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***Placynthium australiense* sp. nov. (lichenised Ascomycota, Placynthiaceae) from South Australia**Patrick M. McCarthy<sup>a</sup> & Gintaras Kantvilas<sup>b</sup><sup>a</sup>Australian Biological Resources Study, G.P.O. Box 787, Canberra, Australian Capital Territory 2601  
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E-mail: Gintaras.Kantvilas@tmag.tas.gov.au**Abstract**

*Placynthium australiense* P.M.McCarthy & Kantvilas (Peltigerales, Placynthiaceae) is described from hard mesic limestone in south-eastern South Australia. It is characterised by having discontinuous colonies of mainly squamulose thalli that lack a hypothallus and prothallus, as well as comparatively broad, 1-septate ascospores. Three other lichens, *Candelariella aurella* (Hoffm.) Zahlbr., *Endocarpon pallidum* (Nyl.) Nyl. and *Verrucaria calciseda* DC., are reported for the first time from South Australia.

**Key words:** biodiversity, lichen, new species, taxonomy, *Placynthium*, South Australia.

**Introduction**

The lichen genus *Placynthium* (Ach.) Gray (Peltigerales, Placynthiaceae), with about 25 species, grows mainly on dry to moist or inundated calcareous and siliceous rocks in temperate regions of the Northern Hemisphere. The usually dark to blackish thallus contains a cyanobacterial photobiont, often has a well-developed prothallus, and ranges in habit from crustose-areolate and densely coralloid-isidiate to squamulose with entire or dissected margins, or rosette-like with short to elongate lobes. Apothecia are black, lecideine, with an amyloid hymenium, mainly 8-spored *Peltigera*-type asci, and hyaline, transversely septate ascospores.

The earliest records of *Placynthium* from Australia were of *P. nigrum* (Huds.) Gray from Tasmania (Bratt & Cashin 1975) and, later, that species and *P. subradiatum* (Nyl.) Arnold from southern New South Wales (Weber 1977). Henssen (1984) reported the latter from the Australian Capital Territory, while Allen et al. (2001) cited collections of *P. nigrum* from South Australia and the A.C.T. Records of both species from Victoria (McCarthy 2013) require confirmation. In this contribution, a new species, *P. australiense*, is described from hard mesic limestone in south-eastern South Australia, while three associated lichens, *Candelariella aurella* (Hoffm.) Zahlbr., *Endocarpon pallidum* (Nyl.) Nyl. and *Verrucaria calciseda* DC., are new records for the state.

**Methods**

Observations and measurements of photobiont cells, thallus and apothecium anatomy, asci, ascospores and conidia were made on hand-cut sections mounted in

water and dilute KOH (K). Asci were also observed in Lugol's Iodine (I), with and without pretreatment in K.

**Taxonomy*****Placynthium australiense* P.M.McCarthy & Kantvilas, sp. nov.**

*Thallus* ater, epruinosis, non lobatus, areolatus vel ex squamulis constans, hypothallo prothalloque destitutus; algae *Scytonema pertinentes*; squamulae rotundatae vel irregulares, 0.3–3 mm latae, 0.1–0.6 mm crassae, dispersae vel in tumulis aggregatae, superficie laevi, nodulosa vel coralloideo-isidiata, margine vulgo effigurata. Apothecia abunda, atra, lecideina, 0.25–0.66 mm diametro, ascosporis uniseptatis, comparate latis, 9–15 µm longis, 5.5–8 µm latis.

**Mycobank No.:** MB 807101

**Typus:** SOUTH AUSTRALIA. **Murray River Region:** beside Marne River, 10 km NE of Springton, 34°40'12"S, 139°09'56"E, alt. 280 m, on gently sloping limestone slabs in pasture with *Eucalyptus camaldulensis*, 12 Apr. 2013, P.M.McCarthy 4010 (holo.: AD; iso.: CANB, HO).

*Thallus* epilithic, initially crustose, richly rimose or areolate and 30–60 µm thick, the areoles becoming larger and thicker and often subsquamulose or squamulose, these structures scattered and often resembling minute rosettes, or aggregated and forming colonies (2–) 5–10 (–15) mm wide, greenish-black to black, dull, not swollen and not noticeably gelatinous when wetted, epruinose at all stages of development; often a range of immature, mature and post-mature thalli occupying much of an area of limestone up to 10–20 cm wide, but generally discontinuous and interspersed with small colonies of crustose lichens (mainly Lecanoraceae, Physciaceae, Teloschistaceae and Verrucariaceae).



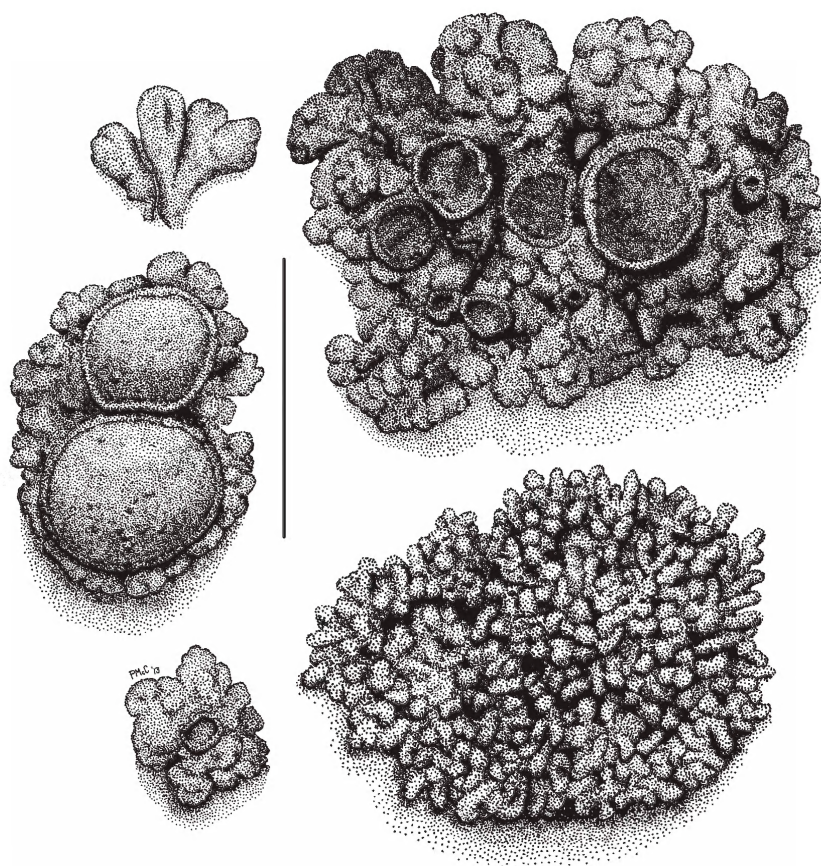
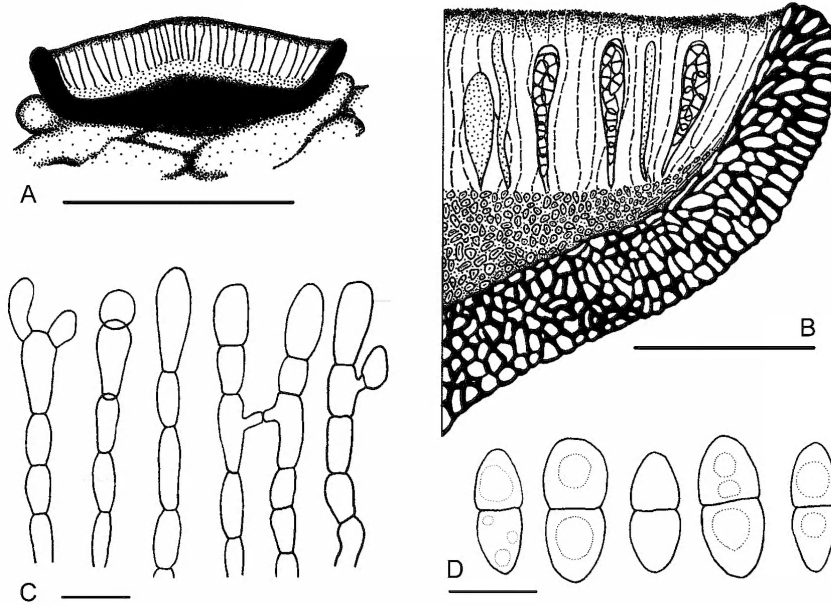


Fig. 1. *Placynthium australiense*. Habit of thalli and apothecia. Scale bar: 1 mm. — Holotype.

*Squamules and areoles* rounded to angular or irregular, closely aggregated in a crust or more scattered and often laminally short-lobulate (with lobules 40–80  $\mu\text{m}$  wide) or marginally effigurate, (0.3–) 0.6–2.2 (–3) mm wide and 0.1–0.35 (–0.6) mm thick, thickest when the thallus is densely isidiate; squamules and areoles with a blackish underside, often markedly constricted at their attachment to the substratum, lacking dedicated attachment organs, such as rhizines. *Thallus margin* usually indistinct, rarely with contiguous to somewhat discrete simple lobes that are tightly appressed to the substratum, to 1 mm long and 0.15–0.25 mm wide. *Thallus surface* rather smooth, or granulose, nodulose or isidiate; isidia 20–50 (–80)  $\mu\text{m}$  diam. and up to 0.25 mm long, simple to irregularly branched, finger-like, furcate or  $\pm$  coralloid, usually more or less erect, others tilted to horizontal and smooth to contorted. *Thalline anatomy* paraplectenchymatous, the cells 5–10 (–15)  $\mu\text{m}$  diam., largest towards the thallus interior, indistinctly corticate; cortical zone yellowish-brown to olive-brown,

amorphous or with rounded and comparatively thick-walled cells 6–12  $\mu\text{m}$  diam. *Photobiont* cyanobacterial, *Scytonema*-like, consisting of scattered or irregularly clustered cells and short to moderately long filaments, occupying almost the entire thallus; cells in filaments yellowish-brown, 8–12  $\mu\text{m}$  wide and 4–10  $\mu\text{m}$  long. *Hypothallus* absent. *Prothallus* usually absent around thalli as well as isolated squamules and areoles; a few squamules with an indistinct and discontinuous blue-black, fimbriate prothallus extending up to 0.3 mm beyond the margin. *Apothecia* sparse to very numerous, laminal, usually solitary, adnate to superficial, not constricted at the base, lecideine, (0.25–) 0.42 (–0.66) mm diam. [ $n = 60$ ], jet-black, usually matt, occasionally slightly glossy (mainly immature apothecia), colour unchanged when wetted; disc usually plane, occasionally slightly to moderately concave or convex at maturity, the surface smooth to minutely and irregularly uneven; proper exciple concolorous with the disc or a little paler, smooth, usually entire, sometimes faintly undulate



**Fig. 2.** *Placynthium australiense*. **A, B** sectioned apothecia (semi-schematic); **C** distal cells of paraphyses; **D** ascospores. Scale bars: **A** 0.5 mm; **B** 0.1 mm; **C, D** 10 µm. — **A–D** holotype.

or flexuose, 30–80 µm thick, often slightly raised, persistent or becoming almost excluded (especially around the most convex apothecia); in section uniformly dark, consisting of radiating, tightly packed hyphae, continuous below the hypothecium, (30–) 40–80 (–100) µm thick at the sides, 60–120 (–150) µm thick at the base; cells at the margin ellipsoid to elongate-ellipsoid, 8–17 × 5–10 µm, with thick greenish-black walls. *Hypothecium* pale to medium greenish-brown or rather dark golden or orange-brown, 50–80 (–100) µm thick, not interspersed with oil droplets or granules, I+ deep blue (fading) to almost black (without pretreatment in K) or I+ deep blue (fading) to reddish-brown (with pretreatment). *Hymenium* 70–100 (–110) µm thick, not interspersed with oil droplets or granules, I+ persistently deep blue to bluish-black (with and without pretreatment in K), subtending a greenish-black or violet-blackish epihymenium 10–15 (–20) µm thick. *Paraphyses* unbranched to sparingly branched and anastomosed distally (scattered branches or anastomoses at all levels of the hymenium), short- to rather long-celled, 3–4 (–6) µm wide, thin-walled, remaining coherent in water and K; shape of apical cells very variable even within a single apothecium, ranging from strongly capitate, with the apical cell rounded or somewhat pointed and 4–5 (–6) µm wide and with a hyaline or partly dark green to violet-blackish wall, or the distal 3–5 cells a little shorter and broader than more proximal cells, or the apical cells little altered in size and shape other than being included

within the pigmented epihymenium. *Asci* narrowly to broadly clavate or clavate-cylindrical, 8-spored, 58–75 × 12–17 µm [*n* = 20], with an external amyloid cap and a thin internal amyloid sheet adjacent to the apex of the ascoplasma. *Ascospores* colourless, 1-septate, overlapping-uniseriate to irregularly biseriata in the asci, ellipsoid, usually slightly constricted at the septum, uniformly thin-walled, lacking a distinct perispore, (9–) 12 (–15) × (5.5–) 7 (–8) µm [*n* = 90]; cells more or less identical in size and shape; apices rounded to subacute; contents usually granular and guttulate. *Pycnidia* spherical, semi-immersed to almost fully immersed in the thallus, 70–100 µm diam., with a greenish-black apex and a hyaline conidiogenous layer; conidiophores short-celled, 10–20 µm long. *Conidia* bacilliform, 3–6 (–7) × c. 0.7 µm. **Fig. 1–3.**

*Remarks.* *Placynthium australiense* is characterised by its blackish, epruinose, non-lobate thallus with squamules and areoles that are neither subtended by a hypothallus nor delimited by a prothallus; it contains a *Scytonema*-like photobiont. The squamules are rounded or irregular in shape, (0.3–) 0.6–2.2 (–3) mm wide and 0.1–0.35 (–0.6) mm thick, scattered or contiguous in small groups, with a smooth, nodulose or coralloid-isidiate surface, commonly with an effigurate margin, abundantly fertile with comparatively small, black, lecideine apothecia (0.25–) 0.42 (–0.66) mm diam. and with comparatively broad, 1-septate ascospores measuring (9–) 12 (–15) × (5.5–) 7 (–8) µm.

*Placynthium* can be subdivided more or less evenly into species with distinct, radial, elongate, marginal lobes and those with thalli that lack well-defined lobes, although individual squamules can have minutely and shallowly effigurate margins. *Placynthium australiense* lies comfortably among the latter, its distinctive and persistently 1-septate spores setting it apart from all but three known taxa.

*Placynthium tremniacum* (A.Massal.) Jatta, from Iceland, the British Isles, continental Europe, Macaronesia, North Africa and Central Asia, has a glossy brown thallus, dark brown apothecia, an indistinct prothallus and narrower ascospores ( $9\text{--}16 \times 4\text{--}6 \mu\text{m}$ : Clauzade & Roux 1985; Jørgensen 2007; Gilbert & James 2009; Burgaz 2010). However, its relationship with *P. nigrum* has yet to be fully resolved, because while most recent authors have regarded the persistently 1-septate spores of *P. tremniacum* as being diagnostic for a distinct species, Czeika & Czeika (2007) examined syntype material, observed a minority of 3-septate propagules, and reduced *P. tremniacum* to synonymy under *P. nigrum*.

*Placynthium anemoideum* (Servit) Gyeln., from the British Isles, France, Croatia and Turkey, has isolated areoles with raised crenulate margins (Czeika & Czeika 2007; Fig. 6b) which are not unlike those of *P. australiense*, but the ascospores are smaller ( $9\text{--}10 \times 5\text{--}6 \mu\text{m}$ ) and the apothecia are only c. 0.3 mm diam. (Clauzade & Roux 1985; Czeika & Czeika 2007; Gilbert & James 2009).

Finally, ascospores very similar to those of *P. australiense* occur in *P. tantaleum* (Hepp) Hue, which is known from Greenland, Iceland, Svalbard, the British Isles, continental Europe (Clauzade & Roux 1985; Czeika & Czeika 2007; Jørgensen 2007; Gilbert & James 2009; Burgaz 2010), south-western (Schultz 2002, as *P. nigrum* (Huds.) Gray) and north-eastern U.S.A., Canada (Henssen 1963, as *P. nigrum* var. *tantaleum* (Hepp) Arnold) and Central Asia. However, *P. tantaleum* has a glossy, mottled grey-brown thallus to 3 cm wide, resting on “a voluminous blue-green prothallus” (Jørgensen 2007) or on “a distinctive blue-black hypothallus” (Gilbert & James 2009).

*Placynthium nigrum*, the most common and widely distributed species, has comparatively elongate, 1–3-septate spores [ $8\text{--}25 \times 4\text{--}6 \mu\text{m}$  (Clauzade & Roux 1985);  $7\text{--}22 \times 3.5\text{--}6 \mu\text{m}$  (Schultz 2002);  $10\text{--}15\text{--}(20) \times 4\text{--}6 \mu\text{m}$  (Jørgensen 2007);  $8\text{--}18 \times 4\text{--}6 \mu\text{m}$  (Czeika & Czeika 2007);  $7\text{--}22 \times 3.5\text{--}6 \mu\text{m}$  (Gilbert & James 2009);  $7.5\text{--}20 \times 2.5\text{--}7.5 \mu\text{m}$  (Gilbert & James 2009)]. However, when Henssen reported *P. nigrum* from Argentina, Chile and New Zealand (Henssen 1984), she circumscribed the species “in the broad sense including var. *tantaleum* (Hepp) Arnold (see Henssen 1963)” and noted “only two-celled spores have been observed in the specimens from the Southern Hemisphere” (Henssen 1984). Recently, Jørgensen (2007) observed that while *P. tantaleum* usually occurs in and beside rivers, specimens

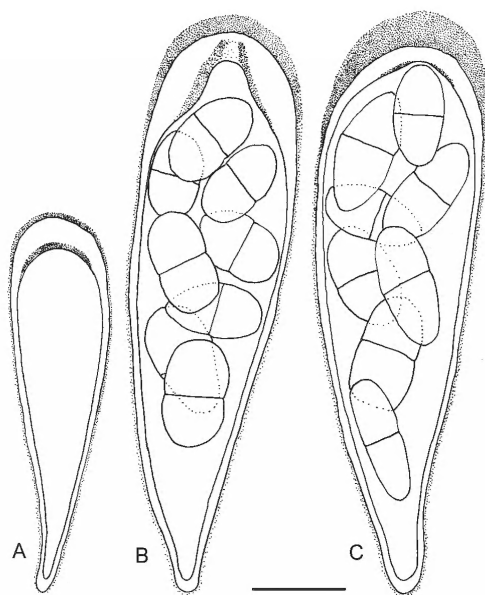


Fig. 3. *Placynthium australiense*. Immature (A), submature (B) and mature (C) asci stained with Lugol's iodine. Scale bar: 10  $\mu\text{m}$ . — HO isotype.

from drier habitats with thin-walled, 1-septate spores “appear only to be part of the variation of *P. nigrum*”. Among the South Australian and Tasmanian specimens examined, there seems to be a clear distinction, based on ascospore septation and dimensions, between *P. nigrum* as it is commonly circumscribed (see above) and *P. nigrum sensu* Henssen (1984) with comparatively short and broad 1-septate ascospores. Whether or not both can be accommodated within the variation of *P. nigrum* will require further study.

There have been inconsistencies in the description of the asci of *Placynthium* by previous authors. Whereas Jørgensen (2007) referred to an amyloid cap and internal sheets, Schultz (2002) mentioned an amyloid tube. Our observations are illustrated in Fig. 3 and interpreted thus: when young, the asci have an intensely amyloid external cap and a thin, internal, amyloid sheet at the base of the tholus adjacent to the apex of the ascoplasm (A). As the asci mature, a distinct, beak-like ocular chamber develops which pushes up through the inner amyloid sheet; the two sides of this sheet become orientated more or less vertically, somewhat approximating the appearance of an amyloid tube-like structure (B). With further development, this inner amyloid structure becomes more squashed and less prominent, although its vestiges can still be evident at the edges of the ocular chamber; the external cap remains prominent throughout (C).

**Distribution & habitat.** *Placynthium australiense* is known only from gently sloping, slab-like outcrops of hard limestone at its type locality in the Murray River region of south-eastern South Australia. Associated lichens include *Aspicilia contorta* (Hoffm.) Kremp., *Buellia albula* (Nyl.) Müll.Arg., *Caloplaca mereschkowskiana* S.Y.Kondr. & Kärnefelt, *Caloplaca* spp., *Candelariella aurella* (Hoffm.) Zahlbr.\*, *Endocarpon pallidum* (Nyl.) Nyl.\*, *Lecania turicensis* (Hepp) Müll.Arg., *Lecanora dispersa* (Pers.) Sommerf., *L. sphaerospora* Müll.Arg., *Placidium* sp., *Rinodina bischoffii* (Hepp) A.Massal., *Toninia* aff. *aromatica* (Sm.) A.Massal., *Verrucaria calciseda* DC.\*, *V. muralis* Ach. and *V. nigrescens* Pers. The three species marked with an asterisk are new records for South Australia.

#### Key to the Australian Species of *Placynthium*

1. Central areoles commonly eroded, leaving arcs or rings of contiguous, radiating marginal lobes 1–1.5 mm long and 0.1–0.25 mm wide; prothallus and hypothallus absent . . . . . *Placynthium subradiatum*
- 1: Central areoles not eroded; thallus without marginal lobes; prothallus and hypothallus present or absent
  2. Thallus a wide-spreading crust of more or less uniform, granulose- and coralloid-isidiate areoles; prothallus usually extending well beyond the thallus margin; hypothallus often thick and visible between the areoles . . . . . *Placynthium nigrum* s.lat.
  - 2: Thallus of rounded to irregular squamules that are scattered or aggregated in small groups; prothallus absent or very faint; hypothallus absent . . . . . *Placynthium australiense*

#### Additional specimens examined

##### *Placynthium nigrum* s.str.

SOUTH AUSTRALIA. **Murray River Region:** 15 km S of Angaston, on marble in pasture, 21 Oct. 1981, J.A.Elix 9243 (CANB 9602209, det. A. Henssen, Sep. 1982).

TASMANIA. Vale of Belvoir, alt. 840 m, on limestone outcrops in buttongrass moorland and heath, 16 May 1987, G.Kantvilas 61/87 (HO 569326); Tiger Road, 1 km NW of Florentine River bridge, 42°35'S, 146°26'E, alt. 370 m, on limestone boulder at edge of wet forest, 17 Dec. 2003, G.Kantvilas 742/03 (HO 524542).

##### *Placynthium nigrum* s.lat. (incl. sensu Henssen 1984)

SOUTH AUSTRALIA. **Yorke Peninsula:** Innes National Park, West Cape, 35°14'49"S, 136°49'31"E, alt. 45 m, on cliff-top limestone outcrops and boulders, 14 Apr. 2013, P.M.McCarthy 4029 (AD). **Kangaroo Island:** Cape Borda, 35°45'S, 136°35'E, alt. 100 m, on semi-exposed limestone rocks in dense heathy vegetation, 27 Sep. 1994, H.Streimann 54956 (AD, B, CANB); track to Cape Gantheaume, 36°04'S, 137°27'E, on coastal limestone outcrops in heathland, 29 Sep. 2008, G.Kantvilas 321/08 (AD, HO); Ravine des Casoars, 35°48'S, 136°35'E, alt. 5 m, on limestone outcrops in coastal heathland, 24 Sep. 2012, G.Kantvilas 453/12 (AD, HO); Point Ellen, 36°00'S, 137°11'E, alt. 5 m, on limestone outcrops in coastal heathland, 26 Sep. 2013, G.Kantvilas 214/13 (AD, HO).

TASMANIA. c. 6 km SW of Hardwood Hill, alt. 75 m, on limestone outcrops in sedgeland heath, 25 Apr. 1985, G.Kantvilas 178/85 (HO 308227, MB); Mole Creek, alt. 350 m, on limestone outcrop in paddock, 19 Feb. 1984, P.James &

G.Kantvilas 364/84 (BM, HO 308225, MB [det. A.Henssen]); W of Mole Creek, near Liena Road and Mersey Forest Road junction, 1 km NW of Florentine River bridge, 41°34'S, 146°15'E, alt. 350 m, on limestone outcrop in pasture, 19 Feb. 1984, G.Kantvilas 365/84 & P.James (BM, HO 564173); Eleven Road, Florentine Valley, 42°37'S, 146°26'E, alt. 430 m, on limestone boulder at edge of wet forest, 17 Dec. 2003, G.Kantvilas 744/03 (HO 524548); Flinders Island, Killiecrankie Bay, W of township, 39°50'S, 147°50'E, alt. 5 m, on outcrop of soft calcarenite along seashore, 2 Apr. 2007, G.Kantvilas 150/07 (HO 544228).

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## *Drosera murfetii* (Droseraceae): a new species from Tasmania, Australia

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### Abstract

*Drosera murfetii* Lowrie & Conran is a new species from south-west Tasmania, Australia, bearing mainly non-carnivorous leaves and usually several large flowers per inflorescence. It is compared to its morphologically closest taxon, *Drosera arcturi* Hook., with which it often grows. The two species are described and illustrated, a key to species and a comparison table of characters is provided. *Drosera arcturi* is lectotypified.

**Keywords:** *Drosera arcturi*, *D. murfetii*, Droseraceae, taxonomy, new species, Tasmania.

### Introduction

*Drosera arcturi* Hook. from alpine southern Australia and New Zealand is very variable across its range and in Tasmania sometimes produces large, robust plants (Morris 2009), including a form bearing several conspicuous, basal glabrous leaves, a usually single, large trapping leaf, with obvious glandular hairs, and often several flowers per scape, each with 4–5 larger, greenish-white or cerise stigmas (Lowrie 1998, Clayton 2003, Gibson 2010). This form is widespread in south-west Tasmania and contrasts strongly with the type form (with which it often co-occurs at more elevated altitudes). The type form of *D. arcturi* is generally a smaller plant and always bears numerous trapping leaves, highly reduced (or no) scale-like glabrous leaves, almost always single flowers per scape, and usually three stigmas (rarely four). The so-called ‘giant form’ of *D. arcturi* was considered by Gibson (1998, 1999, 2010) to be at least an ecotype, while Clayton (2003) thought that the two forms should deserve at least subspecific status; both authors suggested that further study was needed. However, the fact that both morphotypes occur together over such a wide geographic range and in the same habitats, but without apparent intermediate forms, suggests instead that they may be distinct albeit closely related species, as subspecies are generally regarded as being geographically (Schlauer 1996) and/or ecologically allopatric (Stace 1989).

Although *D. arcturi* also occurs in New Zealand, where it grows mainly in montane to subalpine bogs southwards from 39°S (Allan Herbarium 2000, Salmon 2001), it extends down to sea level in the far south of its range in both countries (Allan Herbarium 2000, CHAH 2013). Several New Zealand morphotypes have been

given taxonomic status in the past (Colenso 1890, 1896, 1899), but these were later deemed to be relatively trivial size or foliage colour variants and reduced to synonymy (Cheeseman 1906). Specimens with 4–5 large, greenish white or cerise stigmas are absent from both New Zealand and mainland Australian populations and any large plants occurring there also lack the 2–5 large, non-carnivorous basal leaves seen in the Tasmanian ‘giant form’ plants. Although isolated plants in New Zealand very rarely bear two flowers per peduncle, the plants and flowers are otherwise identical to the ‘type’ form both in size and morphology (Conran, pers. obs.)

The two Australian morphs appear to differ consistently from each other for a range of characteristics relating in particular to the glabrous leaves, flower and stigma number, and there is a lack of apparent intermediate forms for these features when the morphs co-occur. Accordingly, this study compares the morphology of the two forms and examines the taxonomic implications of these differences.

### Methods

Living and dried specimens of *D. arcturi* across its geographic range and covering all known Australian and New Zealand morphotypes were examined under dissecting microscope and/or by SEM. Descriptions and, where possible, type specimens for the formerly segregated names from New Zealand were investigated, as well as *D. arcturi* collections at AD, HO, MEL, OTA, PERTH, Gunn’s and Brown’s collections at K and BM, and personal collections by A. Lowrie and D.E. Murfet.

To assess character variability in the complex, up to five complete specimens per herbarium sheet, representing a total of 354 specimens from 107 accessions



**Table 1.** T-test comparisons between PATN dendrogram groups for the characters used in the cluster analysis assuming unequal variances, as well as Kruskal Wallance and  $r^2$  values from the cluster and ordination analyses of 354 specimens from 107 accessions.

Character code	<i>D. arcturi</i> mean $\pm$ SD	<i>D. murfettii</i> mean $\pm$ SD	t	df	P	KW	$r^2$
<b>E#</b>	0.56 $\pm$ 0.83	2.91 $\pm$ 0.88	25.95	1, 334.38	<0.0001	224.30	0.887
<b>EL</b> (mm)	4.31 $\pm$ 6.02	33.77 $\pm$ 16.67	21.43	1, 290.83	<0.0001	130.51	0.737
<b>EW</b> (mm)	0.87 $\pm$ 1.11	5.48 $\pm$ 1.47	33.12	1, 194.18	<0.0001	145.05	0.727
<b>G#</b>	4.92 $\pm$ 1.44	1.34 $\pm$ 0.57	32.29	1, 282.69	<0.0001	251.54	0.768
<b>GP</b> (mm)	17.21 $\pm$ 7.75	24.46 $\pm$ 14.63	5.58	1, 217	<0.0001	18.67	0.202
<b>GL</b> (mm)	23.20 $\pm$ 9.36	42.71 $\pm$ 22.21	10.24	1, 193.96	<0.0001	106.03	0.125
<b>SC</b> (mm)	44.08 $\pm$ 17.31	92.46 $\pm$ 33.13	16.61	1, 224.95	<0.0001	185.10	0.769
<b>F#</b>	1.01 $\pm$ 0.10	1.20 $\pm$ 0.50	4.74	1, 167.23	<0.0001	6.26	0.203
<b>SL</b> (mm)	6.33 $\pm$ 1.46	8.29 $\pm$ 1.74	11.27	1, 305.54	<0.0001	88.50	0.684
<b>SW</b> (mm)	1.83 $\pm$ 0.47	2.43 $\pm$ 1.05	6.65	1, 208.42	<0.0001	57.56	0.367
<b>PL</b> (mm)	6.57 $\pm$ 1.48	8.99 $\pm$ 1.85	13.37	1, 296.40	<0.0001	115.85	0.667

**Table 2.** Summary comparison of distinguishing morphological character and character states differences between *Drosera arcturi* and *D. murfettii* derived from measurements of 354 specimens from 107 accessions.

Character	<i>Drosera arcturi</i>	<i>Drosera murfettii</i>
<b>Basal, glabrous leaf size</b> (mm)	3–27 $\times$ 0.7–4	(1–) 3–5 (–12) $\times$ 5–15
<b>Glandular leaf number</b>	2–12	(0–) 1–2 (–4)
<b>Glandular leaf length</b> (cm)	1.3–12	3.5–21.7
<b>Scape length</b> (cm)	0.8–9	3–20
<b>Flower number</b>	1 (–2)	1–4
<b>Petals</b> (mm)	3–10 $\times$ 2.5–7	5–14 $\times$ 4–5
<b>Style number</b>	3 (–4)	4–5
<b>Stigma colour</b>	greenish-white to pale yellow	greenish-white or reddish-erise
<b>Seed size</b> (mm)	0.5–1 (–1.3) $\times$ 0.4–0.8	(0.8–) 1–2 $\times$ (0.4–) 0.6–1

collected from Australia and New Zealand, were coded for 11 morphological characters:

1. Glabrous leaf number (**E#**)
2. Longest glabrous leaf length (mm) (**EL**)
3. Longest glabrous leaf width (mm) (**EW**)
4. Glandular leaf number (**G#**)
5. Longest glandular petiole length (mm) (**GP**)
6. Longest glandular lamina length (mm) (**GL**)
7. Scape length (mm) (**SC**)
8. Flowers per scape (**F#**)
9. Sepal length (mm) (**SL**)
10. Sepal width (mm) (**SW**)
11. Petal length (mm) (**PL**).

These data were then transformed by  $\log_{10}+1$  for continuous data and square root + 0.5 for counts (Zar 1996) and then subjected to cluster analysis using Gower Association, flexible UPGMA with a beta value of 0.0. Ordination used non-metric semi-strong multidimensional scaling (SSH) with 100 random starts and a cutoff value of 0.9 in the program PATN v. 3.1.2 (Belbin & Collins 2008), with character/specimen cluster relationships in the ordination space explored using Principal Component Correlation (PCC) analysis (Faith 1991). In addition, character mean comparisons were undertaken on the raw data using t-tests in JMP 4.0.3 (SAS Institute 2000) for the two groups defined by the PATN cluster analyses, with the assumption of unequal variances.

Seed micromorphology is considered important in *Drosera* at subgeneric and sectional level (Dwyer 1983, Boesewinkel 1989), as well as between related species

(Susandarini et al. 2002, Lowrie 2005, Lowrie & Conran 2007, 2008). Accordingly, ten seeds per sample from 14 samples, representing both morphs and including material from New Zealand, were measured and the two morphotypes compared using the Student t-test on  $\log_{10}+1$  transformed data, allowing for unequal variances. SEM micrographs were also produced at The University of Adelaide Microscopy Centre (CEMMSA), following the methods of Susandarini et al. (2002), with additional information on the seeds of New Zealand material of *D. arcturi* obtained from Webb & Simpson (2001).

## Results

The cluster analysis (Fig. 1) and ordination (Fig. 2) both show that there are two clearly separated morphotypes within the *D. arcturi* complex, differing consistently for nearly all of the characters measured. One cluster represents all of the (0–) 1–2 (–4) trapping-leaved, multi-flowered specimens with multiple, large, broad, glabrous leaves from SW Tasmania, including all samples reported to have cerise stigmas; the other, consists of the multiple glandular-leaved, single-flowered and widespread type form with no or few, small, linear, glabrous leaves from New South Wales, Victoria, Tasmania and New Zealand. The vegetative morphological differences between the two forms, as well as inflorescence and floral characteristics clearly support the justification to treat these two taxa as distinctive species (Tables 1, 2), particularly as they co-

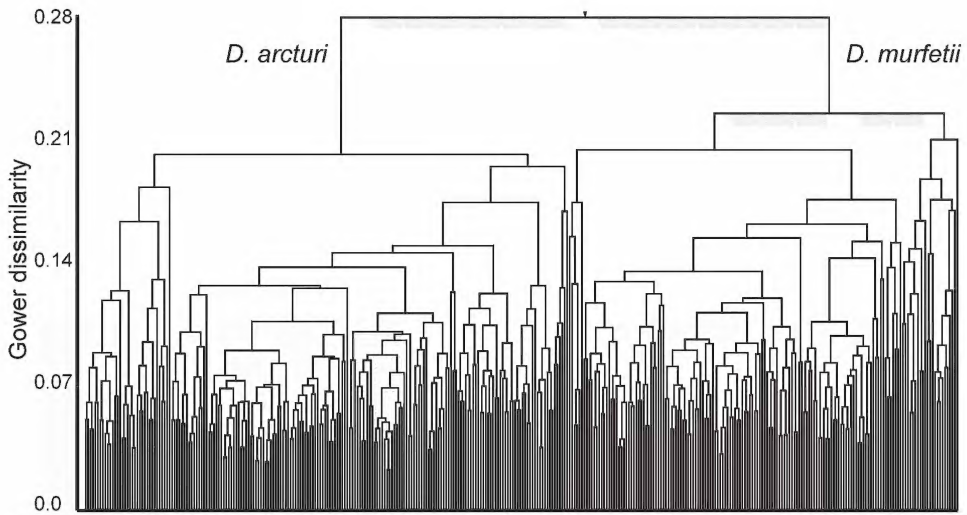


Fig. 1. Gower Metric flexible UPGMA clustering dendrogram of 354 specimens from 107 accessions in the *Drosera arcturi* complex from SE Australia, Tasmania and New Zealand.

occur across a wide part of their respective ranges with no obvious intermediacy seen in our analysis (Stace 1989). Accordingly, a new species, *Drosera murfetii*, is proposed and described here and *D. arcturi* is redefined. Illustrations, descriptions and a comparison table for both species are provided.

Character comparisons between the two clusters (Table 1) show that there are significant mean differences for all features used in the analyses, with *D. murfetii*

on average larger for all features, as well as generally bearing more flowers per scape (i.e. >1) and having larger, broader and more numerous glabrous leaves. In contrast, the type form of *D. arcturi* (which also included all type specimens and related accessions from Australian and New Zealand taxa in the same cluster) has few, small and linear (if any) glabrous leaves, more numerous glandular, trapping ones, but was otherwise significantly smaller for the features measured here.

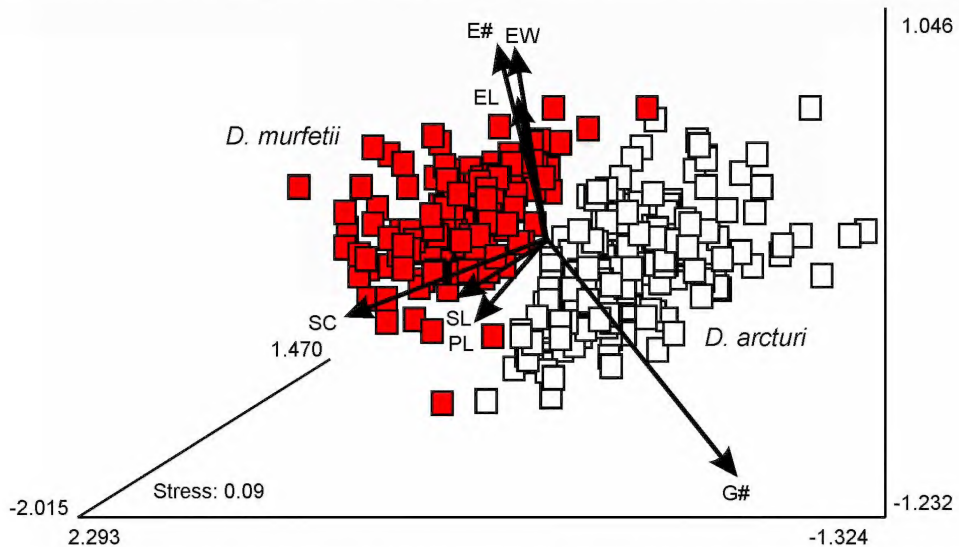


Fig. 2. Non-metric semi-strong hybrid 3-D multidimensional scaling ordination of the *Drosera arcturi* complex specimens and clusters from the dendrogram shown in Fig. 1; white = *D. arcturi*; red = *D. murfetii*; Principal Canonical Correlation vector arrows indicate direction of increasing score in the ordination space for the characters listed in Table 1.

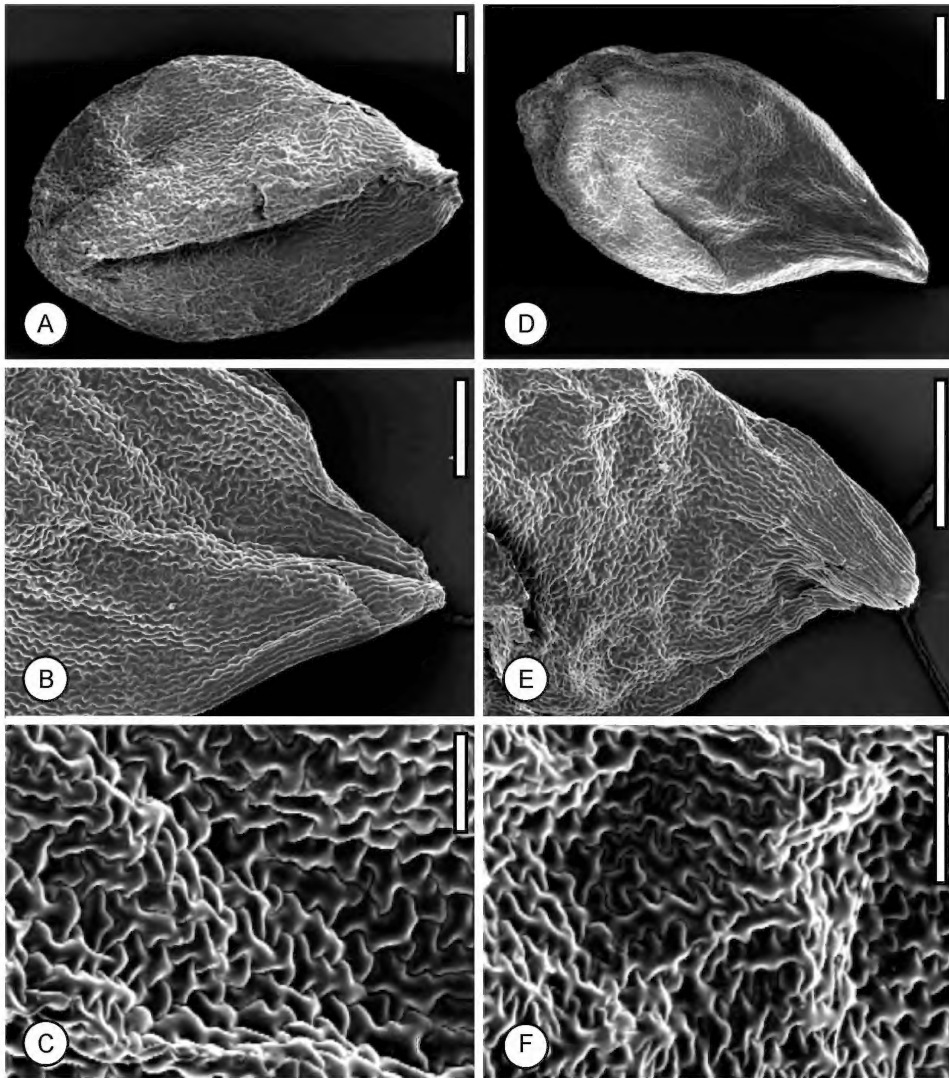


Fig. 3. Seeds of Australasian alpine *Drosera arcturi* complex species under SEM. **A–C** *Drosera arcturi*: **A** seed; **B** close up of funicle; **C** detail of testa. **D–F** *D. murfeti*: **D** seed; **E** close up of funicle; **F** detail of testa. Scale bars: **A–D** 200 µm; **E–F** 100 µm. — **A–C** A.Lowrie 3178; **D–F** A.Lowrie 3181 & D.E.Murfet.

The ordination (Fig. 2) shows that the two clusters had virtually no overlap. The stress value of 0.09 is well within the limits deemed acceptable for dimensional distortion (Belbin & Collins 2008) and the PCC plot shows the same pattern as the t-test and Kruskal-Wallis (KW) comparisons between the clusters from the dendrogram, albeit with much lower  $r^2$  (<0.4) for glandular leaf size features, flower number and sepal width, indicating that these were not as important in the ordination space as the other features (all >0.6).

The features with the highest t, KW and  $r^2$  scores were glabrous leaf number, length, width, glandular leaf number, scape length, sepal and petal length.

The overall character ranges for features observed to differ between the two taxa are listed in Table 2 (including some excluded from the cluster analysis as there were too many specimens missing those characteristics and/or the binary nature of the feature may have skewed the result). The seeds of the two forms, although similar in shape and testal morphology to each

other (Fig. 3), as might be expected for closely related taxa, differ in overall size; the seeds of *Drosera murfetii* being significantly longer ( $t = 14.762$ ,  $df 1$ ,  $81.87$ ,  $P < 0.0001$ ) and wider than those of *D. arcturi* ( $t = 8.505$ ,  $df 1$ ,  $90.62$ ,  $P < 0.0001$ ), though there is some overlap.

**Amended key to the species of Tasmanian Droseraceae**

The key to Tasmanian Droseraceae of Morris (2009) should be amended to incorporate the new species by inserting a new couplet after number 5, as follows:

- 5. Leaves orbicular, < 2 cm long; flowers 2–20 ..... *D. glanduligera*
- 5: Leaves linear-oblong, 3–20 cm long; flowers 1–4
- 5a. Basal leaves broad, spreading, glabrous; inner leaves (0–) 1–2 (–4), glandular, erect ..... *D. murfetii*
- 5a: Basal leaves small or absent; glandular leaves numerous, often semi-erect ..... *D. arcturi*

**Taxonomy**

**1. *Drosera arcturi* Hook.**

J. Bot. (Hooker) 1: 247 (1834), emend.; Icon. Pl. 1: tab. 56 (1837). — **Type citation:** “summit of Mt Arthur Mr Gunn, (n. 139 [sic].)”, corrected by Diels, Pflanzenz. 4(112) [Heft 26]: 64 (1906): “Mount Arthur (Gunn n. 129 [...])”. **Type sheet:** “Summit of Mt Arthur, Van Dn’s [Diemen’s] Land, 129. W. Gunn 1832”, bottom collection on sheet. **Lectotype (here designated, Fig. 6):** K 000215043!\* pro parte [top middle specimen], ex Herb. Hook. **Remaining syntypes:** K 00215043!\* pro parte [remaining five specimens], MEL 96027A!

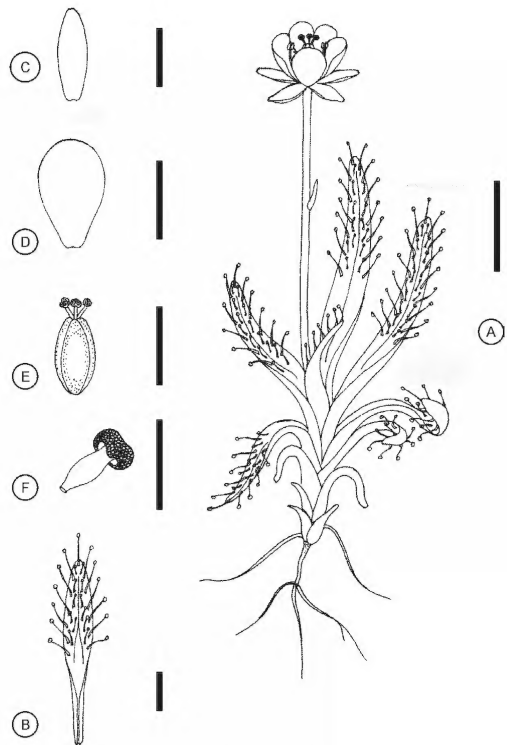
*Drosera polyneura* Colenso, *Trans. & Proc. New Zealand Inst.* 22: 460 (1890) [“1889”]. — **Type citation:** “Swampy spots, base of Mount Tongariro, County of East Taupo; 1889.” **Syntype:** Swampy spots, base of Mount Tongariro, County of East Taupo, [1889.] *H.Hill s.n.* (K 000659184).

*Drosera ruahinensis* Colenso, *Trans. & Proc. New Zealand Inst.* 28: 593 (1896). — **Type citation:** “Ruahine Mountain-range; Mr. H.Hill, 1895; Mr. A. Olsen, 1895” **Syntype:** Ruahine Mountain-range, east side, wet spots near summits, [1895.] *A.Olsen s.n.* (K 000659178).

*Drosera atra* Colenso, *Trans. & Proc. New Zealand Inst.* 31: 269 (1899). — **Type citation:** “Ruahine Mountain-range, east side, wet spots near summits.” **Syntype:** Ruahine Mountain-range, east side, wet spots near summits, [1898.] *A.Olsen s.n.* (WELT 23581).

*Drosera ligulata* Colenso, *Trans. & Proc. New Zealand Inst.* 31: 269 (1899). — **Type citation:** “Euahine [sic] Mountain-range, east side, wet spots near summits; 1898.” **Syntype:** Ruahine Mountain-range, east side, in low-lying wet spots, [1898.] *A.Olsen s.n.*; n.v., fide Colenso (1899).

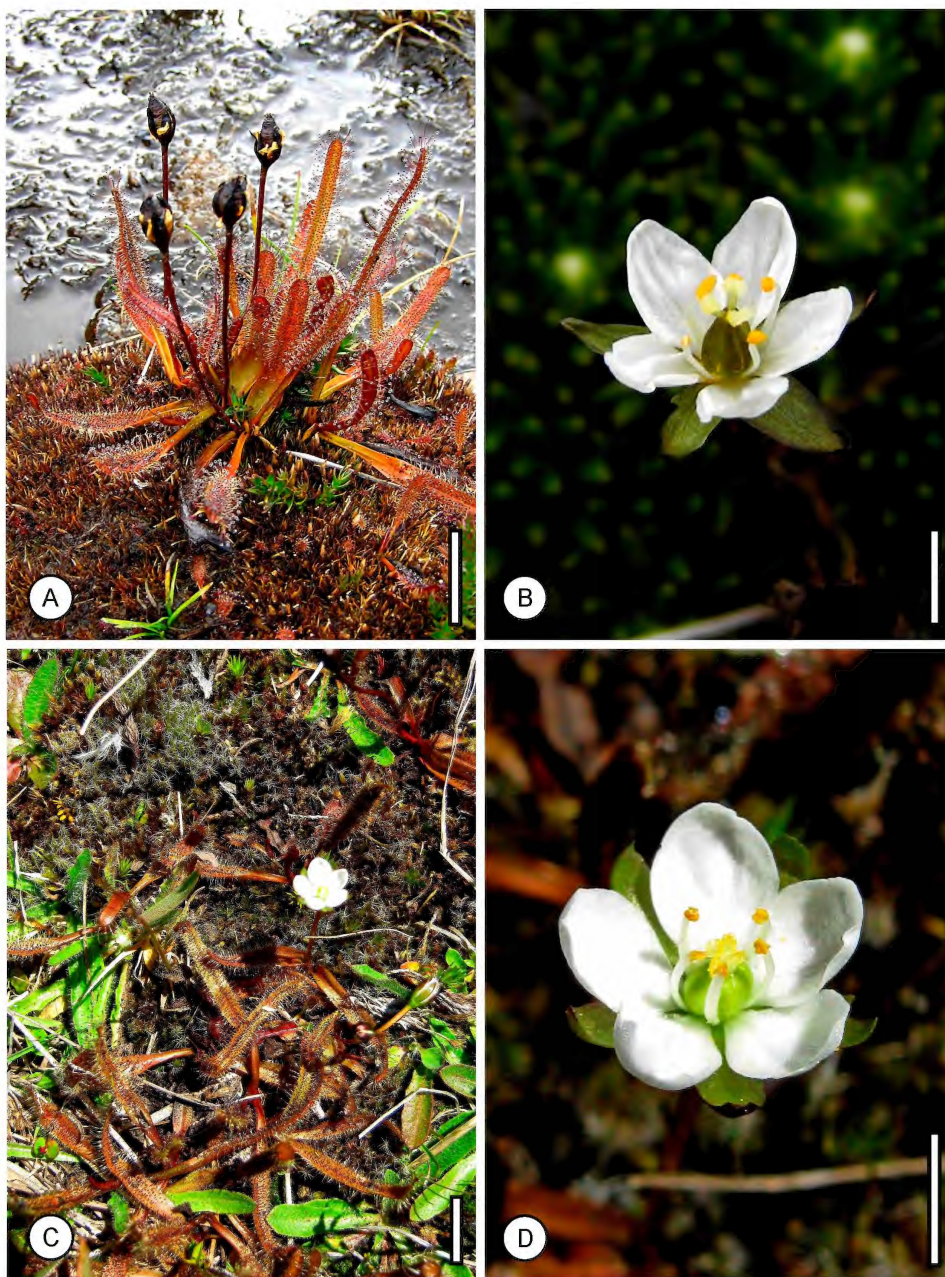
A cold tolerant, fibrous-rooted alpine perennial herb; rhizome 1–5 (>10) cm long, covered with persistent dead leaf bases. *Hibernaculum* bud-like, derived from glabrous basal leaf sheaths covering rhizome apex. *Glabrous leaves* at emergence (0–) 1–5, 3–27 × 0.7–4 mm, lanceolate, apically acute, glabrous, often short-lived and absent by anthesis; *glandular leaves* 2–12, narrowly lanceolate-spathulate, loosely distichous,



**Fig. 4. *Drosera arcturi*.** A plant; B lamina; C sepal; D petal; E gynoceium; F style and stigma. Scale bars: A 10 mm; B–D 5 mm; E–F 1 mm. — Drawn by A. Lowrie, 1988, from live material from the Snowy Mountains, New South Wales.

semi-erect to spreading, 1.3–12 cm long, green to greenish-bronze, red or almost black, persisting after senescence; *petioles* stem-sheathing, 0.6–0.8 mm wide at sheath apex, 1.5–1.8 mm wide at lamina, glabrous; *lamina* 9–70 × 2–6 mm, narrowly oblong, apex rounded, adaxial surface bearing large, sub-marginal insect-catching glands and smaller glands within, abaxial surface glabrous with a prominent midrib. *Inflorescence* terminal, scapose, 1 (–2)-flowered, 0.8–9 cm long, 0.4–0.5 mm diam., glabrous, enclosed basally by leaf sheaths, persistent, erect after senescence. *Flower* shortly pedicellate, erect in fruit; *pedicel* 3–12 mm; *floral bract* subulate, 2–2.5 × 0.4–0.6 mm. *Sepals* greyish-green, 4–10 × 1–3 mm, narrowly elliptic, adaxially concave, horizontal to recurved at anthesis, margins entire, apex obtuse, irregularly crenate, both surfaces glabrous. *Petals* white, 3–10 × 2.5–7 mm, obovate, entire, apex broadly rounded. *Stamens* 5, 4–6 mm long, filaments white, anthers and pollen yellow. *Ovary* 4–4.5 × 2.5–2.7 mm, ellipsoid, green, ovules numerous. *Styles* 3 (–4), greenish-white to pale yellow, 0.5–0.6 mm long (excluding stigmas), semi-erect, fusiform, flat in cross-section; *stigmas* ± reniform-peltate, 0.6–0.7 × 0.2–0.3





**Fig. 5.** *Drosera arcturi* in Australia and New Zealand. **A–B** Hartz Range, Tasmania: **A** habit; **B** close up of flower with 3 styles. **C–D** Grey Lake, Central Otago, New Zealand: **C** habit; **D** close up of flower with 4 styles. Scale bars: **A, C** 10 mm; **B, D** 5 mm. Photos: **A, B** A. Lowrie; **C, D** J.G. Conran.

mm, stigma adaxially papillate. *Fruit* ellipsoid, 10–11 × 4–4.5 mm. *Seeds* c. 50–60, brown, 0.5–1 (–1.3) × 0.4–0.8 mm, irregularly lachrymoid to obovoid, ± longitudinally flattened; *funicle* sulcate; *testa* minutely reticulate-foveolate, anticlinal cells walls sinuous. **Alpine sundew. Figs. 3a–c, 4–7.**

*Etymology.* The epithet *arcturi* comes from the Latinised form of the Ancient Greek Ἀρκτούρος (*Arcturus*), meaning “Guardian of the Bear”, and from which the name Arthur is sometimes thought to be derived; it is referring to the type locality of Mt Arthur, Tasmania.

*Distribution and ecology.* Victoria, New South Wales, Tasmania & New Zealand: *Drosera arcturi* is a relatively common herb of the alpine and sub-alpine regions of mainland Australia and Tasmania, as well as southern New Zealand (Fig. 10), extending to middle altitudes or even down to sea level in western and south-western Tasmania and southern New Zealand. It grows in sphagnum bogs on wet heathlands, as well as in black peat soils along the margins of small mountain streamlets and rivulets, or the boggy margins of lakes. It also frequently grows in cushion plants such as *Donatia novae-zealandiae* Hook.f. (Stylidiaceae) and *Dracophyllum minimum* F.Muell. (Ericaceae) (Cameron 1981) and sometimes grows intermixed with *D. murfetii*, with which it is sympatric over much of south-west Tasmania, but with no clear evidence of hybrids or intermediate plants.

*Conservation status.* Not currently threatened.

*Flowering period.* October–January (during the snow-free season).

*Lectotypification of Drosera arcturi.* William Hooker (1834) gives the type citation for *D. arcturi* as: “Summit of Mount Arthur Mr Gunn, (n. 139. [sic])”, but this appears to be an error, as J.D. Hooker (1860) cited the collection as “Gunn 129” in his *Fl. Tasmaniae*. The type sheet at Kew holds two collections (Fig. 6), but as noted by Diels (1906), the lower sheet gathering with hand notation “summit of Mt Arthur, Van Dn’s [Diemen’s] Land, 129. W. Gunn 1832” (K 000215043) represents the type material of *Drosera arcturi*. Nevertheless, as no lectotype has been nominated previously, we accordingly here nominate the top middle specimen of that collection as the lectotype, with the other 5 duplicate specimens from that collection and the specimens on the duplicate at MEL regarded as residual syntypes. In contrast, the upper sheet gathering with hand notation “129 [over] 1842 Mt Wellington 1/3/39 [1 Mar. 1839] & 31/1/40 [31 Jan. 1840]” (K 000215085), represents material of *D. arcturi* from two separate, later gatherings from Mount Wellington and is not considered to be type material.

The gazetteer (Geoscience Australia 2013) lists three Mt Arthur locations in Tasmania:

1. Wellington Park, NE of Mt Wellington (42°53'6"S, 147°13'5"E), which overlooks the city of Hobart
2. Mt Arthur State Reserve, SW of Port Arthur near the

original English convict penal settlement (43°9'14"S, 147°48'51"E)

3. Lilydale, NW of Launceston (41°16'44"S, 147°17'17"E).

However, of these, Mt Arthur at Lilydale, north-west of Launceston, appears to be where Gunn’s original specimens of *Drosera arcturi* were collected in 1832. Buchanan (1988) noted that Gunn was a resident of Launceston, when he sent his first consignment of herbarium specimens to Hooker in 1832, and that these were gathered from east of Launceston, principally from Ben Nevis and Mt Arthur, including the type material for *Drosera arcturi*.

Robert Brown collected material of what is now *D. arcturi* (Bennett no. 4850: BM 001050170) from near the summit of ‘Table Mountain’ (now part of Mt Wellington) in 1804 and labelled it with the unpublished manuscript name “*Drosera lingulata*” (Chapman et al. 2001). Unfortunately, this excellently preserved flowering material (Fig. 7) was not included in his *Prodromus* (Brown 1810), nor was it apparently seen by Hooker. Gibson (2010, p. 11) referred to this collection, saying “Robert Brown collected samples of the ‘Giant’ form of *D. arcturi* from Port Davey in March 1804, which were later described as *D. ‘lingulata’*.” However, the Brown collection at K is labelled “In paludosis summitatis Montis Tabularis prope fluvio Derwent Feb: 18 Mar 1804” [in a swamp at the summit of Table Mountain near the Derwent River] and Brown is not known to have visited Port Davey in Feb–Mar 1804, but was instead collecting in the region around Hobart (Vallance et al. 2001). This collection is also clearly conspecific with the type form of *D. arcturi* and was placed into that cluster in the analyses. As the epithet “*lingulata*” was never published validly it has no taxonomic standing, nor does the Brown collection represent type material.

Colenso (1890, 1896, 1899) described several taxa from New Zealand which are clearly part of the *D. arcturi* complex and examination of photographs of specimens of *D. atra* (WELT 23581), *D. polyneura* (K 000659184), and *D. ruahinensis* (K 000659178) shows that they all fall well within the variability seen for *D. arcturi* sens. str. to where they were reduced in synonymy by Cheeseman (1906). These specimens also fell into the *D. arcturi* clusters in the numerical analyses.

*Specimens examined (specimens marked \* were used in the numerical analysis)*

NEW SOUTH WALES: Found below Snowy Crossing and not far below Charlotte Pass Road, Kosciuszko Nat. Park, 6 Feb. 1975, *A.M.Ashby 5128* (\*AD 97529011); Near site of old Soil Conservation Hut near Blue Lake, 3 Feb. 1988, *A.M.Buchanan 10806* (\*HO 129367); Near Bett’s Creek S of The Paralyser (c. 9 km ENE of Mt Kosciuszko), 24 Jan. 1957, *Hj.Eichler 13461* (\*AD 95736072); Near Bett’s Creek S of The Paralyser (c. 9 km ENE of Mt Kosciuszko), 24 Jan. 1957, *Hj.Eichler 13472* (\*AD 95736029).

TASMANIA: 1 km N of Reservoir Lakes, 11 Jan. 1984, *D.G.Adams 7* (\*HO 76687); Lake Salome, Walls of Jerusalem, 25 Jan. 1982, *M.J.Brown 117* (\*HO 65857); In paludosis summitatis Montis Tabularis prope fluvio Derwent, 18 Feb.





Fig. 6. Type sheet of *Drosera arcturi* with two collections by Gunn. The lectotype (K 000215043, collected in 1832) is indicated by a thick black line; residual syntypes by a dashed line. The upper collection (K 000215085, mixed collection from 1839 and 1840) is not type material. Image copyright of the Board of Trustees of the Royal Botanic Gardens, Kew, used with permission.





Fig. 7. Robert Brown's 1804 collection of *Drosera arcturi* (Bennett no. 4850: BM 001050170) from near the summit of "Table Mountain" (now part of Mt Wellington) and labelled with the unpublished manuscript name "*Drosera lingulata*". The upper collection on the sheet (BM 001050169) is possibly a duplicate specimen. Image copyright of the The Picture Library, The Natural History Museum, London; used with permission.

1804, *R.Brown 4850* (\*BM 001050170, Fig. 7); Near Giblin River, 7 km from mouth, 23 Jan 1986, *A.M.Buchanan 8091* (HO 142845); Lake Ewart, 4 Feb. 1987, *A.M.Buchanan 9895* (\*HO 409074, mixed collection); SW Nat. Park, Middle Giblin River Basin, 8 km NW of Mt Gaffney, 13 km N of Mulcahy Bay, 17 Feb. 1989, *J.R.Croft 10158* (\*HO 410760); Eagle Tarn, Mt Field Nat. Park, 2 Jan. 1948, *W.M.Curtis s.n.* (\*HO 3309); Mt Wellington, near Hobart, 1 Feb. 1947, *W.M.Curtis s.n.* (\*HO 42667); Cradle Mountain Nat. Park, Lake Dove, near boat shed, 7 Jan. 1960, *Hj.Eichler 16465* (\*AD 96107068); Near Cradle Mt, Along track to Artist Pool, 9 Jan. 1960, *G.Ford s.n.* (\*AD 98142217); Gordon River, 27 Nov. 1937, *H.D.Gordon s.n.* (\*HO 3322); Mt Wellington, 1 Mar. 1839 & 31 Jan. 1840, *R.C.Gunn 129/1842* (\*K 000215085, Fig. 6); Hartz Mt, 18 Dec. 1966, *J.H.Hemsley 6072* (\*HO 3317); Mt Wellington plateau S, 27 Jan. 1968, *J.H.Hemsley 6503* (\*HO 3318); Upper Maxwell Valley, 15 Dec. 1978, *S.J.Jarman s.n.* (\*HO 30380); Surrounds of Lake Esperance, Hartz Mts, alt. 1000 m, 23 Jan. 2005, *A.Lowrie 3105 & D.E.Murfet* (AD, HO, MEL, NSW, PERTH); Near Ben Lomond alpine village, alt. 1425 m, 26 Jan. 2005, *A.Lowrie 3135 & D.E.Murfet* (\*AD, HO, MEL, NSW, PERTH); On Belton & Belcher Lakes walk trail c. 500 m from road to Lake Dobson, Mt Field, alt. 1090 m, 22 Jan. 2006, *A.Lowrie 3173 & D.E.Murfet* (\*AD, HO, MEL, NSW, PERTH); Saddle c. halfway between Mt Arthur & Mt Wellington summits, overlooking Hobart, alt. 1180 m, 23 Jan. 2006, *A.Lowrie 3178 & D.E.Murfet* (\*AD, HO, MEL, NSW, PERTH); Start of the Hobartian Walk Trail on summit of Mt Arthur near road to Mt Wellington summit, alt. 1120 m, 23 Jan. 2006, *A.Lowrie 3180 & D.E.Murfet* (\*AD, HO, MEL, NSW, PERTH); Near Lady Tarn, Hartz Mts, alt. 1000 m, 24 Jan. 2006, *A.Lowrie 3185 & D.E.Murfet* (\*AD, HO, MEL, NSW, PERTH); Second Bar Lake, 11 Mar. 1984, *A.Moscal 6888* (HO 401488); Julian Lakes, 29 Dec. 1984, *A.Moscal 9113* (\*HO 404030); Abbotts Lookout, 24 Mar. 1985, *A.Moscal 10353* (\*HO 143814); Hartz Mts Nat. Park, Lake Esperance area, 23 Jan. 2005, *D.E.Murfet 4893* (\*AD 178970, HO); Hartz Mts Nat. Park, Lake Esperance area, 23 Jan. 2005, *D.E.Murfet 4894* (\*AD 178971, HO); Mt Ben Lomond, near ski lodge area, 26 Jan. 2005, *D.E.Murfet 4912* (\*AD 178963, HO); Lake Dobson in the Mt Field Nat. Park, 22 Jan. 2006, *D.E.Murfet 5184* (\*AD 190697, HO); Lake Belcher/Belton walking trail, Mt Field Nat. Park, 22 Jan. 2006, *D.E.Murfet 5185* (\*AD 190655, HO); Mt Wellington on saddle on way up from Mt Arthur, alt. 1180 m, 23 Jan. 2006, *D.E.Murfet 5190* (\*AD 190792, HO); Mt Arthur, off Mt Wellington road near sharp bend, 23 Jan. 2006, *D.E.Murfet 5191* (\*AD 190791, HO); Ladies Tarn in the Hartz Mts Nat. Park, alt. 1000 m, 24 Jan. 2006, *D.E.Murfet 5196* (\*AD 190654, HO); Hartz Mts Nat. Park, Ladies Tarn, 27 Dec. 2007, *D.E.Murfet 5846* (\*AD 216591, HO); Mt Field Nat. Park, Lake Dobson, 28 Dec. 2007, *D.E.Murfet 5851* (\*AD 216748, HO); Pine Lake on the Highland Lakes Highway, 31 Dec. 2007, *D.E.Murfet 5902* (\*AD 216520, HO); Ben Lomond Nat. Park, Land of Little Sticks, 26 Mar. 1979, *M.G.Noble 28509* (\*HO 73420); Edge of Tarn, Wombat Moor, Mt Field Nat. Park, 26 Mar. 1932, *O.Rodway 104* (\*HO 3311); Upper reaches of North West Bay River, Mt Wellington, 6 Feb. 2000, *A.C.Rozefelds 1626* (\*HO 502869); Near Lake Dobson huts, Mt Field, 6 Jan. 1978, *J.M.B.Smith 246* (\*HO 36364); N end of Tarn Shelf, Mt Field Nat. Park, 21 Mar. 2006, *M.Visoiu 176* (\*HO 539027, mixed collection); Lake Augusta, 13 Feb. 2009, *M.Visoiu 537*, *J.Balmer & M.Van Slageren* (\*HO 551187; Millennium Seedbank Voucher).

VICTORIA: Mt Baw Baw, NE of Ski Village, 22 Jan. 1966, *A.C.Beaglehole 15272* (MEL 538741A); Bogong High Plains, Watchbed Creek, 27 Jan. 1966, *A.C.Beaglehole 15629*

(MEL 538743A); Mt Cope, 21 Feb. 1982, *E.A.Chesterfield 1609* (MEL 2130844A); Bogong High Plains, surroundings of Mt Nelse, alt. 1900 m, 13 Feb. 1958, *Hj.Eichler 14831* (\*AD 96105210); Bogong High Plains, Rocky Knobs, alt. 1800 m, 3 Feb. 1958, *Hj.Eichler s.n.* (\*AD 96105056); Alpine Nat. Park, Bogong High Plains, Head of Middle Creek, about 100 m N of start of track to Cope Hut, alt. 1700 m, 18 Mar. 2009, *J.A.Jeanes 2148* (MEL 2325711A); Mt Mueller, Gippsland, alt. 1540 m, s.dat., *J.G.Luehmann s.n. & C.H.French Jr* (MEL 95997A); Bogong High Plains, Rocky Valley, alt. 1560 m, 20 Jan. 1959, *T.B.Muir 704* (\*AD 96435006); Bridge crossing on walk to Derrick Hut, S of Mt Lock, 2 Jan. 2005, *D.E.Murfet 4866* (\*AD 178932, HO); Near Mt Cope on Bogong High Plains, 13 Jan. 2005, *D.E.Murfet 4871* (\*AD 178939, HO); Bogong High Plains, 20 Jan. 1936, *R.T.Patton s.n.* (MEL 96023A); Mt Erica, s.dat., *G.Weindorfer s.n.* (MEL 580029A); Bogong High Plains, (c. 130 km SE of Wangaratta), s.dat., *J.H.Willis s.n.* (MEL 96024A); Echo Flat, Lake Mt, near Marysville, alt. 1480 m, 6 Dec. 1943, *J.H.Willis s.n.* (MEL 2217024A); Echo Flat, Lake Mt, c. 10 miles [16 km] NE of Marysville, alt. 1450 m, 25 Jan. 1948, *J.H.Willis s.n.* (MEL 95999A); Baw Baw Mts, 2 Jan. 1905 *H.B.Williamson s.n.* (MEL 620164A).

NEW ZEALAND: Mt Sebastopol, Canterbury, 3 Feb. 1946, *G.T.S.Bayliss s.n.* (\*OTA); Devils Elbow Stream, Mt Cook, Canterbury, 11 Feb. 1968, *A.M.Buchanan s.n.* (HO 80813); Upper West Matakaitaki River valley, 15 Jan. 1992, *A.M.Buchanan 12263* (HO 538074); Near summit of Mt Whitecoomb, Umbrella Mts, 14 Dec. 1985, *K.J.M.Dickinson & B.D.Race s.n.* (\*OTA); Little Pomohaka Headwater, Umbrella Ecology District, 6 Jan. 1986, *K.J.M.Dickinson & B.D.Race s.n.* (\*OTA); Maungatua, Central Otago, 23 Mar. 1985, *J.Eason s.n.* (\*OTA); Lammermoors, 20 Dec. 1977, *D.Holdsworth s.n.* (\*OTA); Maungatua, Central Otago, s.dat., *J.E.Holloway s.n.* (\*OTA); Lewis Pass, Canterbury, 4 Jan. 1968, *P.N.Johnson s.n.* (\*OTA); Red Mt, NW Otago, 1 Feb. 1975, *W.G.Lee & A.F.Mark s.n.* (\*OTA); Wiarua Valley, Red Hills, 30 Nov. 1972, *W.G.Lee s.n.* (\*OTA); Maungatua, Central Otago, s.dat., *A.B.Lloyd s.n.* (\*OTA); Maungatua, Central Otago, s.dat., *A.F.Mark s.n.* (\*OTA); Blue Mts, 31 Dec. 1964, *A.F.Mark s.n.* (\*OTA); Red Creek Barrier U, Pyke River, 9 Dec. 1969, *A.F.Mark s.n.* (\*OTA); Maungatua, Central Otago, Mar. 1951, *A.F.Mark s.n.* (\*OTA); Olivine Ledge, W. Otago, 17 Feb. 1968, *A.F.Mark s.n.* (\*OTA); Mueller Valley, Turnbull River, Mt Aspiring Nat. Park, 21 Jan. 1969, *A.F.Mark s.n.* (\*OTA); Mueller Valley, Turnbull River, Mt Aspiring Nat. Park, 21 Jan. 1969, *A.F.Mark s.n.* (\*OTA); Upper Makarorua Valley, Young Range, Mt Aspiring Nat. Park, Fiordland, 9 Feb. 1969, *A.F.Mark s.n.* (\*OTA); Upper Aparima Valley, Takitimu Mts, N Southland, 1 Feb. 1971, *A.F.Mark s.n.* (\*OTA); Waitutu Forest, W Southland, 13 May 1985, *A.F.Mark s.n.* (\*OTA); Lake Sylvester, NW Nelson, 17 Dec. 1967, *A.F.Mark & N.M.Adams s.n.* (\*OTA); Arthurs Pass, Arthurs Pass Nat. Park, 30 Dec. 1967, *A.F.Mark & N.M.Adams s.n.* (\*OTA); Borland Saddle, Hunter Mts, Fiordland, 7 Jan. 1968, *A.F.Mark & N.M.Adams s.n.* (\*OTA); Key Summit, Fiordland, 10 Jan. 1968, *A.F.Mark & N.M.Adams s.n.* (\*OTA); Mt Richmond, Two Thumb Range, Canterbury, 1 Jan. 1969, *A.F.Mark & N.M.Adams s.n.* (\*OTA); Williamson Flat, Joe – Arawhata River, Mt Aspiring Nat. Park, Fiordland, 16 Jan. 1968, *A.F.Mark & M.L.Burke s.n.* (\*OTA); Lake Tehafer, 27 Dec. 1958, *D.Scott s.n.* (\*OTA); Ajax Swamp, Catlins, SE Otago, 29 July 1975, *A.F.Mark, P.H.Johnson & G.T.S.Bayliss s.n.* (\*OTA); Secretary Island, Feb. 1959, *J.Murray 4463* (\*OTA); Gardiners Rd area, 16 Feb. 1980, *J.F.West s.n.* (\*OTA); Gardiners Rd area, Glendhu, 16 Feb. 1980, *J.F.West s.n.* (\*OTA);

**2. *Drosera murfetii* Lowrie & Conran, sp. nov.**

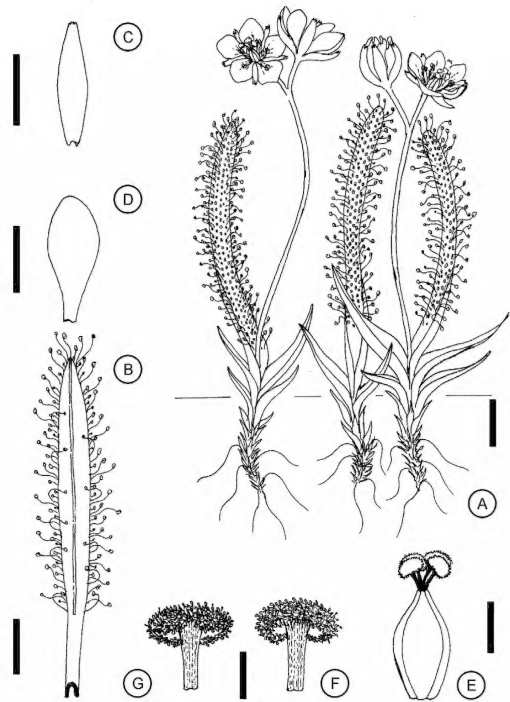
*A Drosera arcturi* foliis viridis et rubis, foliis basalibus 2–5, glabris, (1–) 3–5 (–12) longis, foliis distalis (0–) 1–2 (–4), glandulosis, 3.5–21.7 cm longis, styliis 4–5; viridi-albis ad purpureo-ceriseis stigmata, semina (0.8–) 1–2 × (0.4–) 0.6–1 mm, differt.

**Typus:** shores of Lake Esperance, Hartz Mountains, Tasmania, 43°13'44"S 146°46'14"E, alt. 1000 m, A. Lowrie 3181 & D.E. Murfet, 24 Jan 2006. — **Holotypus:** HO. **Isotypi:** PERTH; MEL, AD, NSW, distribuendi.

*Drosera arcturi* auct. non Hook.: Marchant, Fl. Austral. 8: 54 (1982), pro parte; Lowrie, Carniv. Pl. Austral. 136 (1998), pro parte; Morris, Fl. Tas. Online, Droseraceae 3 (2009), pro parte.

A cold tolerant, green, turning red with age or exposure, fibrous-rooted alpine perennial herb; rhizome 1–5 (>10) cm long, covered with persistent dead leaf bases. *Hibernaculum* bud-like, derived from non-glandular basal leaf sheaths covering rhizome apex. *Leaves* at emergence 2–5, (1–) 3–5 (–12) × 0.5–1.5 cm, lanceolate, apically acute, glabrous; *glandular leaves* (0–) 1–2 (–4), linear to narrowly lanceolate-spathulate, loosely distichous, erect, 3.5–21.7 cm long, persisting after senescence; *petioles* stem-sheathing, 1.5–2.5 cm long, 0.8–1 mm wide at sheath apex, 1.5–2 mm wide at lamina, glabrous; *lamina* 22–55 (>75) × 2–6 mm, more or less linear to lanceolate or narrowly oblong, apex blunt to rounded, adaxial surface bearing large, sub-marginal insect-catching glands and smaller glands within, abaxial surface glabrous with a prominent midrib (occasional plants bear no trapping leaves at all). *Inflorescence* terminal, scapose, 1–4-flowered, 3–20 cm long, 0.5–0.6 mm diam, glabrous, enclosed basally by leaf sheaths, persistent, prostrate after senescence. *Flowers* shortly pedicellate, erect in fruit; *pedicels* 1.5–12 mm long; *floral bract* subulate, 1–2 × 0.4–0.5 mm. *Sepals* greyish-green, 10–16 × 2.3–2.5 mm, narrowly elliptic, adaxially concave, horizontal at anthesis, margins entire, apex obtuse, irregularly crenate, both surfaces glabrous. *Petals* white, 5–14 × 4–5 mm, obovate, entire, apex broadly rounded. *Stamens* 5, 6–7 mm long, filaments white, anthers and pollen yellow. *Ovary* 7–8.5 × 4.2–5.1 mm, ellipsoid, green, ovules numerous. *Styles* 4–5, white, basally black, 0.8–2 × 0.2–0.3 mm (excluding stigmas), semi-erect, fusiform, flat in cross-section; *stigmas* greenish-white throughout most of its range or reddish-cerise (Hartz Mountains), ± reniform-peltate, 1.5–2.5 × 0.5–0.6 mm, stigma adaxially papillate. *Fruit* ellipsoid, 7–11 × 4.5–7.7 mm. *Seeds* c. 80–90, dark brown, (0.8–) 1–2 × (0.4–) 0.6–1 mm, irregularly lachrymoid to obovoid, ± longitudinally flattened; *funicle* sulcate; *testa* minutely reticulate-foveolate, anticlinal cells walls sinuous. **Giant alpine sundew. Figs. 3d–f, 8, 9.**

**Etymology.** The species is named in honour of Denzel Edwin Murfet (1957–), communications technician, amateur botanist, carnivorous plant, *Stylidium* and orchid enthusiast, who collected the species in the Hartz Range, Tasmania.



**Fig. 8. *Drosera murfetii*.** A plant; B lamina; C sepal; D petal; E gynoecium; F style and stigma, posterior view; G style and stigma, anterior view. Scale bars: A 10 mm; B–D 5 mm; E–G 1 mm. — Drawn by A. Lowrie, 2007, from type material (A. Lowrie 3181 & D.E. Murfet).

**Distribution and ecology.** Widespread from sea-level to alpine areas of western and south-western Tasmania (Fig. 11) in wet heathlands, near the shores of tarns, and at higher altitudes, commonly grows in cushion plants (*Donatia novae-zealandiae* and *Dracophyllum minimum*), often alongside *Drosera arcturi*.

**Conservation status.** *Drosera murfetii* throughout its range is common and not threatened.

**Flowering period.** November–January, with a peak flowering period for *D. murfetii* observed by AL and DEM at the end of Dec. 2007 (during the snow-free season).

**Distinguishing characters.** The morphologically most similar species to *D. murfetii* is *D. arcturi*, whose distinguishing characters are given in parenthesis. *Drosera murfetii* is distinguished by having: green and red foliage (green to greenish-bronze, red or almost black) conspicuous, glabrous basal leaves, usually (1–) 3–5 (–12) cm long above the soil surface (glabrous basal leaves absent or small, linear, mostly 3–12 mm long, but occasionally up to 27 mm); glandular leaves commonly 1, sometimes 2, rarely up to 4, usually 3.5–8 cm long, but sometimes up to 21.7 cm long or longer (glandular leaves 3–12, 3–5 cm long, but sometimes up to 12 cm



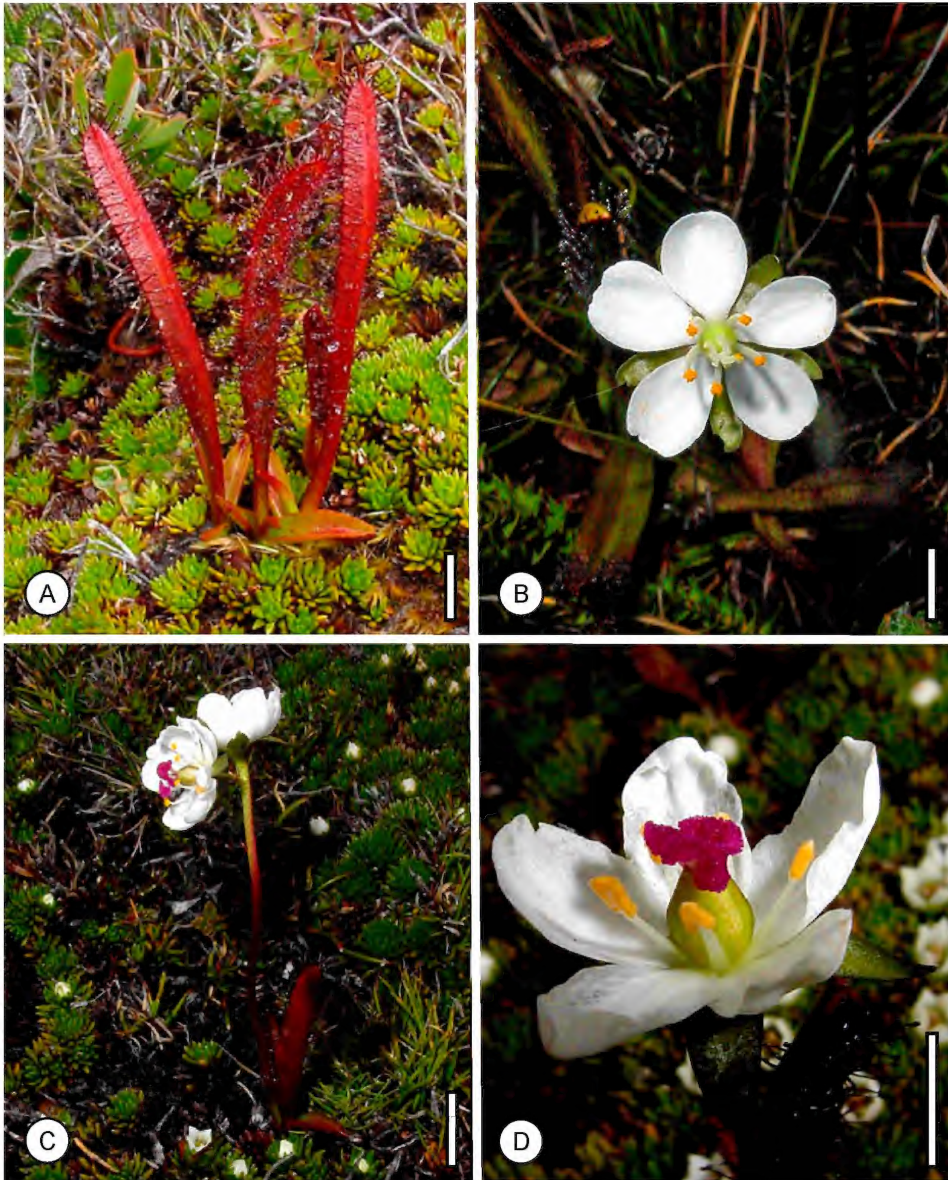


Fig. 9. *Drosera murfetii* in the Hartz Mountains, Tasmania. **A** plants showing broad glabrous basal leaves and few, erect trapping leaves; **B** close up of flower with white stigmas; **C** plant showing multiple flowers per scape; **D** close up of cerise stigma form. Scale bars: **A, C** 10 mm; **B, D** 5 mm. — Photos: A. Lowrie.

long); styles 4–5 (styles 3–4); seeds (0.8–) 1–2 × (0.4–) 0.6–1 mm (seeds 0.5–1 (–1.3) × 0.4–0.8 mm).

*Notes.* Throughout its range, *D. murfetii* is more common than *D. arcturi* at lower elevations and particularly at or near sea level in south west Tasmania. *Drosera*

*murfetii* coexists with *D. arcturi* at higher elevations, where it commonly grows side by side with *D. arcturi*, sharing the same cushion plants. Despite extensive field explorations carried out by AL and DEM in Jan. 2005, Jan. 2006 and Dec. 2007 at several sites in south-west Tasmania, no intermediate forms were found in terms of

the possession of large glabrous leaves and few, erect (versus numerous, semi-erect) trapping leaves.

*Specimens examined (specimens marked \* were used in the numerical analysis)*

TASMANIA: Moores Garden, 14 Jan. 1984, *D.G.Adams 41* (\*HO 76650); 1 km NE of the W-most causeway on the S side of Lake Augusta, 5 Jan. 1971, *W.R.Barker 1030* (\*AD 97114123); Ooze Lake, 31 Jan. 1981, *A.Brown 221* (\*HO 327549); Head of D'Entrecasteaux River, 22 Mar. 1984, *A.M.Buchanan 3039* (\*HO 76816); Jubilee Range, 13 Jan. 1985, *A.M.Buchanan 5241* (\*HO 120685); 2 km W of Granite Tor, 22 Jan. 1985, *A.M.Buchanan 5469* (\*HO 122115); Giblin River c. 7 km from mouth, 11 Jan. 1986, *A.M.Buchanan 7804* (\*HO 405459); S ridge of Mt Gaffney, 14 Jan. 1986, *A.M.Buchanan 7862* (\*HO 405516); N peak of Mt Gaffney, 14 Jan. 1986, *A.M.Buchanan 7880* (\*HO 405532); SE ridge of the Lawson Range, 25 Jan. 1986, *A.M.Buchanan 8107* (\*HO 404985); Low hills behind Coffin Bay, Port Davey, 5 Jan. 1987, *A.M.Buchanan 9244* (\*HO 405370); Ridge E of Deadmans Creek, 21 Jan. 1987, *A.M.Buchanan 9761* (\*HO 402904); Lake Ewart, 04 Feb. 1987, *A.M.Buchanan 9895* (HO 409074, mixed collection); Between Deadmans Bay and Lousy Bay, 19 Jan. 1987, *A.M.Buchanan 9638* (\*HO 123668); Schnells Ridge, 27 Jan. 1998, *A.M.Buchanan 15037* (HO 324160); Mt Read S side of summit, 21 Feb. 2008, *A.M.Buchanan 16916* (HO 548612); Lake Dobson, Mt Field Nat. Park, 22 Jan. 1949, *N.T.Burbidge 3259* (\*HO 3310); Darwin Plateau, 25 Dec. 1984, *P.Collier 220* (\*HO 116495); Mt Field Nat. Park (Lake Belcher track, beyond saddle), 2 Feb. 1969, *E.M.Canning s.n.* (\*AD 97026096); Mt Solitary summit, 25 Mar. 1990, *P.Collier 4641* (\*HO 142923); Lake Dobson, Mt Field Nat. Park, 23 Jan. 1944, *W.M.Curtis s.n.* (\*HO 42666); Near Cradle Mt, along track to Artist Pool, 9 Jan. 1960, *G.Ford s.n.* (\*AD 98204400); Denison Range, Reeds Peak area, 30 Nov. 1978, *C.Harwood s.n.* (\*HO 29560); Hamilton Range, 29 Jan. 1977, *S.J.Jarman s.n.* (HO 411337); Proping Range, 16 Feb. 1977, *S.J.Jarman s.n.* (\*HO 410974); Mt Humboldt, 17 Jan. 1978, *S.J.Jarman s.n.* (\*HO 411973); Mt Rugby, 16 Feb. 1978, *S.J.Jarman s.n.* (HO 411018); Mt Lee, 3 Mar. 1978, *S.J.Jarman s.n.* (\*HO 411087); Upper tributaries of the Giblin River, E of the Lawson Range, 31 Dec. 1978, *S.J.Jarman s.n.* (\*HO 30472); Moth Creek, Bathurst Harbour, 31 Jan. 1962, *H.J.King s.n.* (\*HO 3315); Melaleuca Creek, 31 Jan. 1929, *F.H.Long s.n.* (HO 3323); Shores and surrounds of Lady Tarn, Hartz Mts, 27 Dec. 2007, *A.Lowrie 3740* & *D.E.Murfet* (\*AD, MEL, NSW, PERTH); Mt Lyell camp, Julia Creek, 8 Dec. 1980, *M.K.Macphail s.n.* (\*HO 37056); Hamilton Moraine, Basin Lake, 9 Dec. 1980, *M.K.Macphail s.n.* (\*HO 37115); Jubilee Range, 8 Jan. 1985, *A.Moscal 9187* (HO 97042); Jubilee Range, 13 Jan. 1985, *A.Moscal 9255* (\*HO 400964); Jubilee Range, 14 Jan. 1985, *A.Moscal 9333* (\*HO 95532); Jubilee Range, 16 Jan. 1985, *A.Moscal 9372* (\*HO 95146); Mulcahy River plain, 13 Jan. 1986, *A.Moscal 11631* (\*HO 144694); Lawson Range, 25 Jan. 1986, *A.Moscal 11944* (\*HO 402114); Wilson Bight, 13 Jan. 1987, *A.Moscal 13935* (\*HO 409828); Hartz Mts Nat. Park, Lake Esperance area, 23 Jan. 2005, *D.E.Murfet 4894* & *A.Lowrie* (\*AD 178971, HO); Lake Dobson in the Mt Field Nat. Park, 22 Jan. 2006, *D.E.Murfet 5183* & *A.Lowrie* (\*AD 190696, HO); 200 m from Ladies Tarn in the Hartz Mts Nat. Park, 24 Jan. 2006, *D.E.Murfet 5192* & *A.Lowrie* (\*AD 190794, HO); Ladies Tarn in the Hartz Mts Nat. Park, 24 Jan. 2006, *D.E.Murfet 5195* & *A.Lowrie* (\*AD 190793, HO); Anthony Rd 8.3 km N of Zeehan Highway, 27 Jan. 2006, *D.E.Murfet 5208* & *A.Lowrie* (\*AD 190708, HO); Hartz Mts Nat. Park, Lake Esperance, 27 Dec. 2007, *D.E.Murfet 5843* & *A.Lowrie* (\*AD 216534, HO);

Hartz Mts Nat. Park, Ladies Tarn, 27 Dec. 2007, *D.E.Murfet 5844* & *A.Lowrie* (\*AD 216536, HO); Mt Field Nat. Park, Lake Dobson, 28 Dec. 2007, *D.E.Murfet 5850* & *A.Lowrie* (\*AD 216513, HO); Queenstown, along Anthony Rd toward Tullah, 29 Dec. 2007, *D.E.Murfet 5867* & *A.Lowrie* (\*AD 216515, HO); Hartz Mts, 29 Jan. 1938, *A.M.Olsen s.n.* (\*HO 411530); Hartz Mts, 22 Jan. 1939, *A.M.Olsen s.n.* (\*HO 312393); Mt Wellington, 31 Dec. 1892, *L.Rodway 190* (\*HO 3316); Twelvetees Range, 12 Jan. 1980, *D. Jan Morris 8038* (HO 32596); Dove Lake, 31 Dec. 1908, *L.Rodway 231* (\*HO 3312); Near Arve River, below hut, Hartz Mts, no date, *J.Somerville s.n.* (\*HO 3313); Moth Creek, Bathurst Harbour, 31 Jan. 1962, *S.Stanier s.n.* (\*HO 3314); N end of Tarn Shelf, Mt Field Nat. Park, 21 Mar. 2006, *M.Visoiu 176* (\*HO 539027, mixed collection); Sharlands Peak, Frenchmans Cap Nat. Park, 2 Jan. 1981, *T.J.Wardlaw s.n.* (\*HO 541098); Charles Range, summit of Southern Peak, SW aspect, 17 Feb. 1987, *J.M.Wells* (\*HO 315576).

## Discussion

*Drosera arcturi* occurs in the alpine regions of Victoria and New South Wales on the mainland of Australia, as well as Tasmania and New Zealand. The species is placed in subgenus *Arcturia* (Planch.) Schlauer [= *Drosera* section *Psychophila* auct. non. Planch. sensu Diels (1906) and Marchant et al. (1982)], along with *D. murfetti*. The New Zealand endemic *Drosera stenopetala* J.D.Hook and *D. uniflora* Willd. from southern South America are also traditionally included here (Diels 1906), but Culham (1993) found that pollen of *D. arcturi* was distinct from *D. uniflora*. This led Schlauer (1996) to transfer the latter to subgen. *Ptycnostigma* (Planch.) Drude, albeit with reservations on its placement. Although molecular studies also widely separated these two species, *D. stenopetala* was found to be sister to *D. uniflora* in an isolated lineage inside *Drosera* L. subgen. *Drosera*, rather than close to *D. arcturi* (Rivadavia et al. 2003, Yesson & Culham 2006). The latter is instead sister to most of the genus, with only the isolated South African *D. regia* Stephens sitting below it in the phylogenetic tree of Cameron et al. (2002).

Species concepts and taxon variability in Droseraceae vary considerably, with many taxa that are currently recognised at specific level within Australia (CHAH 2008–) reduced in rank or placed into synonymy by some overseas researchers (Schlauer 1996, 2006–), largely due to differences in opinion on species definitions. Nevertheless, recent research on *Drosera* has found that there are generally more species than were thought previously within so-called species complexes, with the trend being to recognise more rather than fewer entities, usually as a result of detailed multi-character comparisons (e.g. Fleischmann et al. 2008, 2011; Rivadavia et al. 2009; Gonella et al. 2014).

Cluster analysis and ordination is a standard method for the determination of morphometric variability within and between plant taxa (e.g. Stace 1989; Quinn & Keogh 2002) and the technique was applied recently to the polymorphic *Drosera peltata* Thunb. complex (Gibson



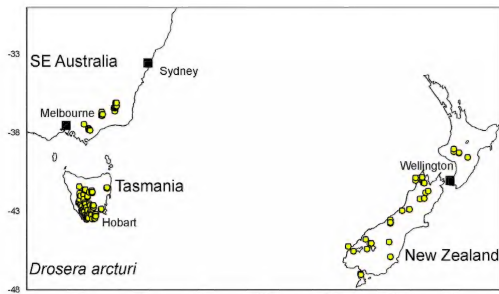


Fig. 10. Distribution map of *Drosera arcturi*. Map derived from AVH and specimens examined at AD, HO, MEL, OTA, and PERTH.

et al. 2012). As with the present study, the use of multi-character comparisons including morphometrics, found that there were clear differences between the different entities in the complex, allowing the determination of exactly how many taxa there are for the group.

When applied to *D. arcturi*, this approach shows that there are two discrete entities which differ in a range of features. Although *D. murfetii* is statistically significantly larger for nearly all measured features, there is still wide variability and overlap with *D. arcturi* for most of the size-related characteristics. Similarly, although the majority of *D. arcturi* specimens examined had three stigmas, while those of *D. murfetii* mostly had five, there were still plants in both taxa which possessed four.

The most obvious difference between the two species relates to the possession of broad, glabrous non-trapping leaves. These were completely absent in *D. arcturi*, where, if there were still glabrous leaves present at anthesis, they were tiny linear structures, the leaves instead all being typical, mostly semi-erect to spreading *Drosera* glandular trapping leaves. In contrast, all the *D. murfetii* plants examined bore broad, obviously photosynthetic outer leaves with only 1–2 larger, erect, inner gland-bearing leaves, or in the case of ten plants examined, apparently no trapping leaves at all. These features, combined with the overlapping distributions of the plants in south-western Tasmania and absence in the field of any obvious intermediate plants for these features, even when both taxa are growing in mixed populations, support our conclusion that they represent discrete taxa at species level.

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The Directors of herbaria AD, HO, MEL, OTA and PERTH are thanked for access to specimens, as are various Australian Botanical Liaison Officers at K. The Board of Trustees of the Royal Botanic Gardens, Kew, and The Picture Library, The Natural History Museum, London, are thanked for providing images of Gunn's and Brown's collections. The School of Earth & Environmental Sciences is thanked for provision of facilities for some of this research.

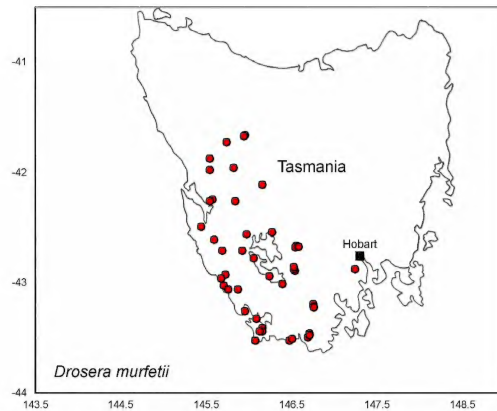


Fig. 11. Distribution map of *D. murfetii*. Map derived from AVH and specimens examined at AD and HO.

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## New combinations for the Phillip Island wheat grass, *Anthosachne kingiana* subsp. *kingiana* (Poaceae)

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### Abstract

Phillip Island wheat grass has been known under many different scientific names. The taxon is now mostly placed in the genus *Anthosachne* Steud., following recent molecular phylogenetic data. Unfortunately no correct name is currently available under that genus which is rectified here. The new combinations *Anthosachne kingiana* (Endl.) Govaerts and *Anthosachne kingiana* subsp. *multiflora* (Banks & Sol. ex Hook.f.) Govaerts are made.

**Key words:** nomenclature, new name, grass, Poaceae, *Anothosachne*, Phillip Island, Norfolk Island, Lord Howe Island, Australia.

### Introduction

Since the early 1990's I have maintained a database on plants recorded as being extinct. The entire database is not currently online, though the data feed into the *World checklist of selected plant families* (WCSP 2014). Species recorded as being extinct are indicated with a dagger (†) after the relevant geographical code. When transferring the Phillip Island wheat grass from the genus *Elymus* L. to *Anthosachne* Steud., I noticed a nomenclatural problem, which I resolve in this paper.

The Phillip Island wheat grass is a rare species listed as critically endangered in the Australian legislation protecting rare and endangered plants and animals under the name *Elymus multiflorus* subsp. *kingianus* (Endl.) de Lange & R.O.Gardner (Department of the Environment 2014). Until recently, it was considered to be endemic to Phillip Island, off Norfolk Island, and was thought to be extinct together with the two other endemics, *Hibiscus insularis* Endl. and *Streblorrhiza speciosa* Endl., as nearly all the vegetation on the islet had been eaten by goats, pigs and rabbits. When these feral animals were removed, Phillip Island wheat grass was able to recolonize the area, and was rediscovered on Phillip Island in 1987 (Sykes & Atkinson 1988). The species has now also been found on Norfolk Island and Lord Howe Island (Green 1994: 469) and therefore can no longer be considered as being endemic to Phillip Island.

After the removal of feral animals, the near-endemic *Abutilon julianae* Endl. also reappeared (Green 1994). This species was first described from Norfolk Island, but seems to have become extinct there a long time ago and can now only be found on Phillip Island. Another, previously unknown species, *Achyranthes margaretarum* de Lange (2001), was discovered recently, adding a third endemic species to the island.

At the species level *Elymus multiflorus* (Banks & Sol. ex Hook.f.) Á.Löve & Connor is found in coastal eastern Australia (Connor 1990; de Lange et al. 2005). So it seems that the only true endemics to Phillip Island are *Achyranthes margaretarum*, *Hibiscus insularis* and *Streblorrhiza speciosa*, of which the last two are still considered to be extinct (Green 1994).

### Discussion

The Phillip Island wheat grass was previously classified within the genus *Elymus*. Recent morphological and molecular studies (Barkworth & Jacobs 2011), however, have shown this taxon to be part of an Australasian group, distinct from *Elymus*, and the name *Anthosachne* has been resurrected to accommodate this group (Barkworth & Jacobs 2011).

When updating my personal database on plants recorded as being extinct, I noticed a problem with the newly published combination, *Anthosachne multiflora* (Banks & Sol. ex Hook.f.) C.Yen & J.L.Yang subsp. *kingiana* (Endl.) Barkworth & S.W.L.Jacobs. It seems that the basionym of the species name, dating from 1853, is later than the basionym of the infraspecific name, which has priority from 1833, thus making the subspecies superfluous and illegitimate (ICN Art. 52.1; McNeill et al. 2012). This error seems to have started when Connor published the name *Elymus multiflorus* (Banks & Sol. ex Hook.f.) Á.Löve & Connor var. *kingianus* (Endl.) Connor (Connor 1990), rather than making the combination under *Elymus kingianus*, and was perpetuated thereafter. This is hereby corrected.

### Nomenclature

*Anthosachne kingiana* (Endl.) Govaerts, *comb. nov.*

*Triticum kingianum* Endl., Prodr. Fl. Norfolk. 21 (1833).  
— *Festuca kingiana* (Endl.) Steud., Syn. Pl. Glumac. 1:

316 (1854). — *Agropyron kingianum* (Endl.) Petrie ex Laing, Trans. & Proc. New Zealand Inst. 47: 18 (1915). — *Elymus kingianus* (Endl.) Á.Löve, Feddes Repert. 95: 469 (1984). — *Elymus multiflorus* var. *kingianus* (Endl.) Connor, Kew Bull. 45: 680 (1990), nom. superfl. — *Elymus multiflorus* subsp. *kingianus* (Endl.) de Lange & R.O.Gardner, New Zealand J. Bot. 43: 571 (2005), nom. superfl. — *Anthosachne multiflora* subsp. *kingiana* (Endl.) Barkworth & S.W.L.Jacobs, Telopea 13: 50 (2011), nom. superfl.

***Anthosachne kingiana* (Endl.) Govaerts subsp. *kingiana***

This is the correct name for the subspecies from Norfolk, Phillip and Lord Howe Islands, commonly known as the **Phillip Island wheat grass**.

***Anthosachne kingiana* subsp. *multiflora* (Banks & Sol. ex Hook.f.) Govaerts, *comb. nov.***

*Triticum multiflorum* Banks & Sol. ex Hook.f., Bot. Antarct. Voy. II (Fl. Nov.-Zel.) 1: 311 (1853). — *Agropyron multiflorum* (Banks & Sol. ex Hook.f.) Kirk ex Hack. in Cheeseman, Man. New Zealand Fl.: 921 (1906). — *Agropyron kirkii* Zotov, Trans. & Proc. Roy. Soc. New Zealand 73: 233 (1943), nom. superfl. — *Elymus multiflorus* (Banks & Sol. ex Hook.f.) Á.Löve & Connor, New Zealand J. Bot. 20: 183 (1982). — *Anthosachne multiflora* (Banks & Sol. ex Hook.f.) C.Yen & J.L.Yang, Xiao mai zu sheng wu xi tong xue 3: 232 (2006).

This is the correct name for the subspecies from south-eastern Australia and New Zealand, commonly known as the **short-awned wheat grass**.

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## Three new species of, and realignments in, *Rhododendron* sect. *Schistanthe* (Ericaceae)

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### Abstract

Three new species are described, two from Sulawesi and one from New Guinea: *Rhododendron dissilistellatum* Craven, *R. gumineense* Craven and *R. torajaense* Craven. The circumscriptions of *R. seranicum* J.J.Sm. sensu Argent, *R. radians* J.J.Sm. sensu Argent & Sleumer, and *R. javanicum* (Blume) Benn. sensu Argent are considered to be excessively broad and the taxonomy of these three species is amended. One new name and six new combinations resulting from realignments in taxonomic status are proposed: *R. biappendiculatum* Craven, *R. cladotrichum* (Sleumer) Craven, *R. cockburnii* (Argent, A.Lamb & Phillipps) Craven, *R. extraneum* (Sleumer) Craven, *R. kinabaluense* (Argent, A.Lamb & Phillipps) Craven, *R. minahasae* (Sleumer) Craven, *R. palawanense* (Argent) Craven.

**Keywords:** *Rhododendron*, *Rhododendron* sect. *Schistanthe*, vireya rhododendrons, Ericaceae, new species, realignments, taxonomy, Malesia

### Introduction

Fieldwork in support of the doctoral research of Gillian Brown (School of Botany, The University of Melbourne, and CSIRO Plant Industry, Canberra) into the morphological systematics of *Rhododendron* sect. *Schistanthe* Schltr. (at that time called sect. *Vireya* (C.B.Clarke) H.F.Copel.) was undertaken in Sulawesi, Indonesia, in 2002 (see also Brown 2004, 2006a, 2006b). During the fieldwork, several collections of non-fertile plants were made and living material (seed or cuttings) was obtained of these in order to grow them on to flowering, at which point the plants could then be identified. In several other cases, herbarium collections were identified to a preliminary point only and detailed investigations into their identity were not then made.

The identification of the Sulawesi collections has recently been revisited and I have concluded that the taxonomy of *R. radians* J.J.Sm. sensu Argent (2006) and Sleumer (1966), and of *R. javanicum* (Blume) Benn. sensu Argent (2006) is unsatisfactory. The differences between the several taxa included in these two species are as great as the differences between other taxa accepted as “good” species by these two authors. Accordingly, realignments in the taxonomy of these two species and of *R. seranicum* J.J.Sm. sensu Argent (2013) are proposed below. Notwithstanding any possible interpretation to the contrary, all the new species in the present contribution are accepted as species insofar as the provisions of the *International*

*Code of Nomenclature* (McNeill et al. 2012) relating to acceptance of taxa by their authors are concerned.

Based upon studies of several DNA sequences conducted in the Benjamin D. Hall laboratory, Seattle, USA, Goetsch et al. (2011) published an inferred phylogeny of sect. *Schistanthe*. This research was used as the basis for proposing a new classification of *Schistanthe* (Craven et al. 2011). An important finding of the phylogenetic research was that there was no support for the formal recognition of subsections which are now known to be artificial assemblages of species with certain common morphological traits. In the newly proposed classification, the subsections are treated as informal groups. The advantage of this approach is that the informal groups, which can be keyed, are useful for identificatory purposes. In the text below, the names of the informal groups are given in Roman font.

It is worth noting in the context of taxon recognition in the present discussion that Sleumer (1966) apparently used the rank ‘variety’ when he was uncertain of the status of the entity involved (Argent 2006: 6). In other words, when Sleumer was uncertain as to whether or not an entity should be recognised at species rank or perhaps even not recognised at all, he ranked it as a variety. This led to his including taxa of uncertain acceptance within a “good” species, the expanded circumscription thus making that species itself of uncertain status. Argent (2006) has used the ranks of variety and subspecies in infraspecific taxonomies, but has not given a rationale for their application. In some cases he apparently has followed Sleumer in using the rank variety, e.g., for *R. radians* (see below).

† The author passed away on 11 July 2014, three weeks after submitting the final version of this paper. — Editor.

## Taxonomy

### 1. On the *Euvireya* group in western Malesia and Sulawesi

#### 1.1. *Rhododendron javanicum* sensu Argent (2006)

Argent (2006) adopted a very broad circumscription for *R. javanicum*, one that is difficult to justify and that was criticised by Craven (2007). One significant issue is that there is no character state or combination of character states that uniquely defines the species *R. javanicum* sensu Argent. In fact, if one accepts that the summed character states of *R. javanicum* sensu Argent circumscribe a species of sect. *Schistanthe* then at least several other species accepted by Argent as being distinct species of the section would have to be included within his concept of *R. javanicum*.

It seems the taxa mentioned with respect to the discussion of *R. javanicum* sensu Argent (2006) are probably closely related; in Goetsch et al. (2011), clade 4 consists of western Malesian species that include several of the treated or mentioned taxa. It is pertinent also to note that within clade 4, *R. brookeanum* H.Low ex Lindl. and *R. javanicum* are in different, strongly supported clades, thus supporting Sleumer (1966) who maintained these two as distinct species.

Very little is known about the extent of sympatry within this group of species, which is unfortunate, as biotic sympatry can be a powerful indicator of genetic distinctness. Sleumer (1966) indicates that *R. teysmannii* Miq. and *R. javanicum* rarely occur in biotic sympatry, which is evidence they are reproductively isolated.

Several characters that are diagnostic for the western Malesian sect. *Schistanthe* species included by Argent (2006) in *R. javanicum* are listed in Table 1, with the relevant states indicated for each taxon as far as the states can be determined. The character states predominantly have been taken from Argent (2006) and Sleumer (1966), supplemented with data from Callard (2014), protologues and personal observations. Where a state was not given by Argent (2006) or Sleumer (1966) for one of the infraspecific taxa they treated, but those authors indicated that the infraspecific taxon was morphologically the same as the autonymic, infraspecific taxon except for particular, designated features, the applicable state of a character has been determined by inference. Typically branchlets of taxa within the complex are scaly and lack hairs, but when Sleumer (1966) and/or Argent (2006) state that an organ is glabrous it is interpreted as there being neither scales nor hairs. Characters that I consider to be valuable for characterising species include leaf arrangement, leaf lamina anatomy, outer perulæ shape, corolla form, ovary surface and the ovary-style interface.

The leaves of *Rhododendron* species are spirally arranged on each seasonal growth flush, either pseudowhorled or dispersed, and the possession of one or other of these two latter states is diagnostic. Occasionally, a

species, in which the pseudowhorled condition is the usual state, may have dispersed leaves on a particularly vigorous growth or “water shoot” but this axis reverts to the pseudowhorled condition once the abnormally vigorous growth has slowed. Taxa which always possess the dispersed state are *R. kinabaluense* (Argent, A.Lamb & Phillipps) Craven, *R. palawanense* (Argent) