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Two new species of *Euryops* (Asteraceae: Senecioneae) from the Sneeuberg, Eastern Cape Province, South Africa

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Abstract

We describe two new species from the Sneeuberg, Eastern Cape Province, South Africa: *Euryops proteoides* and *E. exsudans*. Both species are locally prolific with populations centred east of the Nardousberg (Graaff-Reinet District). In a molecular phylogeny based on Internal Transcribed Spacer (ITS) sequence data, *E. exsudans* is sister to *E. galpinii*, but morphology suggests affinities to *E. virgineus, E. algoënsis* and *E. latifolius*, all of which are Eastern Cape species. The affinities of *E. proteoides* are less certain, but it is shown to be basal to a clade comprising *E. tenuissimus*, *E. linifolius* and *E. hebecarpus*, although with no support. Morphologically the species is very similar to the Drakensberg species *E. evansii*. These two new species augment the suggestion that the greater Sneeuberg region should be recognised as a local centre of Asteraceae diversity and as a centre of diversity for *Euryops* in particular.

Keywords: Asteraceae; Centre of Endemism; *Euryops*; Great Escarpment; New species; Sneeuberg

1. Introduction

The Sneeuberg mountain complex in the Eastern Cape Province, South Africa, has been the subject of a floristic study since 2005 and numerous poorly collected and several new plant taxa have been recorded (Clark et al., submitted for publication). These authors conclude that the Sneeuberg occupies a unique position as the western-most local centre of Afromontane diversity and endemism in the suite of local centres that characterises the moist eastern Great Escarpment in South Africa (Mucina and Rutherford, 2006; Van Wyk and Smith, 2001).

The Asteraceae is the most speciose family in the Sneeuberg, and one of the characteristic genera of the family in the region is *Euryops* Cass. in the Senecioneae. This genus was revised by Nordenstam (1968a,b, 1969), who recognized 97 species, 89 of which occur in southern Africa south of the Limpopo and Cunene rivers. Nordenstam (1969) reported a total of 16 species from the Sneeuberg and adjacent Winterberg-Amatola-Stormberg mountains and designated these mountains as the "Sneeuwbergen Centre" of endemism.

During the course of field work in the Sneeuberg, two morphologically distinct, geographically localized and undescribed taxa of *Euryops* were collected on the south-eastern end of the Sneeuberg. These new species are here described, and their taxonomic and phylogenetic relationships within the genus are discussed on the basis of morphological and molecular data.

2. Materials and methods

2.1. Species description and sampling

Plants were studied in situ and herbarium material was collected and housed in the Selmar Schönland Herbarium, Grahamstown (GRA). Duplicates were sent to the Swedish Museum of Natural History (S) for verification. Morphological characters were assessed by stereo microscope and floral details were examined on dissected florets mounted in Hoyer's

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solution. Living material was also collected for cultivation at Rhodes University, Grahamstown.

2.2. Phylogenetic analysis

As a previous study had already resulted in a preliminary phylogeny of *Euryops* (Devos et al., submitted for publication), we felt it relevant and appropriate to place the two new species in a phylogenetic context, and thus undertook a molecular phylogenetic analysis of the Internal Transcribed Spacer (ITS) region, following the methods outlined by Devos et al. (submitted for publication). Sequences obtained for this study were deposited in GenBank under numbers EU979538 (*E. proteoides*; *Clark VR, Coombs G 105*), EU979539 (*E. exsudans*; *Clark VR, Coombs G 110*) and EU979540 (*E. exsudans*; *McKenzie MJ, Weston P, Clark VR 175*).

In order to obtain a phylogeny, Bayesian inference (BI) was employed for phylogeny reconstruction. The MCMC sampling procedure was performed using the program MrBayes (Huelsenbeck and Ronquist, 2001), employing the GTR+4Γ model of nucleotide substitution. Four MCMC chains were run simultaneously for 2000000 iterations each, sampling every 1000th tree. For burn-in, the first 500 of the sampled trees were discarded, leaving a final MCMC sample of 1500 trees.

