

PEDALIACEAE

DEWINTERIA, A NEW SEMISUCCULENT, CLIFF-DWELLING GENUS ENDEMIC TO THE KAOKOVELD, NAMIBIA

While studying cremophilous plants in the northern Namib Desert (Kaokoveld), Namibia, specimens of the hitherto poorly known *Rogeria petrophila* De Winter, a small, herbaceous and semisucculent chasmo-cremno-phyte, were collected in July 2002 and January 2005. This enabled us to record, for the first time, the reproductive behaviour of the species in its natural cliff-face habitat, and to collect ample sterile and reproductive material for a comparative morphological study. A re-evaluation of the taxonomic position of the species was considered necessary in the light of its unique dimorphic fruiting capsules, texture and morphology of the seeds and specialized filiform basal branches by which it differs markedly from the other three species of *Rogeria*. We concluded that *R. petrophila* warrants separate generic status and it is here formally described as a new monotypic genus.

Dewinteria *Van Jaarsv. & A.E.van Wyk*, genus novum, *Rogeriae* J.Gay ex Delile affine, sed differt caracteribus sequentibus: *herba* biennis vel perennis, saepius caulibus procumbentibus 100–200 mm longis. *Folia* cordata, margine grosse dentato. *Capsula* 2.0–2.5 mm longa, lateraliter compressa chartacea. *Semina* 2.0–2.2 mm longa, anguste oblonga ad clavata, leviter lateraliter compressa, pagina minuta reticulata. Ad basim rami filiformes 0.25 mm diametri, ad 200 mm longi, ferentes folia integra ovata 2–4 × 0.6–1.7 mm, et flores axillares cleistogamos, 2 mm longos et capsulas complanatas ovatas ad ovato-cordatas 5–8 × 4.0–5.5 mm; semina lineari-obovoidea 2.5–3.0 mm longa.

Type species: *D. petrophila* (De Winter) Van Jaarsv. & A.E.van Wyk.

Rogeria J.Gay ex Delile subgen. *Microrogeria* Ihlenf.: 73 (1967).

Description partly based on De Winter (1961).

Soft, somewhat trailing, branched, biennial or perennial herb, up to 200 mm long; most parts covered with mucilage glands; base of stem slightly swollen, semisucculent, somewhat ovate, up to 5 mm diam., often compressed due to narrow crevices. *Roots* fibrous. *Main branches* 3–4 mm diam. at base. *Specialized branchlets* annual, usually dying back after fruiting, filiform, 0.25 mm diam., basally produced, trailing, negatively phototropic. *Leaves on main branches* opposite (internodes 8–14 mm long), broadly cordate to kidney-shaped, up to 40 × 55 mm, grey-green; margin coarsely dentate; petiole 20–60 mm long; mostly with a paired or single extrafloral nectary in the axil. *Leaves on specialized branchlets* (arise as accessory shoots below the extrafloral nectary and flower) small, 2–4 × 0.6–1.7 mm, entire, ovate; petiole 3–4 mm long, sometimes becoming slightly longer but then leaves becoming broader and coarsely toothed.

Flowers on main branch in axils of leaves, mostly single, rarely in pairs, conspicuous, trumpet-shaped, up to 30–70 mm long; pedicel 1.2–4.0 mm long. *Calyx*

slightly zygomorphic, persistent, 5-partite; lobes oblong-triangular, up to 3 mm long. *Corolla* slightly swollen at base, somewhat 2-lipped, sparsely covered with mucilage glands; cream-coloured (pale yellow in bud stage) and maroon-purple in throat and tube; lobes 5, broadly ovate, emarginate, lower pair slightly larger than upper 3. *Stamens* 4, arising from base of corolla tube, with short staminode between the pairs; filaments filiform, slightly flattened, up to 12 mm long, pilose; anthers basifixed. *Ovary* elongate-conical, 2-chambered, placentation axile, with 3–5-seriate ovules; style up to 23 mm long; stigma capitate, up to 1.5 mm diam. *Cleistogamous flowers on specialized branchlets*, 2 mm long, light yellowish green; pedicels up to 1.5 mm long. *Capsules on main branches* lanceolate in side view, 18–25 mm long, tapering into a curved apex, laterally flattened, dehiscing loculicidally; valves 2, chartaceous. *Specialized capsules* flattened, ovate to ovate-cordate, 5–8 × 4.0–5.5 mm, brown; both carpels dehiscing loculicidally, false septa nearly completely reduced to small seams at base of capsule. *Seeds of main branch capsules* linear-oblong to club-shaped, slightly flattened, 2.0–2.2 mm long, minutely foveate, brownish. *Specialized seeds* oblong-obovoid, slightly flattened, 2.5–3.0 mm long, minutely fringed. Figures 6–8.

The new genus is named in honour of Dr Bernard de Winter, retired Director of the former Botanical Research Institute in Pretoria (now part of the South African National Biodiversity Institute), who collected and described *Rogeria petrophila* and who first mentioned the possibility of fruit dimorphism in this species (De Winter 1961).

The genus includes a single species:

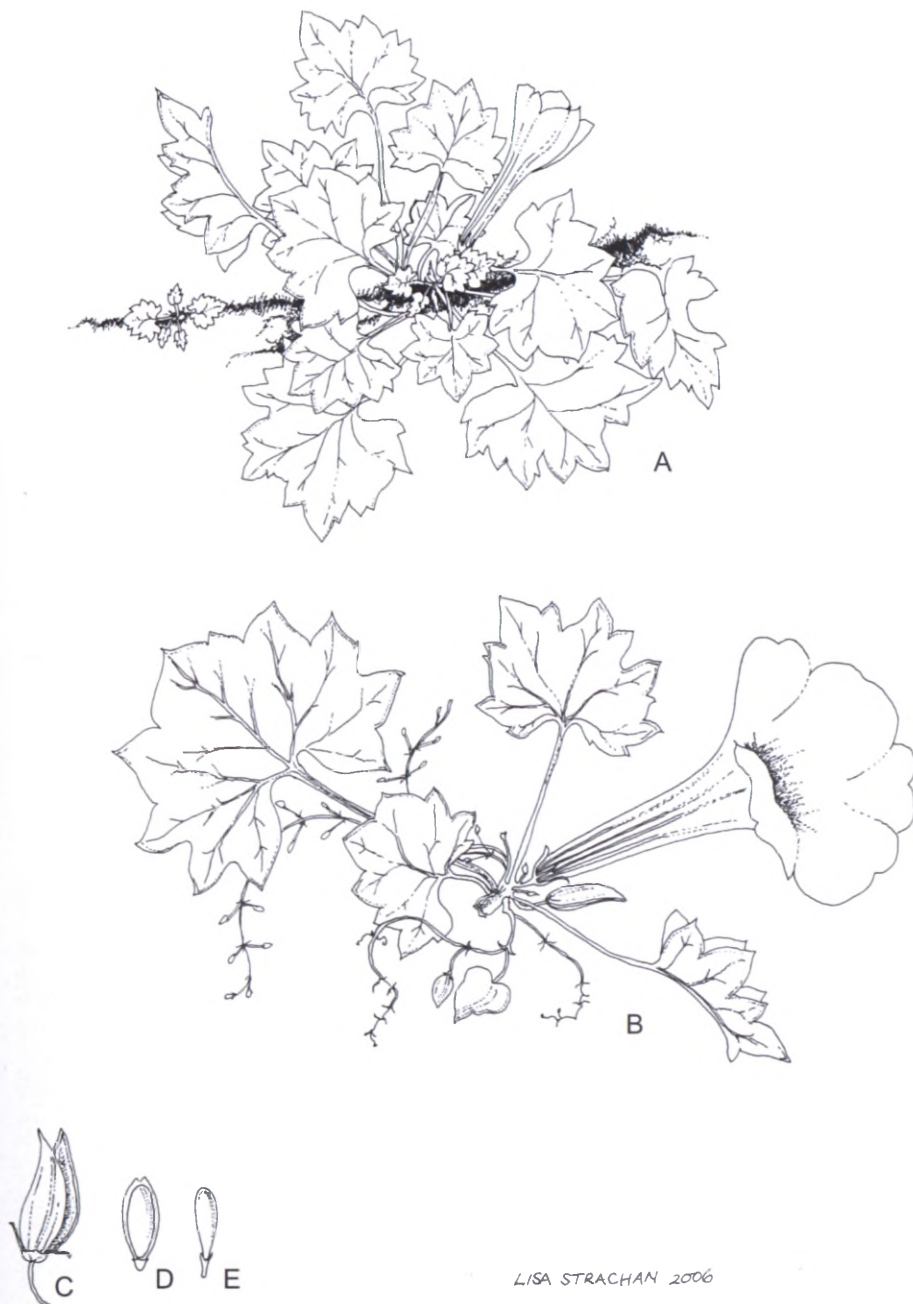
Dewinteria petrophila (*De Winter*) *Van Jaarsv. & A.E.van Wyk*, comb. nov.

Rogeria petrophila De Winter in Kirkia 1: 106–108 (1961). Type: South West Africa [Namibia] 1712 (Orokatuwo): Kaokoveld, 30 miles S of Kunene River on road to Orupembe. (–DA), 10-05-1957, *De Winter & Leistner 5790* (PRE, holo.; K, M, SRGH, iso.).

Description as for genus.

DISCUSSION

Distribution and ecology: *Dewinteria petrophila* is a semisucculent, biennial or perennial chasmo-cremno-phyte, at present only known from crevices and fissures on granite cliffs of the Otjihipa Mountains in the western Kaokoveld of northern Namibia (Figure 9). It grows on all aspects but is more abundant on south-facing ones and at altitudes of about 600–1 700 m on the northwestern peaks of these mountains (eastern margin of the Marienfluss). The upper slopes receive fog and are cooler, with Cape floristic elements such as species of *Eriocephalus*, *Othonna* and *Pelargonium*. The average annual rainfall in the Kaokoveld varies from less than 50 mm along the coast to 350 mm in the highlands (Mendelsohn *et al.* 2002). This species is a constitu-



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FIGURE 6.—*Dewinteria petrophila*: A, plant growing in crevice, $\times 0.7$; B, plant in flower, with stem bearing normal flowers and fruiting capsule as well as thread-like branchlets, $\times 0.7$; C, normal fruiting capsule, $\times 0.7$; D, specialized seed, $\times 5$; E, normal seed, $\times 5$. Artist: Lisa Strachan.

ent of arid *Colophospermum mopane* woodland, with several species of *Commiphora* prominent. It shares its habitat with other cremnophytes such as *Aeollanthus haumannii*, *Kalanchoe lanceolata*, *Plectranthus dinteri* and *Tetradenia kaokoensis*. The range of *D. petrophila* almost certainly extends to the adjacent high mountains of southwestern Angola, especially the botanically poorly known Serra Cafema range just north of the Otjihipa Range. *Dewinteria* is one of about seven genera endemic to the Kaokoveld Centre of Endemism, a biogeographical region in arid northwestern Namibia and adjacent southwestern Angola (Van Wyk & Smith 2001).

Cliffs provide a stable, safe environment for plants in the absence of larger herbivores and there is often a defence relaxation tendency (disarmament) in obligate cliff dwellers (Van Jaarsveld & Van Wyk 2003). However, the vertical habitat (extreme water runoff) and a lack of space to grow, demand a shift in habit and reproductive output. This often results in specialist fea-

tures such as succulence, compact growth form, dwarf clustering, cylindrical shape, pendent habit, profuse flowering and an increase in vivipary (vegetative reproduction) (Snogerup 1971; Van Jaarsveld & Van Wyk 2003). There is also a shift towards wind-dispersed seed (anemochory).

In his original description of *Rogeria petrophila*, De Winter (1961) mentions thread-like branches and smaller capsules of which the function was uncertain. His surmise is correct. *Dewinteria petrophila* does have a remarkable and unique dimorphic facultative reproduction strategy—an adaptation that helps it to survive under the extreme desert conditions of its cliff habitat. In addition to its conventional aerial branches bearing insect-pollinated flowers and wind-dispersed seeds, it produces specialized shoots that are negatively phototropic, entering hairline cracks and other crevices. These bear small cleistogamous flowers with \pm heart-shaped capsules with fewer but larger, differently shaped seeds



FIGURE 7.—*Dewinteria petrophila* in flower in a fissure on granite cliffs of the Otjhipa Mountains in northwestern Namibia.

(Figures 6, 8). This unique adaptation ensures that seeds are buried deep into crevices near the mother plant.

Dewinteria petrophila displays a unique amphicarpous condition, with both atelechorous and anemochorous dispersal methods. This is a remarkable adaptation and the first of its kind recorded for an obligate cliff-dwelling species. Its larger seeds are a self-preserving strategy, ensuring its long-term survival in its present habitat. This atelechorous seed dispersal ensures self-cloning, and the normal smaller anemochorous seeds (from insect-pollinated flowers) ensures interbreeding and dispersal to new sites. The larger seed carries larger reserves that the seedling needs after germination. The thread-like branches in the crevices ensure an almost 100% survival rate if the mother plant should die owing to drought or natural causes. The smaller capsules produce about five or fewer seeds per capsule, whereas the normal and larger aerial seed capsules produce more than 50 seeds per capsule. Winds on the cliffs are often strong and updrafts ensure the seeds' effective dispersal to other crevices. *D. petrophila* flowers in the rainy season, dispersing its seeds in autumn. Seeds are covered with mucilage, which is often associated with plants from desert or semi-desert regions, helping to anchor the seeds to the substrate (Van der Pijl 1982).

Systematic affinities: the genera of the Pedaliaceae (a small family of \pm 13 genera and 70 species, mostly African) are delimited largely by their fruit type (Ihlenfeldt 1964, 1967; Kadereit 2003). They occur mainly in semi-arid and arid habitats of the Old World tropics (Smithies & Herman 2003). Life forms in the family are remarkably diverse, varying from erect annuals or biennials (*Rogeria*), trailing perennials (*Dicerocaryum*), thickset chamaephytes (*Pterodiscus*), to dwarf trees (*Sesamothamnus*). Members have mainly opposite leaves and attractive, gamopetalous, tubular flowers, the pedicels bearing characteristic extrafloral nectar glands at the base. The fruits are very diverse, varying from winged to heavily armoured capsules, that are dehiscent or indehiscent. Mucilage glands are common in the family. Perhaps the best known member is

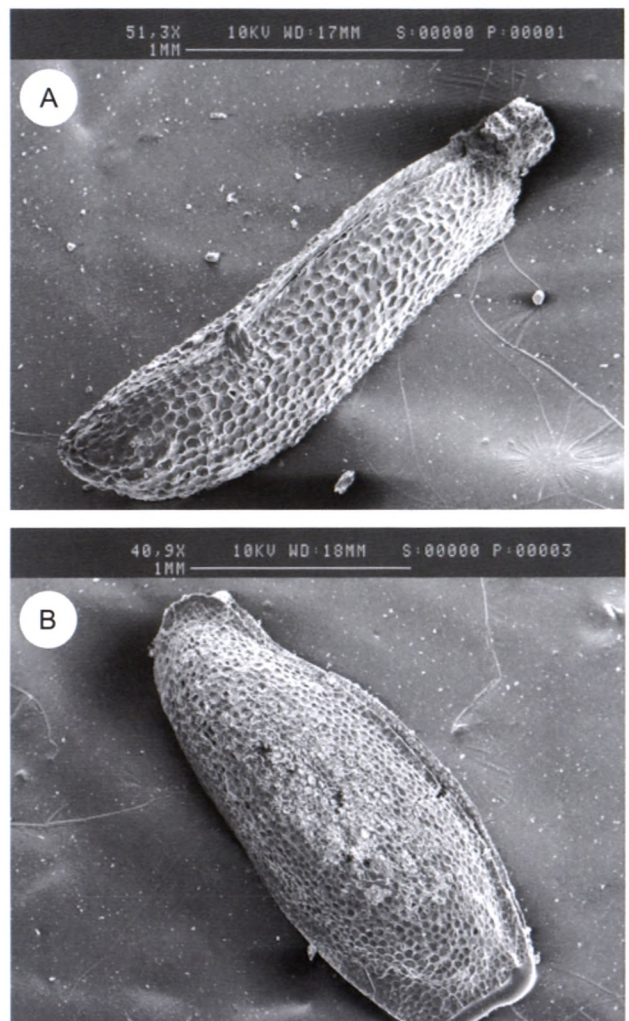


FIGURE 8.—*Dewinteria petrophila*, Van Jaarsveld & Swanepoel 19413: A, normal seed; B, specialized seed (SEM).

