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Drosera xerophila (*Droseraceae*), a new species from Overberg District, South Africa, and an overview of the rosetted hemicryptophyte sundew species from Western Cape Province

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Abstract: *Drosera xerophila* A. Fleischm., a new species of sundew from Overberg District, Western Cape Province, South Africa, is described and illustrated together with details on its distribution, ecology, habitats and conservation status. The new species is morphologically compared with presumably closely related taxa. An identification key and synopsis are provided for all rosetted hemicryptophyte (”perennially growing”) *Drosera* species of the SW part of Western Cape Province, with synonymy, types, distribution (including maps) and citation of specimens and georeferenced photographs. The names *D. aliciae* Raym.-Hamet, *D. curviscapa* T. M. Salter and *D. curviscapa* var. *esterhuyseniae* T. M. Salter are lectotypified.

Key words: carnivorous plants, *Drosera*, *Droseraceae*, Fernkloof Nature Reserve, fynbos, new species, nomenclature, Overberg District, South Africa, sundew, taxonomy, typification, Western Cape Province

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Introduction

The genus *Drosera* L. (*Droseraceae*, *Nepenthales* or noncore *Caryophyllales*) comprises c. 250 species of carnivorous herbs commonly referred to as sundews, which catch small invertebrate prey by means of adhesive flypaper traps formed by their tentacle-bearing leaves. There are four centres of species diversity (hosting more than 20 species) in the genus, which are all situated in the S hemisphere: the SW part of Western Australia, tropical N Australia, the SC Brazilian highlands and the Cape Floristic Region of South Africa. With the exception of tropical N Australia, these *Drosera* diversity hotspots lie in Mediterranean or subtropical climates, and are found in open, low shrubby vegetation over nutrient poor, usually sandstone-based, acidic soils (Fleischmann & al. 2018).

The mountain ranges of the Overberg District, Western Cape Province, South Africa, which range from Franschhoek to Kleinmond (covering Hottentots Holland Mountains and Kogelberg Mountains) host the highest plant biodiversity and highest number of species endemism of the Cape Floristic Region, in a unique but threatened vegetation type referred to as the Kogelberg Sandstone Fynbos (Rebelo & al. 2006; Mucina & Rutherford 2006). These mountains are also the centre of diversity of the genus *Drosera* in the Cape, with at least 14 species, of which four are endemic to the region. A floristically very similar vegetation type within the Fynbos Biome, the Overberg Sand-

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stone Fynbos, is found in the mountains from Bot River in the west to Bredasdorp in the east, including the Babylonstoring Mountains, the Kleinrivier Mountains and Napier Mountain (Rebelo & al. 2006). The Fernkloof Nature Reserve in the Kleinrivier Mountains is particularly rich in *Drosera*: nine species and one natural hybrid have been recorded so far (Gibson & Green 1999). The narrow endemic *D. slackii* Cheek is confined to the Overberg, where it has been recorded from the Kleinrivier (Fernkloof and Phillipskop) and Kogelberg (Palmietriver valley) Mountains (see specimens examined; Bennett & Cheek 1990).

Some confusion arose about a peculiar, conspicuous *Drosera* with bright green, spatulate leaves and contrasting, bright red tentacles that grows on comparatively dry quarzitic soils in the coastal mountains of the Overberg District. These plants have been known for a long time, and have been occasionally collected and photographed, for example from the Fernkloof Nature Reserve near Hermanus (e.g. Gibson 1997, 1998). The name *D. curviscapa* T. M. Salter has long been applied erroneously to these plants. However, close examination of Salter's type material and description (Salter 1940) revealed that his *D. curviscapa* is conspecific with the widespread *D. aliciae* Raym.-Hamet (a name of which Salter was obviously unaware). The description of *D. aliciae* (Hamet 1905, published in September 1905 when that author was 15 years old) only briefly predated Diels's generic treatment for Engler's *Das Pflanzenreich* (Diels 1906, printed in March–June 1906, issued at the end of July 1906) and was probably unknown to Diels until his monograph went to print. Hamet likewise was unaware of Diels's forthcoming monograph (see Hamet 1907), so it is reasonable to assume that both authors did not correspond at the time. Hence, *D. aliciae* was not included in Diels's treatment, which was for long a trusted source of information for contemporary botanists. Note that, in Diels's monograph and prior to that (e.g. Sonder 1859), all flat-rosetted *Drosera* species from the Cape with stipulate, narrowly cuneate to cuneiform leaves had been treated as a single species, *D. cuneifolia* L. f., comprising, apart from *D. cuneifolia*, those species here recognized as *D. admirabilis* Debbert and *D. aliciae*. As a consequence, the name *D. aliciae* had frequently been overlooked in the early 20th century, and the younger, heterotypic synonym *D. curviscapa* had been unknowingly applied to that taxon (e.g. by Salter 1950; Exell & Laundon 1956; Batten & Bokelmann 1966; Taylor 1978). It was not until 1970 (Kress 1970; Obermeyer 1970) that the forgotten name *D. aliciae* was resurrected and became rightly established for the taxon, as first circumscribed by Hamet (1905, 1907), and the previously applied *D. curviscapa* was sunk into its synonymy. Despite this, Salter's name *D. curviscapa* was sometimes still erroneously used in parallel for a notably distinct taxon of drier, quarzitic soils from the Overberg mountains (Debbert 1992; Gibson 1997, 1998; Rivadavia 2000). This sundew turned out to represent a distinctive and as yet unnamed species, which is described as new to science here.

Material and methods

Measurements were taken from dried herbarium specimens from B, BOL, G, K, M, NBG, PRE and WAG (herbarium codes following Thiers (2017+). Information on ecology and habitats was taken from herbarium label data, as well as from personal observations made in situ in the Western Cape in September 2006 (SANBI Flora Research Permit No. AAA005-00064-0028). The maps in Fig. 3 are based on an OpenStreetMap image for the Western Cape retrieved from https://maps-for-free.com (accessed July 2017), colour-adjusted and edited with Adobe Photoshop; distribution data on the maps are from the specimens examined and georeferenced photographs from iSpot Nature (https://www.ispotnature.org, accessed July 2017).

Preparation of herbarium material — Flat-rosetted *Drosera* species with decumbent, cuneate to oblong leaves are among the most taxonomically difficult in the genus regarding species identification (see, e.g., Rivadavia & al. 2014) because diagnostic foliar characters, such as stipule shape and abaxial leaf indumentum, are usually obscured by the compact growth. This is particularly true in pressed herbarium specimens, where the dense, spiral leaf arrangement often does not allow the examination of lower leaf surfaces and the characteristic, membranous stipule adnate to each leaf base. For identification purposes, careful dissection of a single leaf (comprising the entire leaf base including its stipule) from the rosette is recommended for all rosetted *Drosera*, although this can sometimes be difficult in brittle herbarium material. The dried detached leaf material can then be re-softened in boiling water, in order to spread the leaf and stipule for microscopic study, and can be re-pressed afterwards (ideally, the leaf preparation should be returned to the respective herbarium specimen). When collecting fresh material to make herbarium specimens of flat-rosetted *Drosera* species, to facilitate later identification, at least one mature leaf should be pulled from the rosette directly in the field (taking care to remove the entire leaf base with its stipule) and pressed separately with the collected plant. It is recommended to detach at least two leaves from each fresh rosette when preparing herbarium specimens – one to be fixed later to the herbarium sheet showing its adaxial (tentacle-bearing) side, the other showing its abaxial (lower) side.

Results

Drosera xerophila A. Fleischm., **sp. nov.** – Fig. 1, 2, 4A, 5B.

Holotype: South Africa, South Western Region [Western Cape], Caledon Division, NE of Somerset Sneeuwkop [Sneeukop] between Somerset, Sneeuwkop & Guardian, 3000–3500 ft [915–1067 m], sandy slopes, 6 Jan 1944, *Esterhuysen 9802b* (BOL201166! [4 plants marked "b"; Fig. 5B]).

