fig. 2d and h) the styles remain erect and relatively short whereas in the other species they lengthen markedly and become reflexed. The styles of *C. leiocarpon* become reflexed far beyond the base of the stylopodium (Fig. 2c and g), while in the similar *C. lutzeyeri* they are reflexed only up to, at most, the stylopodium base (Fig. 2f). In *C. africanum* there appears to be some variability in that the styles may become reflexed either up to or beyond the base of the stylopodium.

The fruit of *Capnophyllum* are dorsally compressed, with the marginal ribs expanded into narrow wings (Fig. 2) and the commissure extending over the full width of the mericarp (i.e. to the very edge of both marginal ribs). The marginal wings are distinct in that they are slightly to prominently involute, so that the commissural surface is very slightly to prominently concave (Fig. 3). In transverse sections of immature fruit, the commissural



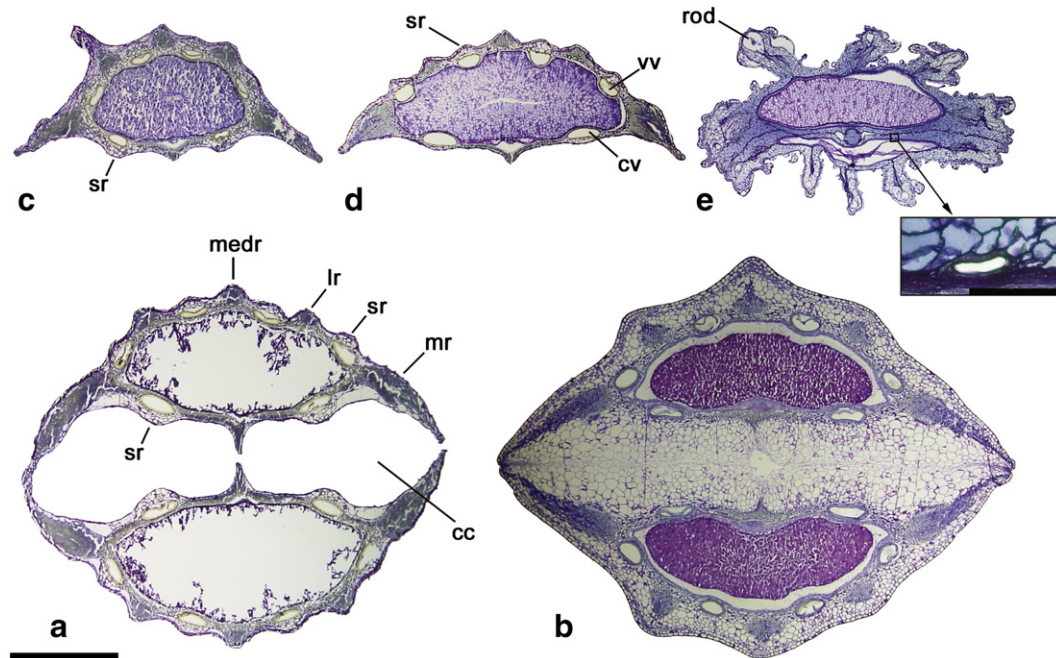


Fig. 3. Transverse sections through the fruit of *Capnophyllum* (a–d) and *Krubera* (e): (a) *C. lutzeyeri*; (b) *C. macrocarpum* (almost mature fruit); (c) *C. africanum*; (d) *C. leiocarpon*; (e) *K. peregrinum* with inlay showing enlargement of a commissural vitta. Vouchers: (a) Magee et al. 106, JRAU; (b) Magee et al. 133, JRAU; (c) Winter 110, JRAU; (d) Williamson 3825, PRE; (e) Lippert 22959, PRE. cc=commissural cavity; cv=commissural vitta; lr=lateral rib; medr=median rib; mr=marginal rib; rod=rib oil duct; sr=secondary ribs; vv=vallecular vitta. Scale: a–e=1 mm, inlay=0.2 mm.

area between the marginal wings is composed of parenchymatous cells which do not become lignified with maturation of the fruit. Instead these cells disintegrate to create a hollow between the two mericarps (Fig. 3a and b). The median and lateral ribs are slightly prominent to prominent and are diagnostically tubercled in *C. africanum* (Fig. 2a) and *C. macrocarpum* (Fig. 2d). Secondary ribs are often present above the vallecular and commissural vittae in *C. africanum*, *C. leiocarpon* and *C. lutzeyeri* (Fig. 3a, c and d). The fruit of *C. macrocarpum* (Fig. 2d) are the largest in the genus, with even the smallest fruit of this species distinctly larger than the largest fruit of *C. africanum* (Fig. 2a). In transverse section there are two commissural vittae as well as four solitary vallecular vittae (Figs. 3 and 4) in each mericarp of all the species.

In *Capnophyllum macrocarpum* there is a prominent sterile apical portion on the fruit that can most easily be seen by comparing the extent of the commissural vittae (Fig. 4a). In this species the commissural vittae terminate well below the stylopodium; in *C. lutzeyeri* they terminate slightly below the stylopodium leaving a much smaller sterile portion (Fig. 4c). In the remaining species the commissural vittae terminate at the base of the stylopodium so that there is no conspicuous sterile portion (Fig. 4b and d).