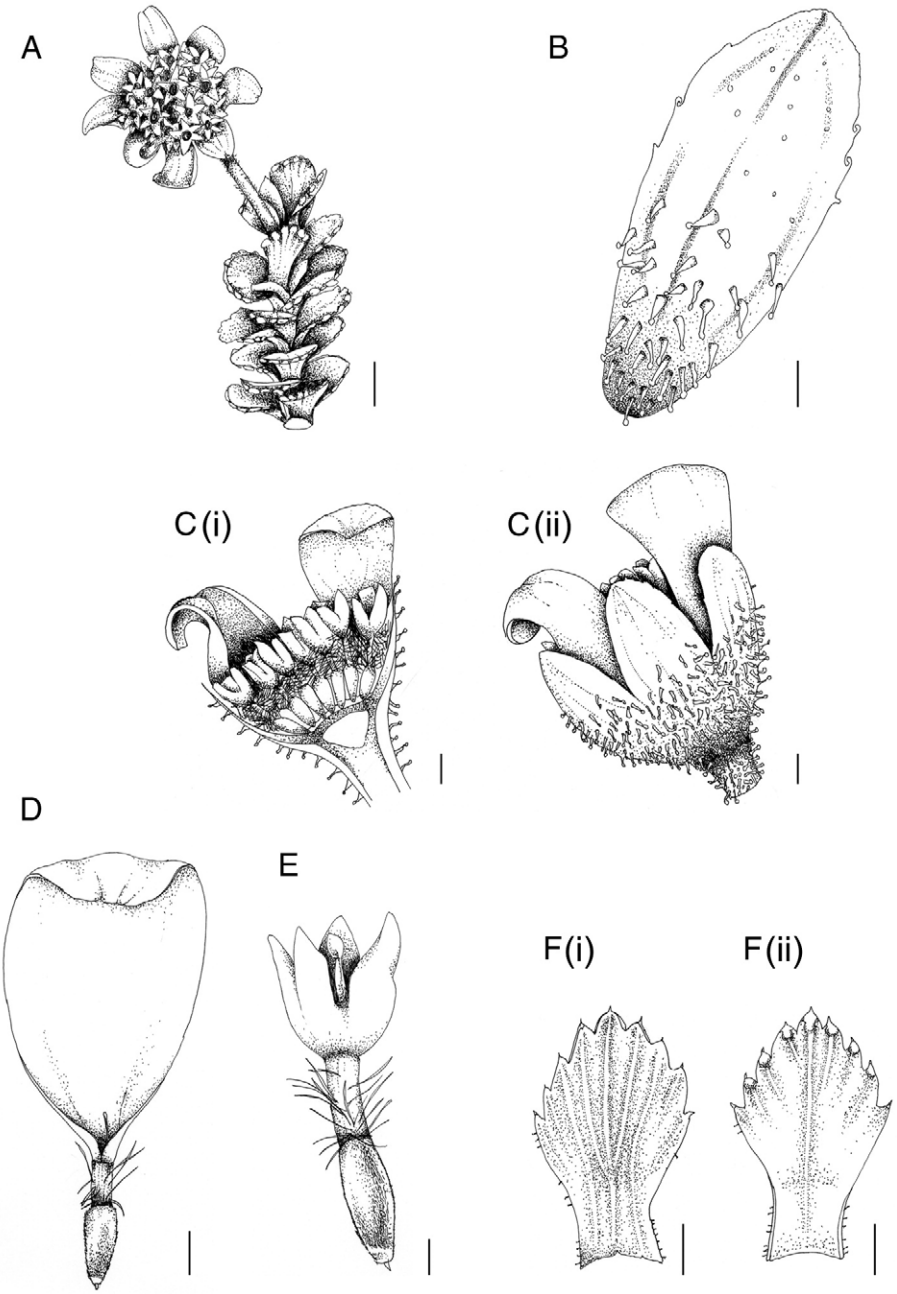

Fig. 1. *Euryops exsudans*, drawn from the type collection. (A) flowering portion of stem; (B) involucral bract; (C) capitulum, cross-section (i), and exterior (ii); (D) ray-floret; (E) disc-floret; (F) leaf, adaxial surface (i), abaxial surface (ii). Scale bar: (A) 35 mm; (B) 0.6 mm; (C) (i) & (ii) 1 mm; (D) 0.6 mm; (E) 0.4 mm; (F) (i) & (ii) 1 mm. Del. L. de Wet; graphics S. Abraham.