Harpagophytum, a tuberous-rooted trailing plant of the Kalahari, used world-wide as a medicine for arthritis (Van Wyk *et al.* 1997). Plants of the genus *Rogeria* (three species and exclusive to Africa) are robust, erect annuals or weak perennials from semidesert to desert regions of southern Africa (Smithies & Herman 2003). *Rogeria longiflora* (Royen) J.Gay ex DC. occurs in southern Namibia and up the Orange River Valley as far as Upington in South Africa, and two species in Namibia, *R. adenophylla* J.Gay ex Delile (also extends to the southern edge of the Sahara from Djibouti to Senegal and the Cape Verde Islands), and *R. bigibbosa* Engl. (Merxmüller & Schreiber 1968) on the escarpment in central Namibia. They usually grow in disturbed sites and dry watercourses. The main morphological differences between the new genus and *Rogeria* are summarized in Table 1.

Specimens examined

NAMIBIA.—1712 (Orokatuwo): east of Ezorotuu, 17°23'32.0" S 12°35'0.8" E, (–BC), Van Jaarsveld, Voigt & Cilliers 17520 (Wind); east of Otjihungwa, west-facing slopes of Otjihipa. (–BC), Van Jaarsveld & Swanepoel 19413, 19527 (Wind); northwestern Kaokoveld, (–DA), Becker & Ihlenfeldt 107560 (Wind).

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TABLE 1.—Main differences between *Dewinteria* and *Rogeria*

| | <i>Dewinteria</i> | <i>Rogeria</i> |
|---------------------------------------|---|---|
| Habit | Decumbent, no distinct main stem, amphicarpic | Distinct, erect main stem soon becoming woody, annual or biennial, not amphicarpic |
| Ecology | Chasmo-cremophyte | Opportunistic |
| Branches | | |
| normal | Trailing, fragile | Erect, rigid |
| specialized | Annual, trailing, filiform, negatively phototropic, with small leaves and cleistogamous flowers | Absent |
| Capsules | | |
| normal | Lanceolate in side view, slightly curved, chartaceous, 18–25 mm long | Oblong with distinct beak, lignified, bearing 2–8 emergences such as spines, tubercles or wings |
| specialized | Flattened, ovate to ovatecordate, 5–8 × 4.0–5.5 mm | Absent |
| Carpels | Nearly equal in size | Distinctly different in size |
| dehiscence | Loculicidal, false septa nearly completely reduced to small seams at base of capsule | Smaller adaxial carpel remains closed, bearing nearly complete false septa |
| Seed | | |
| normal | Linear-oblong to club-shaped, 2.0–2.2 mm, with no distinct fringe; surface minutely foveate | Flattened, with distinct fringe; surface foveate |
| specialized, in cleistogamous flowers | Oblong-obovoid, 2.5–3.0 mm long, slightly flattened, minutely fringed, surface similar to normal seed | Absent |

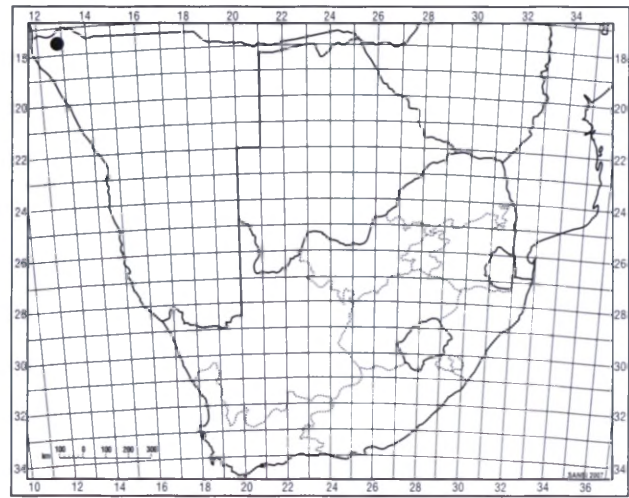


FIGURE 9.—Known distribution of *Dewinteria petrophila*.

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