### 3.3. Comparison of *Capnophyllum* and *Krubera*

The fruit of *Capnophyllum* and *Krubera* are superficially similar in having prominent ridges on the dorsal surface, a broad commissure, dorsally compressed mericarps and marginal ribs extended into wings. On close examination of the fruit anatomy, however, the two genera are clearly distinct. The fruit of *Krubera* (Fig. 3e) have extremely small, inconspicuous commis-

sural and vallecular vittae unlike those of the species of *Capnophyllum* (Fig. 3a–d) where the vittae are relatively large and conspicuous. The fruit of *Krubera* also differ markedly in the presence of large rib oil ducts. The fruit anatomical data therefore supports the separation of the two genera as found by Magee et al. (in press).

### 4. Taxonomic treatment

***Capnophyllum*** Gaertn., Fruct. 2: 32 (1792); DC., Prodr. 4: 187 (1825); Sond. in Harv. and Sond., Fl. Cap. 2: 562 (1862); Adamson in Fl. Cape Penins. 625 (1950); Dyer, Gen. S. Afr. Flowering Pl. 2: 426 (1975), p.p. maj.; B.L. Burt in Edinb. J. Bot. 48(2): 189 (1991). Type: *C. africanum* (L.) Gaertn.

*Abioton* Raf., Good Book 56 (1840) reimp. Scad. Gen. Omb. Pl. 56 (Amer. Midl. Nat. Repr. No. 3, 1913), nom. illegit. Type: *A. africanum* (L.) Raf.

*Actinocladus* E.Mey. in Ind. Sem. Hort. Bot. Regiomont (1846) and in Ann. Sci. Nat. Bot. Ser. 3,7: 380 (1847). Type: *A. cinerascens* E.Mey.

Sprawling sympodial herbs, 0.05–0.5 m tall, annual. *Stems* well-branched at the base, branches usually prostrate or decumbent. *Leaves* cauline, 15–210 mm × 7–90 mm, usually becoming smaller towards the upper part of the stem, pinnate to bi-pinnate, glabrous, glaucous (and closely resembling those of *Fumaria*). *Petioles* 5–110 mm long, angular, basal sheaths prominent, 3–12 mm × 2–9 mm, margins widely membranous. *Ultimate leaflets* ovate to broadly ovate or obovate, 7–17 mm × 3–13 mm, pinnatisect, venation not visible or pinnate; segments linear-oblong, 1–6 mm long, less than 1 mm broad, flat or subterete, apex obtuse to acute. *Umbels* compound;

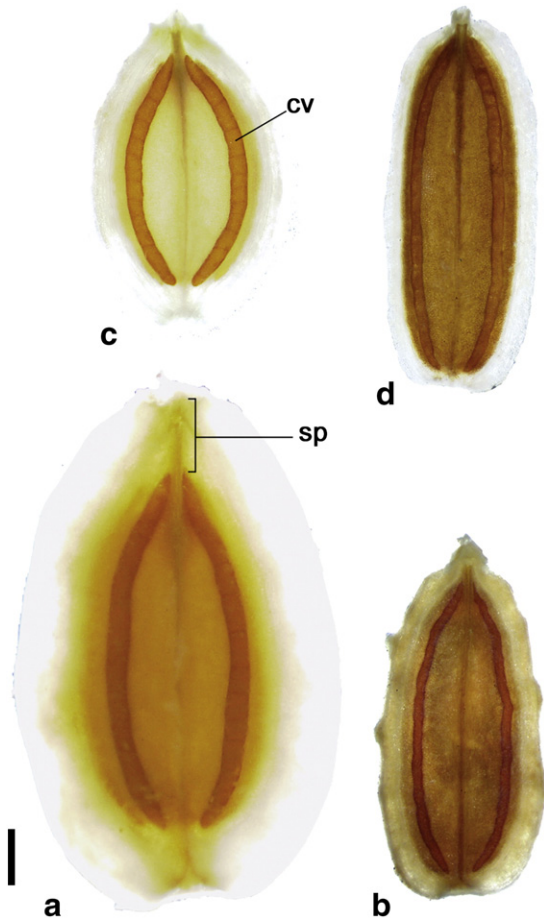


Fig. 4. Three-dimensional structure of the commissural vittae of *Capnophyllum* species: (a) *C. macrocarpum*; (b) *C. africanum*; (c) *C. lutzeyeri*; (d) *C. leiocarpon*. Vouchers: (a) Magee et al. 133, JRAU; (b) Van der Merwe 1767, NBG; (c) Magee et al. 106, JRAU; (d) Williamson 3825, BOL. cv=commissural vitta; sp=sterile portion. Scale: 1 mm.