3. Species descriptions

3.1. Euryops exsudans B.Nord. & V.R.Clark, sp. nov.

3.1.1. Typus

South Africa, Eastern Cape Province, 3225AC, Farm 360: on the mountains behind the old town of Petersburg (now in Asante Sana Private Game Reserve) Graaff-Reinet District, Sneeuberg. 32°15′00″S 25°00′00″E, 1900 m, 6 December 2005, *Clark VR, Coombs G 110* (GRA, holo; S, iso).

Frutex erectus sparse ramosus. Folia imbricata erecto-patentia demum patentia elliptico-obovata coriacea multivenia apicem versus 7–10-dentata glutinosa. Capitula solitaria vel pauca ex axillis subterminalibus radiata; pedunculi axillares simplices glanduloso-pubescentes. Involucri bracteae plerumque 8 uniseriatae anguste elliptico-ovatae ca. 5 mm longae 2.5–3 mm latae ad medio connatae glanduloso-pubescentes. Receptaculum convexum distincte alveolatum. Flores radii 8–11; tubus cylindricus 0.8–1 mm longus; lamina flava elliptico-oblonga 4–5-nervosa. Flores disci corolla 3.5–4 mm longa, tubo cylindrico, limbo campanulato lobis triangulari-ovatis. Antherae 1.5 mm longae ecaudatae. Styli rami anguste oblongi 0.7–0.8 mm longi. Cypselae anguste elliptico-oblongae usque 3.5 mm longae et 1.7 mm latae costatae albo-villosae madefactae mucilaginae. Pappi setae copiosae albae barbellatae caducae.

Small erect little or moderately branched shrub ca. 50 cm tall; branches densely leafy, becoming nude and marked with leaf-scars. *Leaves* alternate, sessile, imbricate, erecto-patent or eventually spreading, elliptic-obovate or broadly cuneate, 5–8 mm long, 2.5–6 mm wide, coriaceous, greyish or glaucous green, obscurely punctate, finely 8–10-veined with subparallel

Plate 1. (A) *Euryops proteoides* in habitat, at the type locality in Asante Sana Private Game Reserve (*Clark VR, Coombs G 700*); (B) *Euryops proteoides*, close-up of the inflorescence (*Clark VR, Coombs G 700*); (C) *Euryops exsudans* in situ, Asante Sana Private Game Reserve (*Clark VR, Coombs G 701*). Photographs by V.R. Clark and G. Coombs.

veins thickened distally, apically rounded-obtuse and 8–10-dentate with triangular-ovate mucronate and somewhat cucullate teeth covered by a rich light brown or honey-coloured foetid resin exudate; leaf-margins finely glandular with delicate stalked glands. *Capitula* solitary on lateral axillary peduncles 1–4 in subterminal position on flowering branches, radiate; *peduncle* suberect, simple, 10–25 mm long, nude, moderately densely pubescent with stalked glandular hairs. *Involucre* broadly campanulate–hemispherical, ca. 10 mm in diameter and 5 mm high; *involucral bracts* usually 8, uniseriate, narrowly elliptic-ovate, connate to the middle, 5 mm long, 2.5–3 mm wide, moderately densely glandular-pubescent, green, faintly veined; the free lobes triangular-ovate, 2.5–3 mm long, 2–2.5 mm wide, subacute. *Receptacle* convex, distinctly alveolate (honey-combed). *Ray-florets* 8–11; tube 0.8–1 mm long; lamina yellow, elliptic-oblong, 4–5 mm long, 2.5–3 mm wide, 4–5-veined. *Disc-florets* many (ca. 25–30), yellow. *Corolla* 3.5–4 mm long; tube 1–1.5 mm long, cylindrical; limb campanulate, 2.5 mm long; lobes triangular-ovate, 1 mm long, acute, distinctly mid-lined and with marginal veins. *Anthers* 1.5 mm long including deltoid-ovate apical appendage, ecaudate with obtuse base; filament collar very short. *Style* branches narrowly oblong, 0.7–0.8 mm long, apically convex with short lateral sweeping-hairs, inside with distinctly separated stigmatic areas. *Cypsela* narrowly elliptic-obovate, 2.8–3.5 mm long, 1.2–1.7 mm wide, bluntly 5-ribbed, brown, densely white-villous with short obtuse twin hairs, strongly mucilaginous when soaked. *Pappus* bristles copious, 1.5–2 mm long, flexuous, white, softly distinctly barbellate, caducous. (Fig. 1; Plate 1).