Diagnosis — Related to *Drosera esterhuyseniae* (T. M. Salter) Debbert, but differs from that species in having broadly spatulate, decumbent, rosette leaves (leaves narrowly cuneate to rectangular, held upright at an angle of 70°–30°) and glabrous, emarginate to bifid stigmatic tips (stigmas entire, knob-shaped, papillate). Resembles *D. aliciae* Raym.-Hamet due to similar flat, rosetted habit and basally ascending inflorescence scape, but differs from that species in having well-pronounced, cuneate, eglandular petioles (3–)5–10 mm long (petiole 1–3(–5) mm long and hence leaves appearing almost sessile ["apetiolate"] in *D. aliciae*), in style arms entire or only shortly bifid in distal ⅓–¼ (style arms forking below middle, usually again bifid or tripartite in distal part) and fusiform seeds without terminal appendages (seeds narrowly fusiform with filiform appendage on micropylar and chalazal end).

Description — Rosetted perennial herb, aged specimens forming column-like, condensed stems to 2 cm tall, densely covered by persistent dead leaves; rosettes of flowering individuals (2–)3–5 cm in diam. (excluding long marginal tentacles). *Roots* terete, dark, sparsely branched. *Leaves* 14–25 mm long (excluding marginal tentacles), bright green to yellowish green with bright red tentacles, leaf vernation geniculate, active leaves 8–14, decumbent, broadly spatulate (rarely nearly cuneate), apex obtuse; *petiole* narrowly cuneiform, (3–)5–10 mm long, c. 1 mm wide at base, gradually widening to 2–3.5 mm, adaxial surface glabrous (sometimes covered with single white, eglandular hairs), lateral margins and abaxial surface densely covered with appressed, upward-facing, straight or only slightly curled, white-translucent, simple, eglandular hairs 2–3.5 mm long, hairs tapering toward acute apex; *lamina* (tentacle-bearing part of leaf) spatulate, orbicular or transversely elliptic, 7–15 long, 2–3.5 mm wide at base, 5–10 mm wide at greatest width, apex rounded, adaxial surface covered with numerous red, carnivorous, capitate, radially symmetrical tentacles, marginal tentacles at leaf apex unifacial, to 0.8(–1) mm long, with ellipsoid gland head and narrowly triangular, flattened stalk, stalk base to 0.05 mm wide; lamina abaxial surface with appressed, simple, white-translucent hairs 0.5–1 mm long; *stipule* very narrowly triangular, 5–6 mm long, c. 1.5 mm wide at base, membranous, translucent white (drying pale brown), basalmost 1–1.5 mm entire, then divided into 3 unequal segments, 2 lateral segments entire, linear-triangular, tapering from c. 0.25 mm wide base to acute apex, 5–6 mm long, subequalling or exceeding median segment in length; median segment narrowly triangular, 3.5–4.5 mm long, c. 1 mm wide at base, apical ⅓ laciniate, divided into 2 or 3 fimbriae. *Scape* 1(or 2); *peduncle* (10–)12–20 cm long (including floriferous part), 1–2 mm in diam. near base, arcuate at very base, terete, reddish, glabrous (single, appressed, white, eglandular hairs on very few basal mm), floriferous part densely covered with small, short-stalked, reddish glands. *Inflorescence* a simple scorpioid cyme, bearing up to 9 flowers, each c. 20 mm in diam., opening consecutively, lasting only one day; *bracts* caducous, 1–3 × 0.1–0.2 mm, narrowly obovate to subulate, glandular pilose; *pedicel* 1–5 mm long at anthesis, to 10 mm long in fruit, sparsely glandular pilose. *Sepals* 3–4 × 1–1.5 mm, basally connate, persistent in fruit, obovate to elliptic, sparsely glandular pilose, apex obtuse to acute; *petals* 10–12 × 8–10 mm, broadly obovate, light pink to violet-pink. *Stamens* 5, c. 4 mm long; *filaments* white, apically strongly dilated; *anthers* 3–4 mm long, bithecate, yellow. *Ovary* 3-carpellate, fused, c. 1 mm in diam., globose, greenish white; *styles* 3, each bifurcate from base, style arms c. 5 mm long (including stigmas), c. 0.2 mm wide, terete, dark pink, sometimes apically bifurcate; *stigmas* obtuse, emarginate or shortly bifurcate, translucent white, stigmatic surface smooth. *Fruit* a dry dehiscent capsule, ellipsoid, 3-valvate. *Seeds* fusiform, without terminal appendages, 1–1.2 mm long; testa black, reticulate.

Phenology — Collected and photographed in both flower and fruit in December and January.

Distribution — *Drosera xerophila* is endemic to the coastal mountains of Overberg District, Western Cape (local municipalities of Overstrand and westernmost part of Theewaterskloof), from Hottentots-Holland Mountains to Kleinmond (Kogelberg Mountains), frequent in the Kleinrivier Mountains near Hermanus and extending eastwards to the Napier Mountains (Soetmuisberg) (Fig. 3). This distribution pattern is shared with the often sympatric, closely related *D. esterhuyseniae* (T. M. Salter) Debbert, which however extends further to the northwest (Babylonstoring, Caledon Swartberg and Franschhoek), from where *D. xerophila* has not yet been recorded. A similar distribution range is shared by the Cape endemic genera *Orothamnus* Pappe ex Hook. (*Proteaceae*), *Pillansia* L. Bolus (*Iridaceae*), *Retzia* Thunb. (*Stilbaceae*) and *Sonderothamnus* R. Dahlgren (*Penaeaceae*) (Rebelo & al. 2006), and by *Otholobium thomii* (Harv.) C. H. Stirt. (*Fabaceae*) (Charles Stirton, pers. comm.).

Ecology and habitats — *Drosera xerophila* grows in Sandstone Fynbos vegetation over Table Mountain Sandstone, on well-drained ground in sandstone gravel, in cracks of sandstone rock, or in sandy soils with little organic matter (Fig. 2A, B).

A few other perennial *Drosera* species of the Western Cape share similar habitat preferences of only slightly moist soils in fynbos habitats, namely the stem-forming species *D. ericgreenii* A. Fleischm. & al., *D. esterhuyseniae*, *D. glabripes* (Harv.) Stein, *D. hilaris* Cham. & Schltdl., *D. ramentacea* Burch. ex Harv. & Sond. and the rosetted *D. cuneifolia* – with *D. esterhuyseniae* and