peduncle short; involucre bracts 2 to 4 (to 6), connate or free, lanceolate to ovate, apex acuminate, margins widely membranous, glabrous; rays (2 to) 4 to 10 (to 14), 10–45 mm long at anthesis, glabrous; involucre bracteoles 4 (to 6), connate or free, lanceolate to ovate, apex acuminate, margins widely membranous, glabrous; raylets 6 to 25, 2–8 mm long at anthesis, glabrous. *Flowers* hermaphroditic; pentamerous; sepals indistinct; petals white,  $\pm 1$  mm long and broad, broadly obovate, tips inflexed, acuminate, septum present on inner face, apex truncate to shallowly emarginate, papillose; stamens with anthers inflexed; ovary inferior, smooth or tubercled, stylopodium shortly conical or flat, raised above or sunken below the fruit apex; styles at first erect, short, often longer in mature fruit, either remaining erect or becoming reflexed up to or beyond the base of the stylopodium. *Fruit* a schizocarp, dorsally compressed, elliptic to broadly elliptic or ovate to broadly ovate in dorsal view, 5.5–9.0 mm  $\times$  2.5–5.5 mm; narrowly elliptic and convex in lateral view; base obtuse to truncate or shallowly concave; apex obtuse to truncate; mericarps homomorphic, very slightly to markedly concave on the commissural surface; median and lateral ribs slightly prominent to prominent, straight

or flexuose, smooth or tubercled; marginal ribs narrowly winged, slightly to prominently involute, leaving a small to large commissural cavity; secondary ribs often present above the vallecular and commissural vittae; commissural vittae 2, terminating either directly below or some distance from the base of the stylopodium; vallecular vittae 4; commissure very broad, 100% of mericarp width; carpophore bipartite.

#### 4.1. Diagnostic characters

Species of *Capnophyllum* are annual, often sprawling, white-flowered herbs with soft, glaucous leaves resembling those of *Fumaria*. They differ from other vegetatively similar annual African genera by the dorsally compressed, narrowly-winged fruit with a broad commissure (100% of mericarp width). They are distinct from African peucedanoid genera in their sympodial growth pattern resulting in leaf-opposed umbels. All other African peucedanoid genera have a monopodial growth pattern with terminal umbels. Furthermore, the fruit differ from those of other annual African peucedanoids in the usually prominent median and lateral ribs, the narrowly-winged marginal ribs which are slightly to prominently involute, the often conspicuous secondary ribs on both the commissural and dorsal surfaces, the slightly to prominently concave commissural surface of the mericarps and the strongly elliptical outline in both dorsal and lateral views as a result of the convex outer surface.

The species often co-occur with the superficially similar and widespread *Sonderina hispida* (Thunb.) H. Wolff. Although the fruit of *Capnophyllum* are fundamentally different from those of *Sonderina* (in *Sonderina* the fruit are isodiametric, lack marginal wings and have a narrow commissure), when in flower they may easily be confused with one another. However, even when in flower *Capnophyllum* species can be distinguished by their prostrate habit, glaucous leaves, tubercled ovaries in *C. africanum* and *C. macrocarpum* (glabrous or more usually scabrous or pilose in *Sonderina hispida*), petals appearing truncate or at most shallowly-emarginate in dorsal view (deeply-emarginate in *Sonderina*), and glabrous umbels (scabrous in *Sonderina hispida*).

#### 4.2. Distribution and habitat

The four species are endemic to the Cape Floristic Region of South Africa (Figs. 5 and 6) and occur in sandy soil near to the coast. The species are generally allopatric in their distributions; however there is some overlap between the ranges of *C. africanum* and *C. leiocarpon* around Langebaan and Saldanha.

#### 4.3. Phenology

Seeds germinate during winter after the first autumn rains. Flowering occurs in spring (September and October) with mature fruit forming from late spring to early summer (November and December). All four species are annuals that wither and die during the dry mid-summer (January).



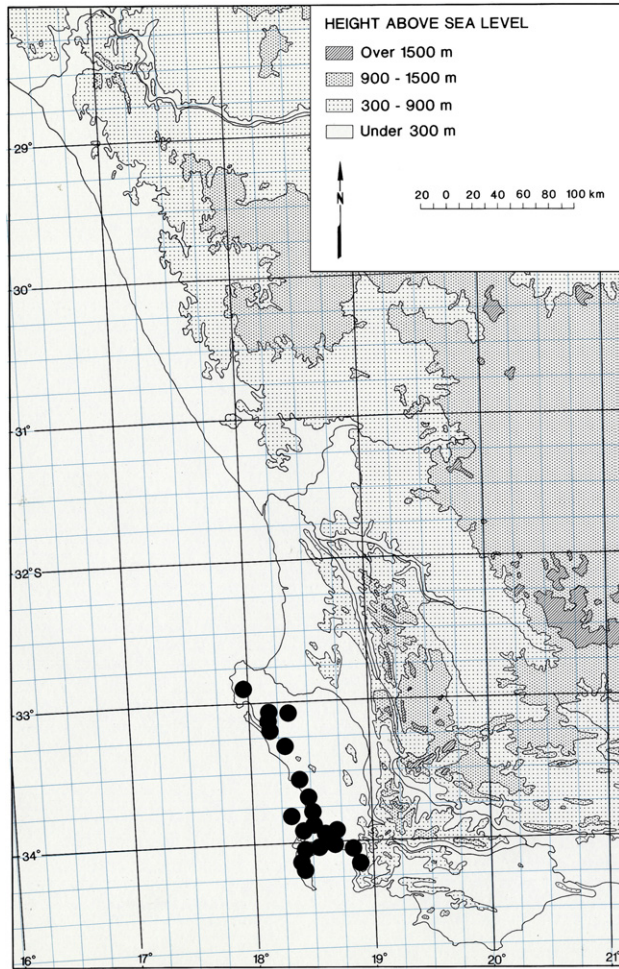


Fig. 5. Geographical distribution of *Capnophyllum africanum*.