The fan-shaped denticulate leaves with copious and foetid resin exudate make it difficult to confuse this species with any previously described member of the genus. The glandular-pubescent peduncles are also a key character of this species. Most *Euryops* taxa are resiniferous and some have received common names such as “harpuisbos” and “resin-bush”. Strongly resiniferous and sometimes sticky taxa are found throughout the genus without indicating close relationship: *E. glutinosus* B.Nord. of the Swartberg range in the Western Cape and *E. annae* Phill. of the Eastern Cape are examples. Mucilaginous cypselar hairs are common although not universal in the genus, and may play a role in the dispersal, or more likely germination of the diaspores (Nordenstam, 1968b).

The new species is found on the southern end of the Sneeuberg, on the upper escarpment slopes and plateau immediately east of the Nardousberg (Graaff-Reinet District), on the Bankberg (Cradock District), and on the summit of the Wapadsberg (Graaff-Reinet-Middelburg Districts) (Fig. 2). It is locally abundant above 1600 m, occurring in Karoo Escarpment Grassland, and readily colonises disturbed areas such as old fence-lines, road tracks and overgrazed veld. It is also a common component of “arid fynbos” on rocky summit areas in this region. One plant has been successfully cultivated at Rhodes University, but given its straggly growth form the species may not become more than a horticultural curiosity.

3.1.2. Further Collections

Eastern Cape Province: 3225AD, Mountain Zebra National Park, above Olien Hut, Cradock District, 32°16′S 25°27′E, 3 November 1990, *Palmer AR 2938* (GRA). Eastern Cape Province: 3224BB, Farm Upper Waterkloof 352, Sneeuberg, on the mountains behind the old town of Petersburg (now Asante Sana Private Game Reserve), Graaff-Reinet District, 32°14′33″S 24°56′29″E, 1877 m, 4 March 2006, *McKenzie RJ, Weston P, Clark VR 175* (GRA). Eastern Cape Province: 3224BD, Farm Groot Vallei 428, Sneeuberg, on the mountains behind the old town of Petersburg (now Asante Sana Private Game Reserve), Graaff-Reinet District, summit plateau, 32°14′50″S 24°59′44″E, 2120 m, 3 November 2006, *Clark VR, Ramdhani S 453* (GRA, K, MO, NSW). Eastern Cape Province: 3124DD, Farm 73, Sneeuberg summit plateau SE of main Wapadsberg summit, Graaff-Reinet-Middelburg Districts, 31°53′03″S 24°55′10″E, 2109 m, 11 December 2007, *Clark VR, Pienaar C 118* (GRA). Eastern Cape Province: 3225AC, Farm 360, Sneeuberg, on the mountains behind the old town of Petersburg (now Asante Sana Private Game Reserve), Graaff-Reinet District, 32°15′30″S 25°01′10″E, 1880 m, 31 March 2008, *Clark VR, Crause I 8* (BOL, GRA, NBG, PRE). Eastern Cape Province: 3224BB, Farm Upper Waterkloof 352, Sneeuberg, eastern end of Nardousberg ridge, on the mountains behind the old town of Petersburg (now Asante Sana Private Game Reserve), Graaff-Reinet District, 32°14′45″S 24°55′49″E, 1919–2218 m, 2 April 2008, *Clark VR, Crause I 49, 54* (GRA). Eastern Cape Province: 3225AC, Farm 360, Sneeuberg, on the mountains behind the old town of Petersburg (now in Asante Sana Private Game Reserve), Graaff-