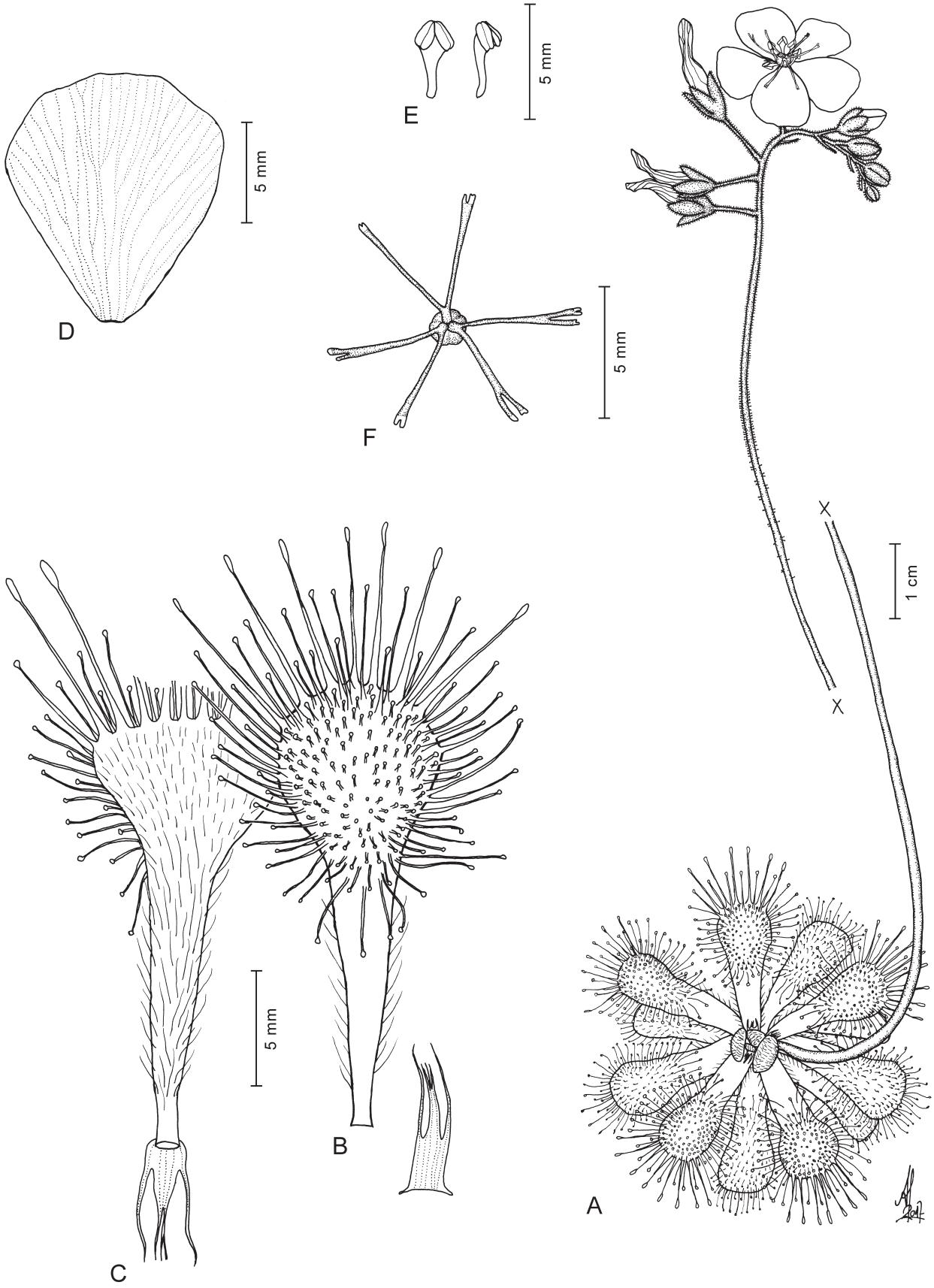

Fig. 1. *Drosera xerophila* – A: habit; B: leaf adaxial surface, stipule detached and pictured to right; C: leaf abaxial surface, stipule reflexed; D: petal; E: stamens, left: face view, right: lateral view; F: gynoecium and styles. – A from *Esterhuysen 9802b*; B–F from *Fleischmann s.n.* – Drawing by A. Fleischmann.

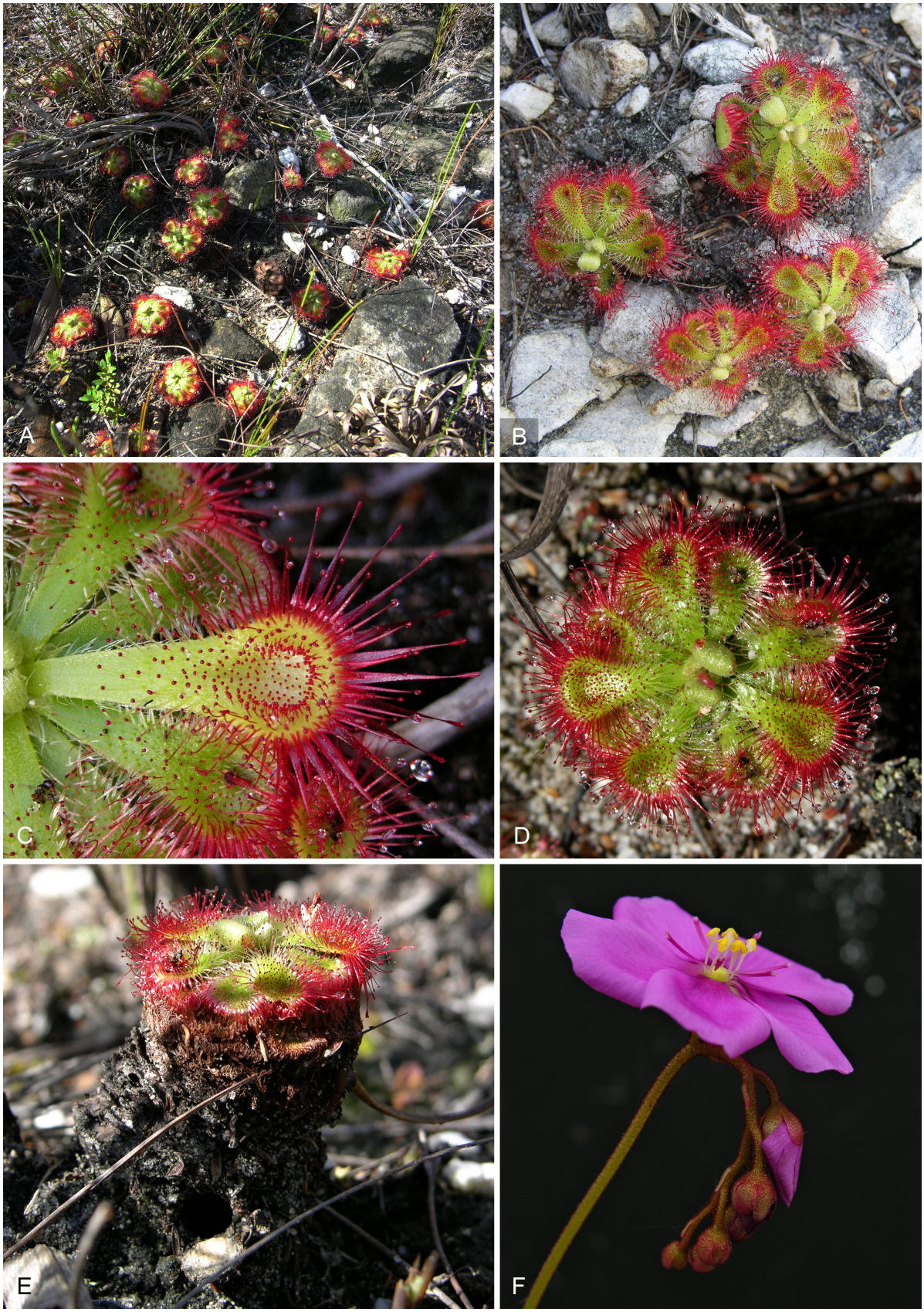

Fig. 2. *Drosera xerophila* – A: habitat in sandy fynbos vegetation in Fernkloof Nature Reserve; B: habit of plants in comparatively dry, quarzitic soil; C: leaf; note long marginal tentacles; D: rosette with developing scape; E: aged specimen with column of old leaf remnants; note burrow of a trapdoor spider in base of stem; F: inflorescence. – A–E: South Africa, Western Cape Province, Fernkloof Nature Reserve, 15 Sep 2006; F: in cultivation; all photographs by A. Fleischmann.