4.4. Key to the species of *Capnophyllum*

- 1a. Flowers and fruit with tubercles on the median and lateral ribs (most prominent on ovaries and young fruit) ..... 2
- 2a. Fruit more than 8.5 mm long; stylopodium sunken below the apex of the fruit, very shortly conical to flat; fruit with conspicuous sterile apical portion (commissural vittae terminating some distance from the base of the stylopodium); rays 2 or 3 per umbel; known only from De Hoop Nature Reserve ..... 4. *C. macrocarpum*
- 2b. Fruit 8 mm long or less; stylopodium not sunken below the apex of the fruit, shortly conical; fruit without a conspicuous sterile apical portion (commissural vittae terminating directly below the base of the stylopodium); rays more than 3 per umbel; from Gordon's Bay northwards along the coast to Vredenburg ..... 1. *C. africanum*

- 1b. Flowers and fruit with smooth median and lateral ribs (without tubercles) ..... 3
- 3a. Styles of mature fruit reflexed and extending ± to the base of the stylopodium, short (0.7–0.8 mm long); mericarp markedly concave on the commissural surface; known only from Stanford in the Western Cape ..... 3. *C. lutzeyeri*
- 3b. Styles of mature fruit reflexed and extending far beyond the base of the stylopodium, long (1.2–1.7 mm long); mericarp only slightly concave on the commissural surface; known from the west coast from Langebaan northwards to Port Nolloth ..... 2. *C. leiocarpon*

4.5. *Capnophyllum africanum*

*C. africanum* (L.) Gaertn., Fruct. 2: 32, tab. 85, f. 6 (1792); DC., Prodr. 4: 187 (1825); Ecklon and Zeyh., Enum. Pl. Afric. Austral. 353 (1837); Sonder in Fl. Cap. 2: 562 (1862); Adamson

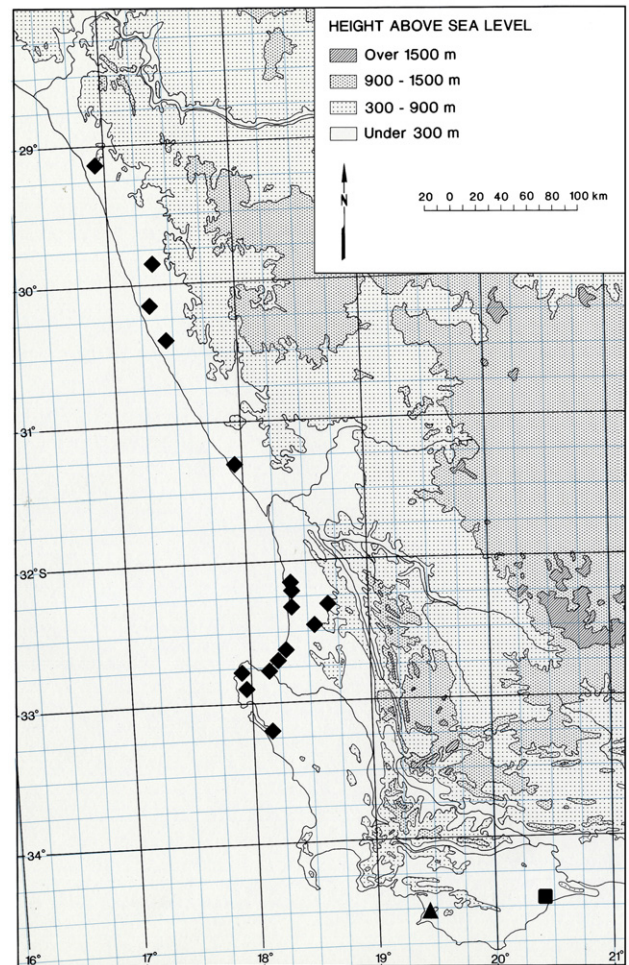


Fig. 6. Geographical distribution of *Capnophyllum leiocarpon* (diamonds), *C. lutzeyeri* (triangle), *C. macrocarpum* (square).

in Fl. Cape Penins. 625 (1950). *Conium africanum* L., Sp. Pl. 243 (1753); Mant. Alt. 252 (1771); Jacq., Hort. Vindob. 2: tab. 194 (1772); Thunb., Fl. Cap. 257 (1823). *Caucalis africana* (L.) Crantz, Cl. Umbell. Emend. 109 (1767). *Cicuta africana* (L.) Lam., Encycl. 2: 4 (1786), saltem quoad basionym. *Abioton africanum* (L.) Raf., Good Book 56 (1840); reimp. Scad. Gen. Omb. 56 (Amer. Midl. Nat. Repr. 3, 1913). Type: “*Caucalis afra, folio minoris Rutae*” in Boerhaave, Index Pl. Alt. 1: 63 (1720), (lecto., designated by Van Wyk and Tilney in Jarvis et al., 2006).

*Capnophyllum simplex* Lagasca, Gen. and Sp. Nov. 13 (1816), nom. illegit.

*Capnophyllum jacquini* DC., Prodr. 4: 187 (1830), p.p. min.

*Actinocladus cinerascens* E.Mey. in Ind. Sem. Hort. Bot. Regiomont (1846) and in Ann. Sci. Nat. Bot. Ser. 3, 7: 380 (1847). Type: Hort. Region, *Zeyher ex herb. Meyer s.n.* (S!, lecto., here designated). [Note: The specimen in S is chosen here as the label is in Meyer’s handwriting and bears the annotation “mihi”].

Sprawling or rarely somewhat erect herb, 0.05–0.3 m tall. Leaves 15–210 mm long × 8–60 mm. Petioles 5–110 mm long, basal sheaths 3–12 mm × 3–9 mm. Ultimate leaflets ovate to broadly ovate, 7–17 mm × 4–13 mm, venation not visible or pinnate; segments linear-oblong, 1–6 mm long, less than 1 mm broad, flat or subterete. Umbels with peduncle short, 5–60 mm long; involucre bracts (2 to) 4 (to 6), connate or free; rays 4 to 7 (to 14), 10–45 mm long at anthesis; involucre bracteoles 4 (to 6), connate or free; raylets 10 to 25, 2–7 mm long at anthesis. Flowers with ovary tubercled; stylopodium shortly conical, raised above the fruit apex; styles lengthening as fruit matures, (0.3–) 0.5–0.8 mm long, becoming reflexed up to or beyond the base of the stylopodium. Fruit elliptic to broadly elliptic or ovate to broadly ovate, 6.5–8.0 mm × 2.5–4.0 mm; base obtuse or shallowly concave; apex obtuse to truncate; mericarps very slightly concave on the commissural surface; median and lateral ribs prominent, flexuose, tubercled; marginal ribs slightly involute; secondary ribs usually present above the vallicular and commissural vittae; commissural vittae terminating directly below the base of the stylopodium.

#### 4.6. Diagnostic characters

*Capnophyllum africanum* is vegetatively similar to *C. leiocarpon* and *C. lutzeyeri* but differs in that both the ovaries and fruit are covered with tubercles on the median and lateral ribs, as in *C. macrocarpum*. It differs from the latter species, however, in the larger number of rays per umbel (4 or more), the smaller fruit (less than 8 mm long) without a sterile apical portion and with the shortly conical stylopodium raised above the fruit apex.

#### 4.7. Distribution and habitat

*Capnophyllum africanum* is endemic to the Western Cape Province, occurring from Gordons Bay and the Cape Peninsula northwards along the coast to Vredenburg (Fig. 5). This species

has also been collected on Robben Island. It occurs in open Strandveld on deep sandy soils.

#### 4.8. Additional specimens examined

South Africa. –**3217 (Vredenburg)**: 5 km from Vredenburg to Saldanha (–DD), *Stirton 10723* (K, NBG). –**3318 (Cape Town)**: Elandsfontein west, second ridge W of farmhouse (–AA), *Thompson 3534* (NBG, PRE); Geelbek Farm, Langebaan (–AA), *Bosenberg & Rutherford 138* (NBG); flats at S end of Langebaan lagoon (–AA), *Goldblatt 2711* (NBG, PRE); along R27, 14 km from Langebaan to Cape Town, near Club Mykonos turnoff (–AA), *Magee & Boatwright 114* (JRAU); along R27, resting area near Swartberg, 33° 13' 12" S 18° 12' 15" E (–AA), *Forest et al. 654* (NBG); along R27, from Velddrif to Cape Town, 33° 07' 38" S 18° 07' 53" E (–AA), *Boatwright et al. 228* (JRAU); along R27, from Velddrif to Cape Town, 33° 10' 33" S 18° 10' 21" E (–AA), *Boatwright et al. 229b* (JRAU); sand near Hopefield (–AB), *Bachmann s.n. sub BOL 1627* (BOL, K); 11 km NNE of Yzerfontein (–AD), *Strid & Strid 38062* (NBG); Buffelsrivier (–CB), *Van der Merwe 1767* (K, NBG, PRE); Buffelsrivier, Hardy Joubert’s sample plots near Bokbaai (–CB), *Taylor 4165* (NBG, PRE); Melkbosstrand (–CB), *Dahlstrand 1064* (PRE); Clifton-on-sea (–CD), *Phillips s.n. sub PRE 59930* (PRE); Milnerton (–CD), *Andreae 381* (NBG); *Wall 196* (S); Robben Island (–CD), *Adamson s.n.* (BOL); Sunset Beach, S of Table View (–CD), *Van Slageren & Newton 842* (K); Brackenfell, Cape Flats (–DC), *Du Plessis 108* (PRE); Cape Flats Nature Reserve (–DC), *Low 866a* (PRE); Cape Flats (–DC); *Pappe s.n.* (K); *Wallich s.n.* (BM); sandy flats near Kuils River (–DC), *Anon ex herb. Worsdell s.n.* (K); high dunes W of Sarepta (–DC), *Acocks 1112, 1294* (S); Stikland (–DC), *Acocks 2253* (S); Vygekraal (–DC), *MacOwan 1751* (BM, NBG, K), *Wolley Dod 706* (K). –**3418 (Simonstown)**: Fish Hoek (–AB), *Young 27349* (PRE, fragment labelled A); near Glencairn (–AB), *Hutchinson 640* (BM, BOL, K, PRE); Kalk Bay (–AB), *Levyns s.n. sub BOL 1625* (BOL); Kommetjie, Imhoff’s Gift (–AB), *Winter 110* (JRAU); Oaklands (–AB), *Jameson s.n.* (K); Retreat Railway Station (–AB), *Bolus 2793* (BOL, PRE); Scarborough (–AB), *Adamson 3081* (BOL); Varkensvlei Experimental Farm (–BA), *Joubert 26147* (NBG); Wynberg Flats (–BA), *Anon ex herb. Prior s.n.* (K); Gordons Bay (–BB), *Parker 3860* (BOL, K, NBG); Somerset in Hottentots Holland (–BB), *Ecklon & Zeyher 2252* (S); Strand (–BB), *Parker 4349* (K, NBG). **Precise locality unknown**: “Prom. b. Spei”, *Masson s.n.* (BM); “In arenosis ad likes maris Sinu False Bay”, *Bolus 4632* (BM, BOL); “In solo arenosa prope Capetown”, *Bolus 2793* (BOL, K, NBG); *Burchell 362* (K, PRE); *Zeyher 742* (K, two sheets); *Zeyher 635* (K); *Ecklon & Zeyher 2252* (NBG).