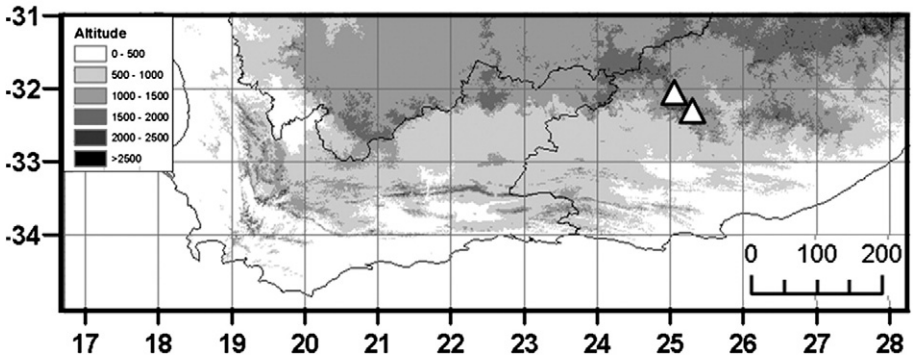

Fig. 2. Distribution of *Euryops exsudans* (scale bar in km); altitude in metres; grid represents latitude and longitude.

Reinet District, 32°15′00″S 25°00′00″E, 1900 m, 6 October 2008, *Clark VR, Coombs G 701* (GRA).

3.2. Euryops proteoides B.Nord. & V.R.Clark, sp. nov.

3.2.1. Typus

South Africa, Eastern Cape Province, 3225AC, Farm 360: on the mountains behind the old town of Petersburg (now in Asante Sana Private Game Reserve) Graaff-Reinet District, Sneeuberg. 32°15′11″S 25°00′00″E, 2014 m, 3 November 2006, *Clark VR, Ramdhani S 452* (GRA, holo; K, iso; MO, iso; S, iso).

Frutex robustus erectus ramosus glaber; rami juveniles dense foliati, vetustiores nudi cicatricosi. Folia alterna erecto-patentia sessilia anguste oblongo-obovata integra 3–6 cm longa 1–1.5 cm lata plana paullum coriacea glaucescentia margine apicem versus 9–12-dentata. Capitula terminalia radiata. Pedunculi terminales foliis aequilongi simplices nudi. Involucrum late campanulatum vel hemisphericum 2–2.5 cm latum; involucri bracteae 9–13 subuniseriatae ad medio connatae 10–15 mm longae 4–5 mm latae. Receptaculum nudum convexum minute alveolatum. Flosculi radii 14–19 flavi; tubus cylindricus 2.5–3 mm longus; lamina anguste oblongo-oblanceolata. Flosculi disci numerosi; corolla flava superne campanulata 6–6.5 mm longa lobis 5 anguste ovatis. Antherae ecaudatae 2.5 mm longae appendice terminali ovati incluso. Styli rami anguste oblongi apice convexi pilis everrentibus ornati. Cypselae anguste elliptico-oblongae fere triquetrae vel leviter curvatae 5–6 mm longae 1.5–1.7 mm latae c. 8-costatae adpresse albopuberulae. Pappi setae copiosae albae barbellatae caducae.

A vigorous erect glabrous moderately branched shrub ca. 1–2.2 m high; branches densely leafy towards the tips, becoming nude and marked with scale-like remains of leaf-bases. *Leaves* alternate, sessile, erecto-patent to spreading, sessile, narrowly oblong-obovate, cuneate towards the base,

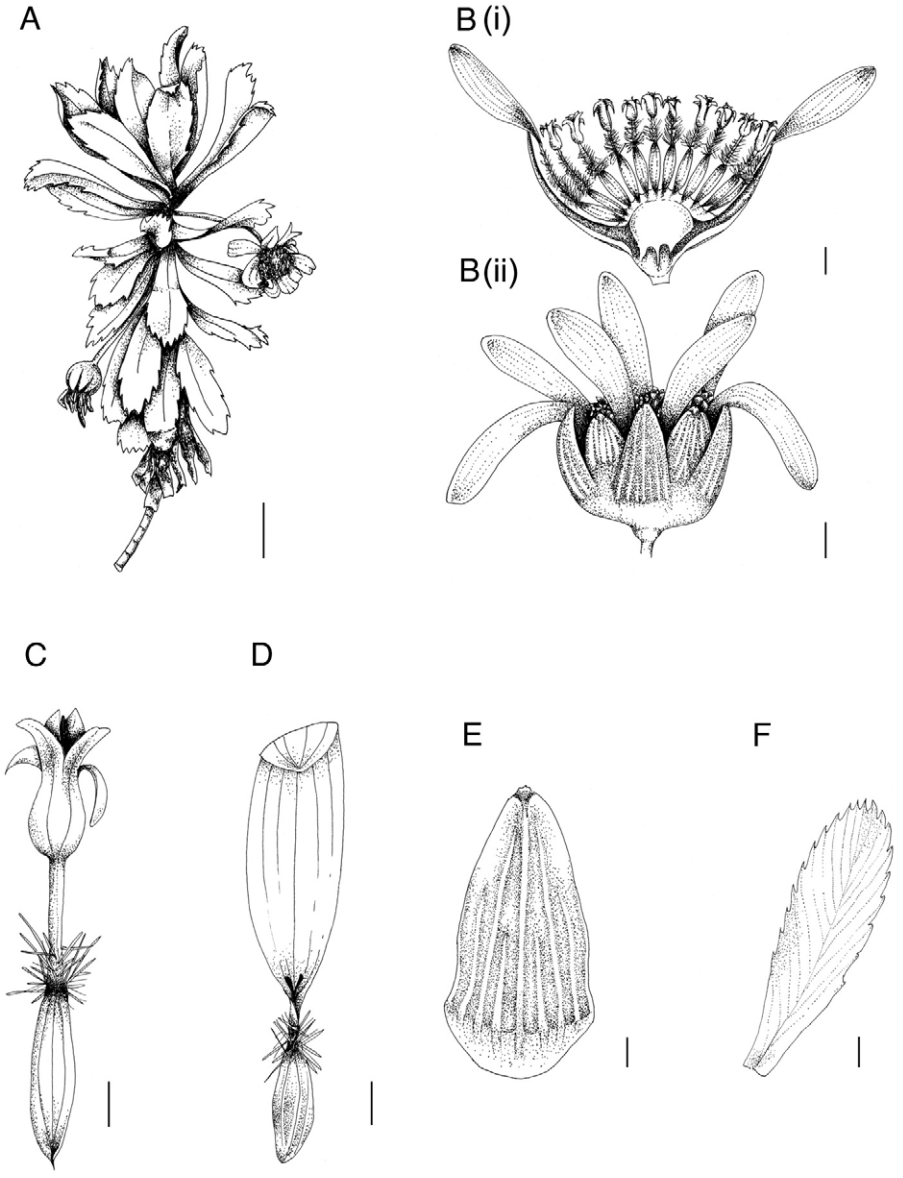

Fig. 3. *Euryops proteoides*, drawn from the type collection. (A) flowering portion of stem; (B) capitulum, cross-section (i), and exterior (ii); (C) disc-floret; (D) ray-floret; (E) involucral bract; (F) leaf, adaxial surface. Scale bar: (A) 23 cm; (B) (i) & (ii) 50 mm; (C) 1 mm; (D) 2.3 mm; (E) 1 mm; (F) 5 mm. Del. L. de Wet; graphics S. Abraham.

3–6 cm long, 1–1.5 cm wide, flat, somewhat coriaceous, greyish green, closely pinnately many-veined with subparallel fine veins, entire but distally 9–12-toothed; teeth ovate, 1–2 mm long, acute or acuminate; leaf-base half-clasping. *Capitula* solitary or few, terminal, radiate, honey-scented. *Peduncle* terminal, nude, simple, equalling the leaves in length or somewhat shorter. *Involucre* broadly campanulate or hemispherical, 2–2.5 cm wide; *involucral bracts* 9–13, subuniseriate, 10–15 mm long, 4–5 mm wide, connate to approximately the middle, glabrous, many (7–9)-veined; the free lobes ovate-triangular, acute. *Receptacle* convex, nude, minutely alveolate. *Ray-florets* 14–19. *Corolla* yellow; tube cylindrical, 2.5–3 mm long; lamina narrowly oblong-oblanceolate, 14–18 mm long, 3.5–4.5 mm wide, 4–5-veined. *Style* branches narrowly oblong, ca. 1 mm long, with distinctly separated stigmatic areas. *Disc-florets* numerous. *Corolla* yellow, 6.5 mm long; tube 3–3.5 mm long, cylindrical; limb campanulate, 3–3.5 mm long; lobes narrowly ovate, 1.5 mm long, mid-lined and with marginal veins. *Anthers* 2.5 mm long incl. the triangular-ovate apical appendage; base ecaudate, slightly sagittate; filament collar oblong, short. *Style* branches narrowly oblong, ca. 1 mm long, with separated stigmatic areas, apically convex and with lateral sweeping-hairs. *Cypselas* narrowly elliptic-oblong, sometimes somewhat triquetrous or curved, 5–6 mm long, 1.5–2 mm wide, ca. 8-ribbed, greyish brown, puberulous with appressed papilliform white obtuse hairs. *Pappus* bristles copious, 4–5 mm long, white, barbellate, caducous. (Fig. 3; Plate 1).