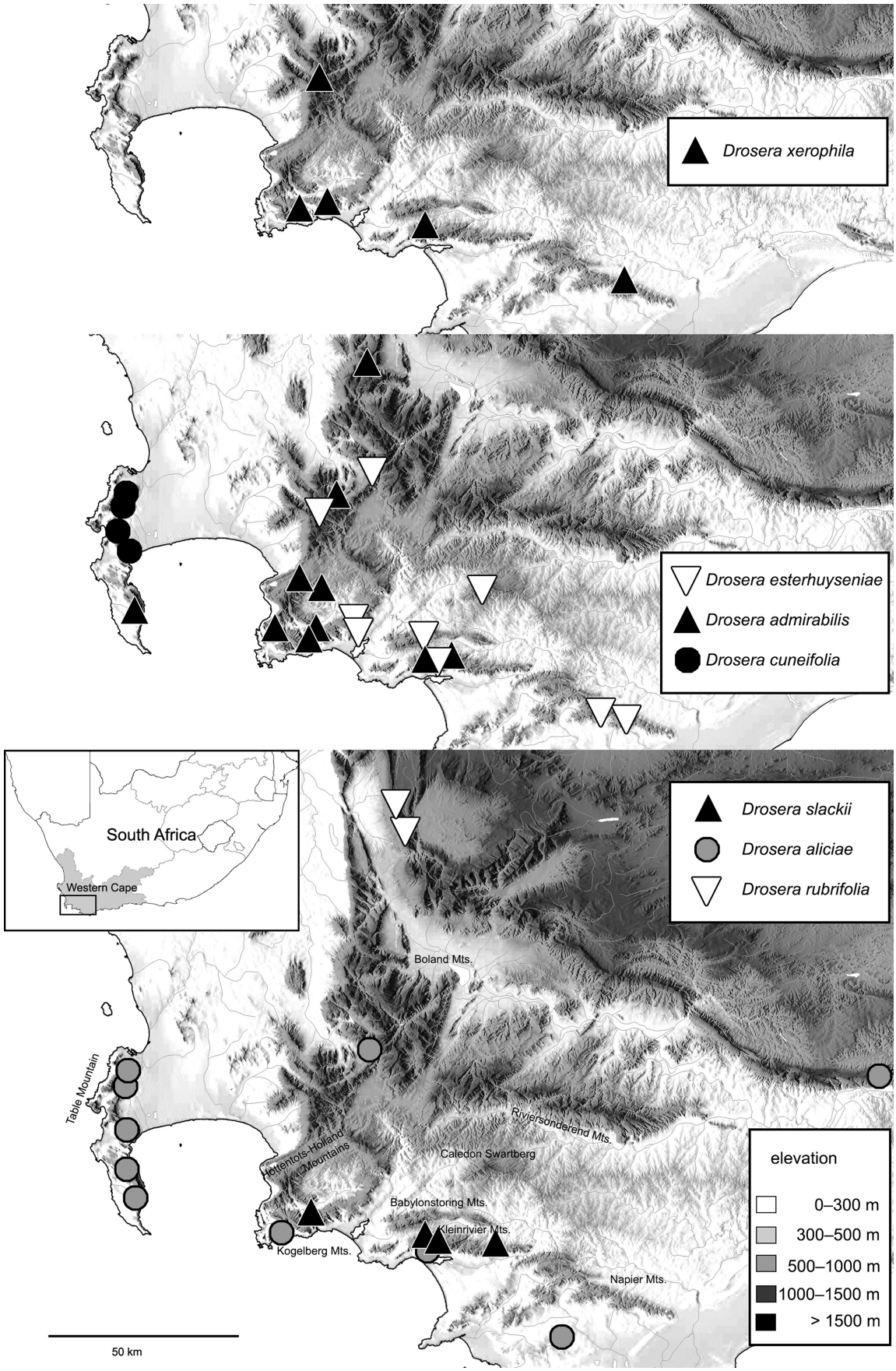

Fig. 3. Distribution of *Drosera xerophila* and related taxa, based on the specimens examined and the georeferenced photographs from iSpot Nature cited in this paper.

D. glabripes often growing together with *D. xerophila*. During the dry season, these species slow down growth and formation of new leaves and, especially in the caulescent species, active leaves often desiccate and the plants survive the dry period as a dormant apical bud (see Fleischmann & al. 2008). Interestingly, none of these species dwelling on drier ground forms adventitious plantlets from the laminae of detached leaves. This mode of asexual propagation is common in those *Drosera* species preferring wetter habitats, such as perennially wet seepage areas in mountain wetlands (e.g. *D. admirabilis*, *D. aliciae*, *D. rubrifolia* Debbert and *D. slackii*). Therefore, the ability of sundews to reproduce asexually from leaves (a feature widely made use of as leaf cuttings by horticulturalists; see, e.g., Slack 1979) could represent an ecological adaptation to wet habitats (and often seasonally flooded conditions), where this mode of vegetative clonal growth also occurs naturally (pers. obs.). However, it is of low use in drier conditions, where soil moisture does not last long enough to establish leaf-derived plantlets, and hence the genetic ability to reproduce asexually from leaves might have been lost. Interestingly, the same is paralleled in Brazilian tetraploid *Drosera*, where wet-growing taxa will reproduce from detached leaves, in contrast to their congeners growing in dry soil (pers. obs.).

Conservation status — Near Threatened (NT), sensu IUCN (2001). Although all known populations lie within the ranges of nature reserves, *Drosera xerophila* occurs in localized and sometimes small populations restricted to a very special habitat. Like most fynbos local endemics, populations can be negatively affected by inappropriate fire regimes (prevention of wildfires or too frequent burning), and human impact on soil hydrology (through drainage or channelling of habitat for urban water supply).

Etymology — The specific epithet denotes the fact that this species prefers to grow on well-drained, drier, only slightly moist ground (*xerophilus* = dry loving). This is not unusual for several species of *Drosera* from Mediterranean areas in the S hemisphere, but contrasts with the "conventional", largely N-hemisphere-based experience of sundews as typical bog plants.

Discussion

Specimens that can be assigned to *Drosera xerophila* were treated under *D. aliciae* by Obermeyer (1970); however, they can be readily distinguished from the latter species as follows. In *D. aliciae*, which also occurs in the Fernkloof valley (but never together with *D. xerophila*, see Ecology and habitats), each of the six style arms is apically further divided into two or three stigmatic tips (vs the six style arms entire [or rarely shortly bifid] in *D. xerophila*; Fig. 1F, 4A, G). The leaves, although of similar overall shape and size in both species, in *D. aliciae* consist of a much longer, cuneate, glandular lamina and a barely noticeable, short petiole 1–3(–5) mm long (hence "tentacles on the entire leaf surface" or "leaves apetiolate"; Fig. 4G). In *D. xerophila*, in contrast, the very broadly spatulate (to cuneate) leaves consist of a more or less orbicular lamina (the glandular part of the leaf), which graduates continuously into a cuneate to narrowly cuneate petiole 5–10 mm long, which is devoid of carnivorous glands and makes up a large part of the leaf (hence "tentacles only in the upper half of the leaf"; Fig. 4A).

Drosera xerophila is closely related to *D. esterhuyseniae*. The close affinity between these two species was first noticed by Debbert (1992), who raised Salter's *D. curviscapa* var. *esterhuyseniae* (Salter 1944) to specific rank, as *D. esterhuyseniae*. However, he was erroneously assuming that Salter's autonymic variety, *D. curviscapa* var. *curviscapa*, was the dry-loving plant described here as *D. xerophila*. Yet Salter (1940) clearly described his *D. curviscapa* as "a marsh species and it is often locally abundant in damp peaty places […]" – habitat preferences that clearly fit *D. aliciae*, as well as the related *D. admirabilis* (Debbert 1987; Gibson 2002; pers. obs.) – and it was just for his "var. *Esterhuysenae* [sic!]" that Salter (1944) noted: "It appears to grow in drier situations than the typical form". From observations made in situ, Gibson (1997, 1998) and others (Eric Green, pers. comm.) were also well aware of these two distinct, rosetted taxa present in the Fernkloof, and depicted two "variants" of what they commonly referred to as *D. curviscapa*, and also highlighted the different ecological preferences of both. However, Gibson's (1998) "*Drosera curviscapa* Hemanus-1" is actually the dry-loving species from sandy soils newly described here as *D. xerophila*, whereas his "*D. curviscapa* Hermanus-2" refers to *D. aliciae*. That *D. aliciae* prefers drier places, as concluded by Bennett & Cheek (1990), could not be confirmed from personal observations in situ or from herbarium label data.

Apart from different habitat preferences, *Drosera aliciae* can be easily distinguished from *D. esterhuyseniae* and *D. xerophila* by floral morphology (the style arms are twice bifid to multifid in the smaller flowers of *D. aliciae*, but undivided to just apically shortly bifid in the latter two species, which also have distinctly larger flowers; Fig. 4A, C, G) and by its seed shape (seeds fusiform, pale brown with a light brown filiform appendage on both the micropylar and chalazal ends in *D. aliciae*, compared to black fusiform seeds without appendages in *D. xerophila* and *D. esterhuyseniae*).