#### 4.9. *Capnophyllum leiocarpon*

*C. leiocarpon* (Sond.) J.C.Manning and Goldblatt in Goldblatt and Manning, Cape Pl. 705 (2000). *Capnophyllum africanum* var. *leiocarpon* Sond. in Harv. and Sond., Fl. Cap. 2: 562 (1862); B.L. Burt in Edinb. J. Bot. 48(2): 189 (1991). Type: South Africa. Near Cape Town, *Drège 6243* (S!, lecto., here designated; BM!, G, K!, two sheets, MO, isolecto.).



Sprawling or somewhat erect herb, 0.1–0.5 m tall. *Leaves* 50–200 mm × 20–90 mm. *Petioles* 8–90 mm long, basal sheaths 4–12 mm × 3–6 mm. *Ultimate leaflets* ovate to broadly ovate or obovate, 7–16 mm × 5–10 mm, venation not visible or pinnate; segments linear-oblong, 1–6 mm long, less than 1 mm broad, flat or subterete. *Umbels* with peduncle short, (3–) 10–60 (–105) mm long; involucre bracts 2 to 4, connate, sometimes free; rays (2 to) 4 to 8, 10–30 mm long at anthesis; involucre bracteoles 4 (to 6), connate; raylets 10 to 25, 2–7 mm long at anthesis. *Flowers* with ovary smooth; stylopodium shortly conical, raised above the fruit apex; styles lengthening as the fruit matures, 1.2–1.7 mm long, becoming reflexed far beyond the base of the stylopodium. *Fruit* elliptic to broadly ovate, 5.5–8.0 mm × 3.0–4.0 mm; base and apex obtuse to truncate; mericarps slightly to very slightly concave on the commissural surface; median and lateral ribs prominent, flexuose, smooth; marginal ribs slightly involute; secondary ribs usually present above the vallicular and commissural vittae; commissural vittae terminating directly below the base of the stylopodium.

#### 4.9.1. Diagnostic characters

*Capnophyllum leiocarpon* differs from *C. africanum* and *C. macrocarpum* in the absence of tubercles on the ribs of both the ovaries and fruit. It can be distinguished from *C. lutzeyeri* by the longer styles of the mature fruit that become reflexed far beyond the base of the stylopodium, and the only very slightly concave commissural surfaces of the mericarps.

#### 4.9.2. Distribution and habitat

This widespread species occurs along the coast from near Langebaan in the Western Cape Province northwards to Port Nolloth in the Northern Cape Province (Fig. 6). It occurs in open Strandveld on deep sandy soil.

#### 4.9.3. Additional specimens examined

South Africa. –**2916 (Port Nolloth)**: ±15 km E of Port Nolloth (–BB), *Williamson 3508* (BOL), 3825 (BOL, NBG, PRE). –**2917 (Springbok)**: Farm Zonnekwa 328, 1 km N of crossroads to Graafwater and Sonnekwa B on road from Vaalkol (–CD), *Le Roux & Lloyd 517* (NBG). –**3017 (Hondeklipbaai)**: Farm Koingaas 475, on road from Hondeklipbaai to Koinghaas on S banks of Swartlintjies River (–AB), *Le Roux & Lloyd 327* (NBG); Farm Ghaams 492, SE of Spoeg River (–AD), *Boucher 5667* (NBG); sand dunes between Wallekraal and Hondeklipbaai (–AD), *Goldblatt 4222* (K, PRE). –**3117 (Lepelfontein)**: Brand-se-Baai (–BD), *Van Rooyen 2154* (PRE). –**3217 (Vredenburg)**: Paternoster Bay (–DD), *Lavranos 11708* (PRE); 5 km from Vredenburg to Saldanha (–DD), *Stirton 10723* (NBG). –**3218 (Clanwilliam)**: Nortier Experimental Station, Lamberts Bay (–AB), *Boucher 2539* (K, PRE), *Liengme 988* (BOL), *Van Breda 4296* (K, PRE), *Van der Merwe 1664* (PRE); Elands Bay (–AD), *Metelkamp 233* (BOL), *Pillans 7899* (BOL); 5 km from Elands Bay on road to Lamberts Bay (–AD), *Stirton & Zantovska 11430* (NBG); 2 km from Redelinghuys (–BC), *Stirton & Zantovska 11432* (NBG, two sheets); Dwarskersbos (–CA), *Taylor 12003* (NBG, PRE); Rocher