The new species is a locally prolific endemic on the Tandjiesberg-Coetzeesberg section of the Sneeuberg, behind the town of Pearston, and on the mountains above the old town of Petersburg (now in the Asante Sana Private Game Reserve, Graaff-Reinet District; Fig. 4). The species occurs on moist south-facing escarpment slopes and below cliff-lines above 1900 m, and along drainage lines from 1200–2000 m. It has a short flowering period confined almost completely to October. The species is named for its superficial resemblance to a *Protea* (Proteaceae) shrub from a distance. Young plants and seedlings transplant easily, and this together with its large showy, capitula suggests this species could be of horticultural interest. A number of plants are being successfully cultivated at Rhodes University.

3.2.2. Further Collections

Eastern Cape Province: 3225AC, Farm 360, on the mountains behind the old town of Petersburg (now in Asante Sana Private Game Reserve) Graaff-Reinet District, Sneeuberg. 32°15′11″S 25°00′00″E, 2014 m, 6 December 2005, *Clark VR, Coombs G 105* (GRA, S). Eastern Cape Province: 3225AC, Farm Waterkloof 2, "Tandjiesberg-Coetzeesberg" section of Sneeuberg behind Pearston, Graaff-Reinet District, 32°17′56″S 25°04′37″E, 1300–2000 m, 12 December 2006, *Clark VR, Coombs G 553* (GRA). Eastern Cape Province: 3224BB, Sneeuberg, Farm 356 & Farm Upper Waterkloof 352, Waterkloof, in the mountains behind the old town of Petersburg (now Asante Sana Private Game Reserve), Graaff-Reinet District, 32°14′54″S 24°56′48″E, 1674–1919 m, 2 April 2008, *Clark VR, Crause I 38, 40, 55* (GRA). Eastern Cape Province: 3225AC, Farm 360, Sneeuberg, on the mountains behind the old town of Petersburg (now in Asante Sana Private Game Reserve), Graaff-Reinet District, 32°15′11″S 25°00′00″E, 2014 m, 6 October 2008, *Clark VR, Coombs G 700* (BOL, GRA, K, MO, NBG, NSW, PRE, S).

4. Phylogenetic relationships and biogeography

The discovery of these two new *Euryops* species further supports the importance of the Sneeuberg (and indeed the Great Escarpment as a whole) as a centre of diversity for South African Asteraceae (Koekemoer, 1996), and for *Euryops* in particular (Nordenstam, 1969). Nordenstam (1969) reported a total of 16 species from the Sneeuberg and the adjacent Great Winterberg-Amatola and Stormberg mountains and designated these mountains as the "Sneeuwbergen Centre" of endemism. With the two new species, no less than 18 species of *Euryops* (18% of the genus) are known from this phytogeographically significant centre. The inclusion here of a preliminary phylogenetic analysis based on one molecular marker provides an opportunity to expand on previous work on the phylogeny of the genus (Devos et al., submitted for publication) and examine the affinities of taxa from the Sneeuberg centre.

On the basis of its morphology, *E. exsudans* belongs in sect. *Angustifoliae* B.Nord. (Nordenstam 1968a) and features such as its habit and leaf-shape suggest affinities to some mainly Eastern Cape species such as *E. algoënsis* DC., *E. virgineus* (L.f.) DC. and *E. latifolius* B.Nord. All of these have glabrous peduncles and involucres and lack the copious and foetid surface resin characteristic of *E. exsudans*. The 50% majority rule consensus of the trees recovered by the Bayesian analysis of the ITS data

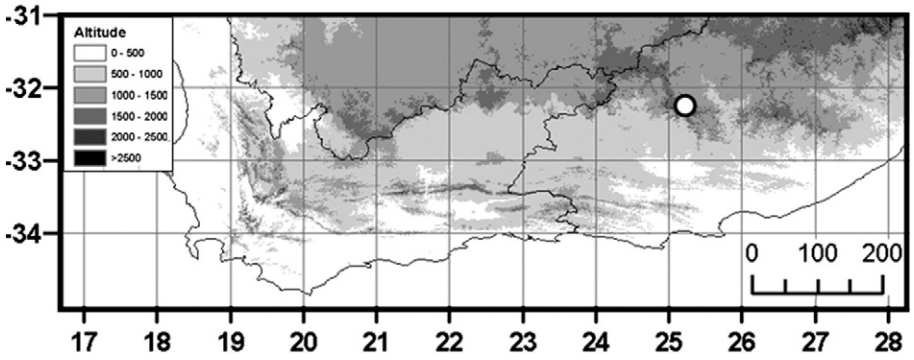

Fig. 4. Distribution of *Euryops proteoides* (scale bar in km); altitude in metres; grid represents latitude and longitude.

Fig. 5. Fifty percent majority-rule consensus of the 1500 trees (burn-in removed) sampled by a Bayesian analysis of *Euryops* ITS sequences using a GTR model of nucleotide evolution with gamma distribution to model within-matrix rate heterogeneity. Branch lengths were averaged over the whole sample of trees. Numbers above branches correspond to their posterior probabilities. *E. exsudans* & *E. proteoides* are in bold.

places *E. exsudans* in a well supported sister relationship with *E. galpinii* Bol. (Fig. 5). This relationship is not corroborated by morphology, since the latter species belongs to sect. *Brachypus* B.Nord., characterized by terminal and sessile or shortly pedunculate capitula with much connate involucral bracts (Nordenstam, 1968a), However, an affinity with *E. galpinii* makes some biogeographic sense, as *E. galpinii* is found in the Sneeuberg, Amatolas and Winterberg mountains, and is thus a component of Nordenstam's "Sneeuwbergen Centre" of endemism (Nordenstam, 1969).

From a morphological perspective, *E. proteoides* fits in section *Chrysops* B.Nord. (Nordenstam, 1968a). In habit and vegetative and floral morphology it comes closest to *Euryops evansii* Schltr, which is a characteristic shrub of the upper montane regions of the Drakensberg and Lesotho Highlands. The leaf dentation easily separates the two species: in *E. proteoides* the teeth number about ten or more, and in *E. evansii* only three or four. The molecular data places *E. proteoides* basal to a clade comprising *E. hebecarpus* (DC.) B.Nord., *E. tenuissimus* (L.) DC. and *E. linifolius* (L.) DC. (Fig. 5) which are all Western Cape taxa. However, this relationship is very poorly supported, and these four species belong to three different sections in Nordenstam's infrageneric taxonomy (Nordenstam, 1968a). This whole clade is sister to *E. evansii* (although again with no support), suggesting that there is some agreement with the morphology-based classification. This also indicates that *E. proteoides* may have links to taxa from the Drakensberg and Lesotho Highlands. However, other species identified by Nordenstam (1969) as being "Sneeuwbergen" endemics (e.g. *E. trilobus* Harv. and *E. galpinii*), having Sneeuberg–Drakensberg ranges (e.g. *E. annae* and *E. candollei* Harv.), or having Sneeuberg–Cape Floristic Region montane ranges (e.g. *E. spathaceus* DC. and *E. anthemoides* B.Nord.) are scattered throughout the phylogeny, suggesting that the diversity in the Sneeuberg is a consequence of species accumulation, rather than in situ diversification. A detailed study of this genus may shed more light on the role the Great Escarpment has played in harbouring species diversity, as well as in acting as a migration route for montane taxa.

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