Although they often occur sympatrically and share several taxonomic characters, *Drosera xerophila* and *D. esterhuyseniae* remain stable and morphologically distinct in cultivation and breed true from seed (pers. obs.). Therefore, they cannot simply represent ecologically induced growth forms of the same taxon, and are accordingly treated here as two distinct species.

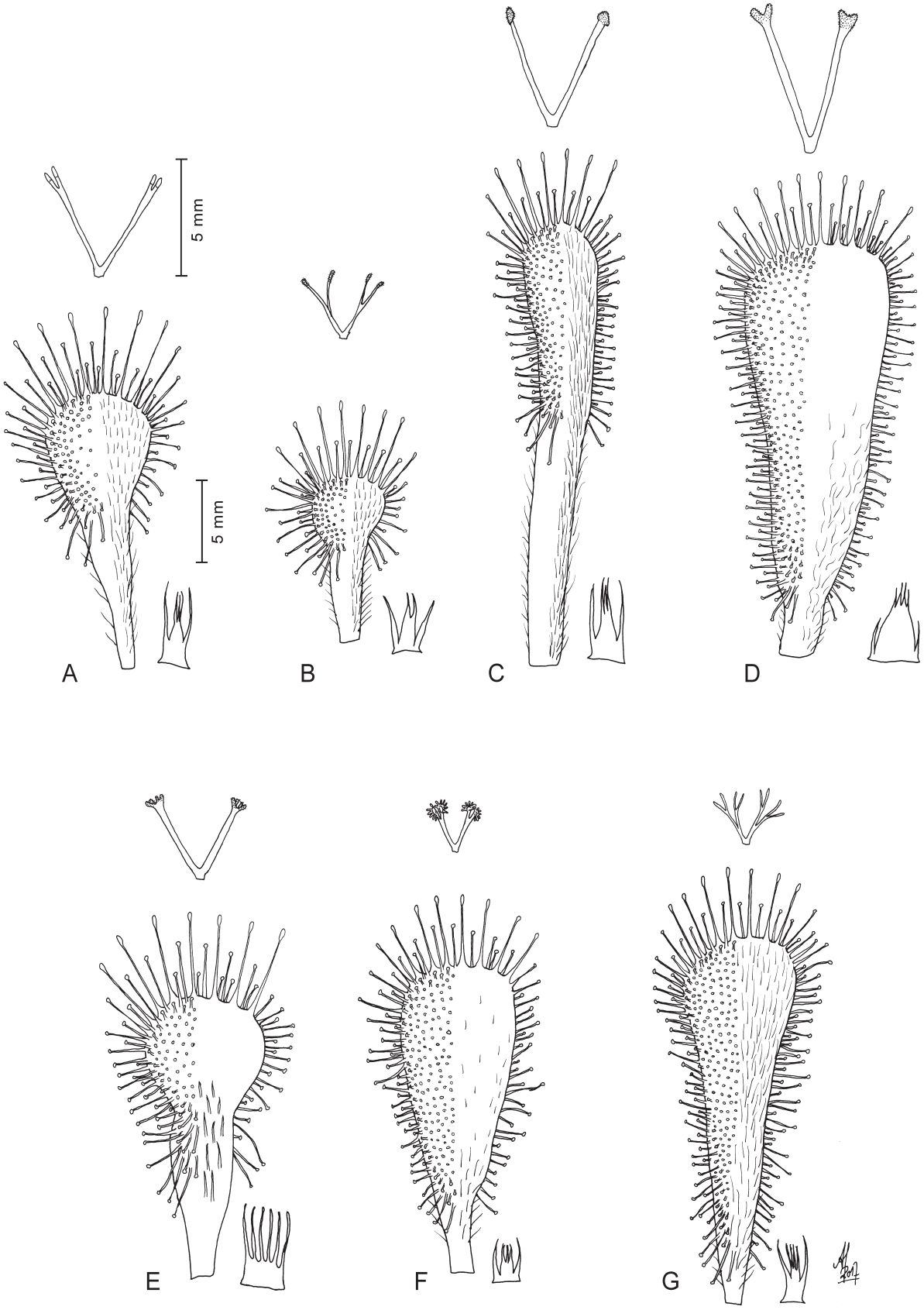

Fig. 4. Comparison of leaves (left half illustrating adaxial surface, right half illustrating abaxial surface) and styles (one of three styles of a flower shown). – A: *Drosera xerophila* (from *Fleischmann s.n.*); B: *D. rubrifolia* (*Debbert 132*); C: *D. esterhuyseniae* (*Debbert 123*); D: *D. cuneifolia* (*Froembling 453*); E: *D. slackii* (*Cheek 2015*); F: *D. admirabilis* (*Debbert 15*); G: *D. aliciae* (*Kress s.n.*). – All at same scale as A. – Drawing by A. Fleischmann.

Fig. 5. A: Lectotype of *Drosera curviscapa* var. *esterhuyseniae* T. M. Salter (≡ *D. esterhuyseniae* (T. M. Salter) Debbert), *Esterhuysen 9802a* (BOL135702). – B: Holotype of *Drosera xerophila* A. Fleischm., *Esterhuysen 9802b* (BOL201166). – Reproduction of herbarium scan with kind permission from Bolus Herbarium (BOL), University of Cape Town, South Africa.

Table 1. Morphological comparison of the rosetted hemicryptophyte *Drosera* species from the Western Cape. Data from herbarium specimens and plants studied in situ.

	D. admirabilis	*D. aliciae*	*D. cuneifolia*	*D. esterhuyseniae*	*D. rubrifolia*	*D. slackii*	*D. xerophila*
leaf shape	obovate to narrowly cuneate, decumbent	narrowly cuneate to narrowly obovate, decumbent	narrowly cuneate, decumbent	narrowly cuneate to rectangular, semi-erect	broadly spatulate, decumbent	pandurate to broadly spatulate, decumbent	broadly spatulate (rarely cuneate), decumbent
petiole length [mm] (= tentacle-free part of leaf)	1–3	1–3(–5)	3–5(–7)	8–15	4–10	(4–)5–10	(3–)5–10
abaxial indumentum of leaf	base covered with appressed, forward-pointing, white, eglandular hairs, apex (sub)glabrous	densely covered with appressed, forward-pointing, white, eglandular hairs	base and margins with woolly, simple, eglandular hairs, apical part (sub)glabrous	densely covered with appressed, forward-pointing, white, eglandular hairs	densely covered with appressed, white, eglandular hairs, at petiole margin hairs patent	glabrous except few red, appressed, thick, eglandular hairs in middle	densely covered with appressed, forward-pointing, white, eglandular hairs
stipule	narrowly triangular, tripartite, lateral setae subequalling median one, papery, translucent white, drying pale brown	narrowly triangular, tripartite, lateral setae subequalling median one, papery, translucent white, drying pale brown	broadly triangular, tripartite, lateral setae much shorter than median one, papery, translucent white, drying brown	narrowly triangular, tripartite, lateral setae subequalling median one, papery, translucent white, drying pale brown	narrowly triangular, tripartite, lateral setae subequalling median one, papery, translucent white, drying pale brown	fleshy, red, drying dark brown, laciniate into 6 or 7 (sub)equal fringes	narrowly triangular, tripartite, lateral setae subequalling median one, papery, translucent white, drying pale brown
inflorescence base	erect to weakly curved	curved	erect	curved	curved	curved	curved
style arms	undivided, rarely single arms weakly bifid	twice bifid, rarely multifid	undivided	undivided	bifid, rarely single arms undivided	undivided	undivided
stigma	flabellate-multifid, glabrous, whitish, pale pink or dark pink	entire, filiform, glabrous, whitish, pale pink or dark pink	spatulate, bilobed or narrowly flabellate, papillate, pale pink to translucent white	entire, knob-shaped[1], papillate, translucent white	entire or shortly bifid, filiform, papillate, pink	shortly bifid or quadrifid, knob-shaped, dilated, papillate, dark pink or translucent white	obtuse, emarginate or shortly bifid, smooth, translucent white
habitat preferences	wet to very wet (waterlogged)	wet to very wet (waterlogged)	slightly moist	slightly moist	wet to very wet (waterlogged)	wet to very wet (waterlogged)	slightly moist

1 Debbert (1992) described the stigma of *Drosera esterhuyseniae* as filiform; however, this was not observed in the type material, nor in the specimen studied by Debbert for his amended description.