Pan Nature Reserve (–CB), *Magee & Boatwright 116* (JRAU), *Van Rooyen & Ramsey 256* (NBG); Berg River Mouth (–CC), *O' Callaghan 8/11* (NBG). –**3318 (Cape Town)**: along R27, from Veldrif to Cape Town, 33° 10' 33" S 18° 10' 21" E (–AA), *Boatwright et al. 229a* (JRAU).

#### 4.10. *Capnophyllum lutzeyeri*

*C. lutzeyeri* Magee and B.-E. van Wyk, species novum, *Capnophyllo africano* et *C. leiocarpo stylopodio brevi costis fructus dorsalibus secundariisque prominentibus similis sed fructu non tuberculato stylis brevioribus et superficiebus commissuralibus valde concavis differt*. Type: South Africa. Caledon district (3419); Grootbos Nature Reserve, Steynsbos (–CB); 15 December 2006; *H. Lutzeyer 7A* (NBG!, holo.; JRAU!, iso.).

Sprawling herb, 0.2–0.5 m tall. *Leaves* 15–60 mm × 7–25 mm. *Petioles* 5–15 mm long, basal sheaths 3–8 mm × 2–5 mm. *Ultimate leaflets* ovate to broadly ovate, 7–15 mm × 4–9 mm, venation not visible; segments linear-oblong, 1.5–3 mm long, less than 1 mm broad, subterete. *Umbels* with peduncle short, 15–75 mm long; involucre bracts 2 to 4, free?; rays (2 to) 4 to 15, 10–30 mm long at anthesis; involucre bracteoles 4, free?; raylets 7 to 10, 2–6 mm long at anthesis. *Flowers* with ovary smooth; stylopodium shortly conical, raised above the fruit apex; styles lengthening slightly as the fruit matures, 0.7–0.8 mm long, becoming reflexed up to or just above the base of the stylopodium. *Fruit* broadly elliptic, 6.0–6.5 mm × 3.5–4.0 mm; base obtuse to truncate; apex obtuse; mericarps markedly concave on the commissural surface; median and lateral ribs slightly prominent, straight, smooth; marginal ribs prominently involute; secondary ribs present above the vallicular and commissural vittae; commissural vittae terminating slightly below the base of the stylopodium.

#### 4.10.1. Diagnostic characters

*Capnophyllum lutzeyeri* differs from *C. africanum* and *C. macrocarpum* in the smooth fruit and from *C. leiocarpon* in the shorter styles, which become reflexed only to the base of the stylopodium, and the markedly concave commissural surface.

#### 4.10.2. Distribution and habitat

The species is known only from the private nature reserve Grootbos, near Stanford in the Western Cape Province (Fig. 6), where it was collected on acid derived sand in Fynbos vegetation that had burnt the previous year. No plants were found in subsequent searches by Mr H. Lutzeyer, suggesting that this species may be a short-lived fireweed.

#### 4.10.3. Additional specimens examined

South Africa. –**3419 (Caledon)**: Steynsbos, Grootbos Nature Reserve (–CB), *Magee et al. 106* (JRAU, NBG, PRE).

#### 4.11. *Capnophyllum macrocarpum*

*C. macrocarpum* Magee and B.-E. van Wyk, species novum, *Capnophyllo africano costis dorsalibus tuberculatis ovarii fructusque similis sed fructu maiori portione apicali sterile*



*longo, stylopodio immerso rudimentali et superficiebus commissuralibus valde concavis differt.* Type: South Africa. Caledon district (3420): De Hoop Nature Reserve, near to De Mond (–AD); 4 November 2007; A.R. Magee, B.-E. Van Wyk and J.S. Boatwright 133 (NBG!, holo.; BOL!, JRAU!, K!, iso.).

Sprawling herb, 0.04–0.08 m tall. *Leaves* 25–85 mm × 10–40 mm. *Petioles* 10–45 mm long, basal sheaths 5–8 mm × 2–3 mm. *Ultimate leaflets* ovate to broadly ovate, 9–12 mm × 8–10 mm, venation not visible; segments linear-oblong, 2–5 mm long, less than 1 mm broad, flat or subterete. *Umbels* with peduncle short, 3–8 mm long; involucre bracts 2 or 4, connate or free; rays 2 or 3, 7–35 mm long at anthesis; involucre bracteoles 4, connate; raylets 10 to 15, 2–5 mm long at anthesis. *Flowers* with ovary tubercled; stylopodium very shortly conical to flat, sunken below the fruit apex; styles not lengthening as the fruit matures, 0.3–0.5 mm long, remaining erect or rarely becoming somewhat reflexed to just above the base of the stylopodium. *Fruit* broadly elliptic to broadly ovate, 8.5–9.0 mm × 4.5–5.5 mm; base obtuse or shallowly concave; apex obtuse to truncate; mericarps markedly concave on the commissural surface; median and lateral ribs prominent, flexuose, tubercled; marginal ribs prominently involute; secondary ribs absent; commissural vittae terminating some distance from the base of the stylopodium.

#### 4.11.1. Diagnostic characters

As in *Capnophyllum africanum*, both the ovaries and fruit are covered with tubercles on the median and lateral ribs. *Capnophyllum macrocarpum* differs from this species in the larger fruit (more than 8.5 mm long) with a conspicuous sterile apical portion and the rudimentary stylopodium that is sunken below the apex of the fruit. Furthermore, the umbels of this species appear to have fewer rays (2 or 3).

#### 4.11.2. Distribution and habitat

This species is known only from De Hoop Nature Reserve in the Western Cape Province (Fig. 6). It was collected in fynbos, on deep sandy soils. A search of the surrounding area did not reveal any further populations, indicating that the species may be highly localised.

#### 4.11.3. Additional specimen examined

South Africa. –3420 (Caledon): De Hoop Nature Reserve, near to De Mond (–AD), Magee et al. 120 (JRAU).

### Acknowledgements

The curators and staff of the cited herbaria are thanked for their kind hospitality and assistance during visits and for making specimens available on loan. The authors would also like to

express gratitude to Dr J.C. Manning (NBG) for assistance with collections and for alerting us to unusual collections. Mr and Mrs Lutzeyer are thanked for their enthusiasm and hospitality while studying the species growing on Grootbos Nature Reserve near Stanford. Dr H. Glen is gratefully acknowledged for translating the diagnoses. We are grateful to Mr A. Marais and his team from De Hoop Nature Reserve for their kind hospitality. This study was funded by the University of Johannesburg and the National Research Foundation.

### References

- Adamson, R.S., 1950. Umbelliferae. In: Adamson, R.S., Salter, T.M. (Eds.), Flora of the Cape Peninsula. Juta and Co., Cape Town.
- Burt, B.L., 1991. Umbelliferae of southern Africa: an introduction and annotated checklist. *Edinburgh Journal of Botany* 48, 133–282.
- Downie, S.R., Ramanath, S., Katz-Downie, D.S., Llanas, E., 1998. Molecular systematics of Apiaceae subfamily Apioideae: phylogenetic analyses of nuclear ribosomal DNA internal transcribed spacer and plastid *rpoC1* intron sequences. *American Journal of Botany* 85, 563–591.
- Downie, S.R., Watson, M.F., Spalik, K., Katz-Downie, D.S., 2000. Molecular systematics of Old World Apioideae (Apiaceae): relationships among some members of tribe Peucedaneae sensu lato, the placement of several island-endemic species, and resolution within the apioid superclade. *Canadian Journal of Botany* 78, 506–528.
- Dyer, R.A., 1975. The genera of Southern African flowering plants, vol. 1. Dicotyledons. Botanical Research Institute, Pretoria.
- Feder, N., O'Brien, T.P., 1968. Plant microtechnique: some principles and new methods. *American Journal of Botany* 55, 123–142.
- Goldblatt, P., Manning, J.C., 2000. Cape Plants: A Conspectus of the Cape Flora of South Africa. *Strelitzia*, vol. 9. National Botanical Institute, Cape Town.
- Holmgren, P.K., Holmgren, N.H., Barnett, L.C., 1990. *Index Herbariorum 1: The Herbaria of the World*. Ed. 8. Regnum Vegetabile. New York Botanical Garden, New York.
- Jarvis, C.E., Reduron, J.-P., Spencer, M.A., Cafferty, S., 2006. Typification of Linnaean plant names in Apiaceae. *Taxon* 55, 207–216.
- Kljuykov, E.V., Liu, M., Ostroumova, T.A., Pimenov, M.G., Tilney, P.M., Van Wyk, B.-E., 2004. Towards a standardised terminology for taxonomically important morphological characters in the Umbelliferae. *South African Journal of Botany* 70, 488–496.
- Leistner, O.A., Morris, J.M., 1976. Southern African place names. *Annals of the Cape Province Museum* 12.
- Magee, A.R., Van Wyk, B.-E., Tilney, P.M., Downie, S.R., in press. Generic delimitations and relationships of the Cape genera *Capnophyllum*, *Dasispermum* and *Sonderina*, the North African genera *Kruberia* and *Stoi-brax*, and a new monotypic genus of the subfamily Apioideae (Apiaceae). *Systematic Botany*.
- Meikle, R.D., 1977. *Flora of Cyprus*, vol. 1. The Bentham-Moxon Trust, London.
- Sonder, W., 1862. Umbelliferae. In: Harvey, W.H., Sonder, W. (Eds.), *Flora Capensis*, vol. 2. Hodges, Smith and Co., Dublin.
- Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M., Webb, D.A., 1968. *Flora Europaea*, vol. 2. Cambridge University Press, Cambridge.
- Winter, P.J.D., Magee, A.R., Phephu, N., Tilney, P.M., Downie, S.R., Van Wyk, B.-E., 2008. A new generic classification for African peucedanoid species (Apiaceae). *Taxon* 57, 347–364.