Salter's (1944) description of *Drosera curviscapa* var. *esterhuyseniae* was most likely at least partly based on both taxa here recognized as *D. esterhuyseniae* and *D. xerophila*, as is evident from the underlying type gathering, *Esterhuysen 9802*, or at least from the duplicate conserved at BOL, which is a mixture of both species now curated as two specimens mounted together on one herbarium sheet: the eight individual plants of *D. esterhuyseniae* curated as *Esterhuysen 9802a* (BOL135702) and the four plants of *D. xerophila* as *Esterhuysen 9802b* (BOL201166) (Fig. 5). The duplicates at K and PRE exclusively consist of *D. esterhuyseniae*. However, in his description of the vegetative parts and his illustration of the leaf, Salter (1944) clearly depicted *D. esterhuyseniae* (sensu Debbert 1992), a specimen of which is therefore designated here as the lectotype for *D. curviscapa* var. *esterhuyseniae* (see under *D. esterhuyseniae* below). Debbert's amended description and material cited for *D. esterhuyseniae* (Debbert 1992) exclusively refer to that species, and do not include *D. xerophila*.

Drosera aliciae is a widespread species, extending along the S coast into the E part of the Western Cape Province (in the Langeberg Mountains in the north, e.g. *McDonald 1645* [NBG!], east in Knysna District and in the Kammanassie Mountains, Oudtshoorn, e.g. *Matthews 1035* [NBG!]) and even into the W part of the Eastern Cape Province as far as Port Elizabeth [Obermeyer 1970]). All other rosetted *Drosera* species treated here are restricted to the mountains in the W part of the Western Cape (Fig. 3). In the E part of its range, *D. aliciae* is usually white-flowered, and becomes difficult to distinguish from two other, often sympatrically occurring, rosetted *Drosera* species that are more widespread in the Eastern Cape: *D. natalensis* Diels and *D. venusta* Debbert. These three species share similar floral morphology (styles twice bifid to multifid with filiform stigmas), fusiform seed shape, and overall habit, but can be distinguished by the number, orientation and shape of the leaves (see Obermeyer 1970; Debbert 1987). In the Kogelberg and Kleinrivier mountains, individuals of *D. aliciae* are particularly large, with wider leaves and larger flowers, and stylar arms that are often multifid. Considering that *D. aliciae* is known to occur in different ploidy levels (Kress 1970; Bennett & Cheek 1990), these could perhaps represent polyploid populations.

Rosetted hemicryptophyte *Drosera* species from the SW Western Cape (municipalities of Cape Town, Overberg and Cape Winelands)

A key to the stem-forming species was provided by Fleischmann & al. (2008).

1. Stipules lacking or reduced to 2 filiform lateral setae at petiole base; inflorescence scape glandular from base; flowers white, cream, pink, lilac or red [summer-dormant geophyte species, not treated here; a key to this group is in preparation].
– Stipules well present at petiole base (sometimes hidden by superposed petioles), triangular, ± fimbriate or laciniate; scape base (sub)glabrous or with eglandular hairs, but never glandular, only upper part of inflorescence generally glandular; flowers pink or rose **2**
2. Stipules fleshy, red (drying dark brown), divided almost to base into 6 or 7 subulate fringes; leaf abaxial surface glabrous except for several conspicuous, thick, dark red, appressed, eglandular hairs in median part; leaves pandurate to broadly spatulate; leaves blood-red when plants growing exposed to full sun . . . . . **6. *D. slackii***
– Stipules papery, translucent white (drying pale brown); leaf abaxial surface at least at base with dense indumentum of fine, white hairs; leaves narrowly cuneate, narrowly obovate or broadly spatulate; leaves entirely red, yellowish green or green with contrasting red glands **3**
3. Scape ± erect from base; leaf abaxial surface glabrous in apical part, only base with hair cover (white appressed hairs or white, woolly hairs) **4**
– Scape with notably curved base (arcuate base sometimes covered by subsequent leaves toward end of anthesis); leaf abaxial surface with white, appressed hairs all over **5**
4. Leaf abaxial base with white, woolly, patent, eglandular hairs; leaves (15–)20–40 mm long and to 15 mm wide; petiole 3–5(–7) mm long; stipules broadly triangular, lateral setae much shorter than broad median one; petals > 8 mm long; styles ≥ 5 mm long, stigmas spatulate . . . . . **3. *D. cuneifolia***
– Leaf abaxial base with white, appressed, straight, eglandular hairs; leaves 10–20 mm long and to 6 mm wide; petiole 1–3 mm long; stipules narrowly triangular, lateral setae subequalling median one; petals ≤ 8 mm long; styles 2.5–4 mm long, stigmas flabellate-multifid . . . . . **1. *D. admirabilis***
5. Leaves semi-erect, narrowly cuneate to rectangular; stigmas undivided . . . . . **4. *D. esterhuyseniae***
– Leaves decumbent (flat on ground); stigmas undivided or divided **6**
6. Leaves narrowly cuneate to narrowly obovate; petiole (tentacle-free part of leaf) very short, 1–3(–5) mm long; style arms twice bifid or multifid; stigmas filiform . . . . . **2. *D. aliciae***
– Leaves broadly spatulate; petiole (tentacle-free part of leaf) (3–)4–10 mm long; style arms undivided or bifid; stigmas widened or filiform **7**
7. Leaves yellowish green with red tentacles; petals 10–12 mm long; style arms c. 5 mm long, undivided; stigma obtuse, emarginate or shortly bifid, smooth . . . . . **7. *D. xerophila***
– Leaves entirely red; petals 8–9 mm long; style arms 3–4 mm long, bifid; stigma filiform, papillate . . . . . **5. *D. rubrifolia***

1. *Drosera admirabilis* Debbert in Mitt. Bot. Staatssamml. München 23: 431. 1987. – Holotype: "[South Africa], Cape Province, Palmiet River Mountains, cultivated in Bot. Gard., Munich", 25 Jun 1985, *Debbert 15* (M!; isotype: BOL135704!). – Fig. 4F.

Distribution — Endemic to the Western Cape, on coastal and inland mountains: Bainskloof, Hottentots-Holland, Kogelberg and Kleinrivier Mountains, also from a single record on the Cape Peninsula, but apparently absent from the actual Table Mountain plateau (Fig. 3).

Additional specimens examined — Kleinmond, Caledon, Palmiet-R[iver], mouth on level, 31 Jan 1933, *Gillett 616* (K); Caledon, Buffels River Valley, Hangklip, in swamp, 20 Nov 1945, *Barker 3912* (NBG); Caledon, Aries Kraal, 18 Nov 1944, *Barker 3349* (NBG); Hottentots Holland Mts., N of Somerset Sneeukop, bogs r [sic!] streamside, 3 Jan 1944, *Esterhuysen 9714* (BOL); Cape, Cape Peninsula, marsh at Smitswinkel, 15 Jan 1942, *Salter 8726* (BOL); Caledon Div., near coast at Palmiet River mouth, 23 Jan 1946, *Esterhuysen 12593* (K); Cape, Grabouw Distr., 20 Dec 1956, *Strey 2953* (K); Viljoens Pass, 300–400 m, 2 Oct 1958, *Werdermann & Oberdieck 386* (B, K); Kogelberg Forest Reserve, plateau E of Buffelstalberg, marshy flats recently burnt, 1600 ft, 11 Mar 1970, *Oliver s.n.* (M); Vogelgat, on rocks in stream, 3000', 18 Nov 1973, *Carlquist 5001* (MO).

2. *Drosera aliciae* Raym.-Hamet in J. Bot. (Morot) 19(2): 114. 1905. – **Lectotype (designated here):** "[South Africa, Western Cape], Cap de Bonne Espérance [Cape of Good Hope]", *Hamet 2842* (P [P00064805!]; isolectotype: P [P00064806!]). – Fig. 4G.

= *Drosera curviscapa* T. M. Salter in J. S. African Bot. 5: 158. 1940. – **Lectotype (designated here):** "Cape Peninsula, ½ mile north of Smith's Farm", 28 Nov 1939, *Salter 8277* (BOL135700!; isolectotypes: BOL135701!, PRE0386648-0!).

Notes on typification — *Drosera aliciae*: Obermeyer (1970: 192) cited the holotype in BM, but no specimen of Hamet could be found in BM and Hamet's entire herbarium is housed in P. Therefore, Obermeyer's typification can be regarded erroneous, and the specimen of *Hamet 2842* with the collection number in handwriting on the label (P00064805) is designated here as lectotype of *D. aliciae*. The assumption by H. Heine (in handwritten annotation on the type sheet, dated 7 Aug 1985) is incorrect, i.e. that Hamet's original herbarium label was false and that the specimens actually originated from Australia, as indicated in Hamet's protologue ("[...] une nouvelle espèce de *Drosera* provenant de la Nouvelle-Hollande, et portant le n° 2842 de notre herbier [a new species of *Drosera* from New Holland [Australia] and bearing the number 2842 of our herbarium]"; Hamet 1905: 113). The type label is correct but the location given in the introduction of the protologue was evidently wrong, an error that was corrected by Hamet himself in a subsequent publication ("*Dr. Aliciae* R. Hamet, [...] Cap de Bonne-Espérance: n° 2842 [Herbier *Hamet*]", Hamet 1907, p. 53). *Hamet 2842* clearly represents a *Drosera* of South African affinity, not matching any similar-looking rosetted taxa from Australia (e.g. *D. spatulata* Labill.).

Drosera curviscapa: The specimen BOL135700 is designated as the lectotype because Salter's handwritten label includes the annotation "Type", whereas the duplicates at BOL and PRE both bear the annotation "Co. type" in Salter's handwriting. Additionally, BOL135700 comprises richer material than the duplicates, including three fertile plants and an attached envelope with three sterile rosettes plus dissected leaves, the latter directly corresponding to Salter's line drawing in the protologue (Salter 1940).

Distribution — Widespread in South Africa, from the S Western Cape (to the Langeberg in the north) to the Eastern Cape as far as Port Elizabeth (Obermeyer 1970). The Western Cape part of the range of the species is shown in Fig. 3.

Additional specimens examined — Only specimens from the Western Cape are listed. — South Africa: Western Cape Province: Marsh between Constantia Berg [Constantiaberg] and Vlaggeberg [Vlakkenberg], Cape Peninsula, 15 Dec 1895, *Wolley Dod 457* (K); Koude Rivier [Elim], 1000', 15 Dec 1896, *Schlechter 9736* (G, K, MO); Smitswinkel Bay, Jan 1896, *Wolley Dod 759* (K); Clarkson, Cape, Aug–Oct 1926, *Thode A832* (K); Kapkolonie, Frenchhoek [Franschhoek], Dec 1933, *Meebold 11780* (M); Constantiaberg vlei, Cape Peninsula, 2000', 16 Dec 1943, *Compton 15472* and *Compton 15473* (NBG); Red Hill near Beauwood Tearoom, Cape Peninsula, 15 Jan 1949, *van Zinderen Bakker 7* (NBG); Tafelberg, Wetterstation, 700–800 m, 20 Sep 1958, *Werdermann & Oberdieck 2* (B); Cape, 3418BD, Simonstown, Bettys Bay [sic!], in swamp between reserve and sea, in recently burnt swamp, 25 Nov 1970, *Barker 10808* (NBG); Dawid's Kraal, Betty's Bay, natural wet ground near fire belt, 22 Dec 1970, *Ebersohn 227* (NBG); Fern Kloof Nature Reserve, Hermanus, level open swampy site, 50 m, 5 Dec 1975, *Orchard 345* (K, MO, NBG, WAG); Fernkloof Nature Reserve, Hermanus, 400 m, open wet peaty site, 21 Jan 1981, *Orchard 585* (MO, WAG); S end of the Tradouw Pass, 10 km S of Barrydale, 370–400 m, wet to marshy finbos [sic!] slopes, sandy ground on sandstone, 22 Oct 1989, *Greuter 22123* (B); Table Mountain National Park, Back Table, road to huts, mountain fynbos, 647 m, 22 Jan 2008, *Cowell & al. MSBP3630* (NBG, K).

3. *Drosera cuneifolia* L. f., Suppl. Pl.: 188. 1782 ≡ *Drosera cuneifolia* Thunb., Prodr. Pl. Cap. 1: 57. 1794 [isonym]. – Lectotype (designated by Obermeyer 1970: 194):

"*Drosera cuneifolia*", "C.B.S. [Caput Bonae Spei]", "T. [Thunberg]", *Thunberg s.n.*, Herb. Linnaeus No. 398.1 (LINN!). – Fig. 4D.

Distribution — Western Cape, endemic to Table Mountain and surroundings (Fig. 3).

Additional specimens examined — Table Mountain, ex Herb. L. Kitching, Jul 1880, *s.n.* (K); Tafelberg, 800–1150 m, 1894, *Kuntze s.n.* (K); Muizenberg, Hall Bay CP, 1000–2000', Dec 1886, *Thode 9388* (NBG); marsh between Vlaggeberg [Vlakkenberg] and Constantiaberg, 15 Dec 1895, *Wolley Dod 263* (K); Table Mountain plateau, near reservoir, 12 Dec 1897, *Froembling 453* (NBG); Plateau des Tafelberges, 29 Oct 1913, *Peter s.n.* (B, M); Table Mt., lower plateau, Cape Peninsula, Jan 1940, *Esterhuysen s.n.* (K); Table Mountain, elevation 3000 feet, 2 Jan 1948, *Rodin 3206* (K).

4. *Drosera esterhuyseniae* (T. M. Salter) Debbert in Mitt. Bot. Staatssamml. München 30: 373. 1992 ≡ *Drosera curviscapa* var. *esterhuyseniae* T. M. Salter in J. S. African Bot. 10: 60. 1944. – **Lectotype (designated here):** South Africa, South Western Region [Western Cape], Caledon Division, NE of Somerset Sneeuwkop [Sneeukop] between Somerset, Sneeuwkop & Guardian, 3000–3500 ft [915–1067 m], sandy slopes, 6 Jan 1944, *Esterhuysen 9802a* (BOL135702! [8 plants marked "a"; Fig. 5A]; isolectotypes: K!, PRE0386647-0!). – Fig. 4C.

Note on typification — This specimen is designated as the lectotype because it includes a fertile plant with a well-spread open flower, matching the descriptions of Salter (1944) and Debbert (1992) in all characters.

Distribution — Endemic to the Western Cape, from Hottentots-Holland Mountains to Franschhoek and Caledon Swartberg (Fig. 3).

Additional specimens examined — Cape Province, Swartberg bei Caledon, auf trockenen sandigen Hängen, c. 1000 m, Dec 1991, *Debbert 123* (M) and *Debbert 122* (B); Kapkolonie, Frenchhoek [Franschhoek], Dec 1933, *Meebold 11779* (M); Kleinmond, Kogelberg State Forest, on rocky ridge facing Dwarsrivierberg, 300 m, 11 Oct 1991, *Vlok & al. 69* (MO); du cap de Bon Esperance [from the Cape of Good Hope, no exact locality given, but certainly not directly from the Cape Peninsula, where this species is not known to occur], without date, *Commerson s.n.* (G) [This certainly constitutes the oldest collection of this taxon, from the late 18th century. Commerson accompanied Bougainville's voyage around the world, but there is no evidence that Commerson himself ever entered the Cape. Some of the specimens assigned to him are known to have been mixed up with those collected by his contemporary Sonnerat, who botanized the Cape in 1773 and 1781 (Gunn & Codd 1981)].

Georeferenced photographs (from iSpot Nature) — Napier Mountain, 29 Sep 2012 (*Charles Stirton*); Babilonstoring ascent above Moreson, 8 Oct 2011 (*Tony Rebelo*); Vogelgat, 24 Nov 2016 (*KlausWehrlin*); Hottentotts Holland Nature Reserve; Paardeberg Trail, N leg of loop (without date or photographer).

5. *Drosera rubrifolia* Debbert in Linzer Biol. Beitr. 34: 798. 2002. – Holotype: "Cape Province, in den Bergen bei Ceres [in the mountains near Ceres]", without date, *Debbert 132* (M-0265424!). – Fig. 4B.

Distribution — Endemic to the Western Cape. So far known only from occasional records near the town of Ceres (Fig. 3), where the plants occur in permanently moist places along mountain streams (Eric Green, pers. comm.).

Additional specimen examined — Bo[o]ntjiesrivier, 3000' [c. 915 m], 5 Nov 1829, *Drège 7260* (P).

6. *Drosera slackii* Cheek in Kew Bull. 42: 738. 1987. – Holotype: "Kleinriviersberge Mts, at edge of mt. Stream, 500–700 m, cultivated", Apr 1987, *Cheek 2015* (K [photo in M!]). – Fig. 4E.

Distribution — Western Cape, endemic to coastal mountains of the Overberg District. So far recorded only from a few localities in the Kleinrivier and Kogelberg Mountains (Fig. 3).

Additional specimen examined — Kogelberg Forest Reserve, damp sandy soil, 600', 23 Oct 1969, *Boucher 819* (NBG).

Georeferenced photographs (from iSpot Nature) — Phillipskop Mountain Reserve, 8 Feb 2017 (*Christopher Whitehouse*); White Rock on Galpin Hut trail, 21 May 2016 (*Tony Rebelo*).

7. *Drosera xerophila* A. Fleischm. — Fig. 1, 2, 4A.

Additional specimens examined — Caledon, Hermanus, Jan 1920, *Burtt-Davy 18489* (BOL); without locality, plant wild-collected in 1990s by P. Debbert and cultivated in Munich Botanical Garden, specimen without date, *Fleischmann s.n.* (M).

Georeferenced photographs (from iSpot Nature) — Fernkloof, Hermanus, 9 Oct 2014 (*Sandra F*), 10 Jun 2017 (*Stevo*); R44, Kleinmond, 13 Jun 2012 (*PatrickMeyer*);

Kogelberg below Three Sisters, 20 Oct 2013 (*MoMo*); Kloof Road, 15 Jan 2014 (*Paul H*); Highlands trail, Kogelberg, 19 Feb 2016 (*magrietb*); Bosch Hoek, 8 Oct 2011, (*Nicky vB*).

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References

Batten A. & Bokelmann H. 1966: Wild flowers of the Eastern Cape Province. – Cape Town: Books of Africa.

Bennett S. T. & Cheek M. 1990: The cytology and morphology of *Drosera slackii* and its relatives in South Africa. – Kew Bull. **45:** 375–381.

Debbert P. 1987: Zwei neue *Drosera*-Arten aus der Kap-Provinz, Südafrika. – Mitt. Bot. Staatssamml. München **23:** 431–436.

Debbert P. 1992 [“1991”]: Einige neue Arten der Gattungen *Drosera* (*Droseraceae*) und *Pinguicula* (*Lentibulariaceae*). – Mitt. Bot. Staatssamml. München **30:** 373–380.

Diels L. 1906: *Droseraceae*. – In: Engler A. (ed.), Das Pflanzenreich. Regni vegetabilis conspectus **IV. 112** (Heft **26**). – Leipzig: Wilhelm Engelmann.

Exell A. W. & Laundon J. R. 1956: New and noteworthy species of *Drosera* from Africa and Madagascar. – Bol. Soc. Brot., ser. 2, **30:** 213–220.

Fleischmann A., Cross A. T., Gibson R., Gonella P. M. & Dixon K. W. 2018: Systematics and evolution of *Droseraceae*. – Pp. 45–57 in: Ellison A. M. & Adamec L. (ed.), Carnivorous plants: physiology, ecology, and evolution. – Oxford: Oxford University Press.

Fleischmann A., Gibson R. & Rivadavia F. 2008: *Drosera ericgreenii* (*Droseraceae*), a new species from the fynbos of South Africa. – Bothalia **38:** 141–144.

Gibson R. 1997: Cape Town adventures. – Bull. Austral. Carniv. Pl. Soc. **16:** 3–14.

Gibson R. 1998: Adventures au Cap: Observations d’une sélection de plantes carnivores du Sud de l’Afrique (2ème partie). – Dionée **40:** 2–10.

Gibson R. 2002: *Drosera cuneifolia* and *D. admirabilis*: two rosetted sundews from the Cape Province, South Africa. – Carniv. Pl. Newslett. **31:** 100–107.

Gibson R. & Green E. 1999: *Drosera* × *corinthiaca* (*Droseraceae*), a newly recognized natural hybrid from the Cape Province, South Africa. – Carniv. Pl. Newslett. **28:** 81–84.

Gunn M. & Codd L. E. 1981: Botanical exploration of southern Africa. – Pretoria: Botanical Research Institute.

Hamet R. 1905: Note sur une nouvelle espèce de *Drosera*. – J. Bot. (Morot) **19(2):** 113–114.

Hamet R. 1907: Observations sur le genre *Drosera*. – Bull. Soc. Bot. France **54:** 26–38, 52–76.

Kress A. 1970: Zytotaxonomische Untersuchungen an einigen Insektenfängern (*Droseraceae*, *Byblidaceae*, *Cephalotaceae*, *Roridulaceae*, *Sarraceniaceae*). – Ber. Deutsch. Bot. Ges. **83:** 55–62.

Mucina L. & Rutherford M. C. 2006: The vegetation of South Africa, Lesotho and Swaziland. – Pretoria: SANBI.

Obermeyer A. A. 1970: *Droseraceae*. – Pp. 187–201 in: Codd L. E., De Winter B., Killick D. J. B & Rycroft H. B. (ed.), Flora of southern Africa **13.** – Pretoria: Department of Agricultural Technical Services.

Rebelo A. G., Boucher C., Helme N., Mucina L. & Rutherford M. C. 2006: Fynbos biome. – Strelitzia **19:** 52–219.

Rivadavia F. 2000: Endless carnivorous plants in Cape Town, South Africa. – Carniv. Pl. Newslett. **29:** 42–45.

Rivadavia F., Gonella P. M., Sano P. T. & Fleischmann A. 2014: Elucidating the controversial *Drosera montana* complex (*Droseraceae*): a taxonomic revision. – Phytotaxa **172:** 141–175.

Salter T. M. 1940 [“1939”]: Notes on some of the species of *Drosera* occurring in the Cape Peninsula, including the new species *D. glabripes* (Harv.) Salter and *D. curviscapa* Salter. – J. S. African Bot. **5:** 157–161.

Salter T. M. 1944: *Drosera curviscapa* Salter, var. *Esterhuysenae* Salter, var. nov. – In: Leighton F. M. & Salter T. M., Plantae novae africanae. Series XXII. – J. S. African Bot. **10:** 60.

Salter T. M. 1950: *Droseraceae* DC. – Pp. 425–428 in: Adamson R. S. & Salter T. M. (ed.), Flora of the Cape Peninsula. – Cape Town and Johannesburg: Juta & Co. Ltd.

Slack A. 1979: Carnivorous plants. – London: Ebury Press.

Sonder O. W. 1859: *Droseraceae*. – Pp. 75–79 in: Harvey W. H. & Sonder O. W. (ed.), Flora capensis **1.** – Dublin: Hodges, Smith and Co.; Capetown: A. S. Robertson.

Taylor H. C. 1978: Capensis. – Pp. 171–230 in: Werger M. J. A. & van Bruggen A. C. (ed.), Biogeography and ecology of southern Africa. – The Hague: Dr. W. Junk.

Thiers B. 2017+ [continuously updated]: Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. – Published at http://sweetgum.nybg.org/science/ih/ [accessed Jul 2017].

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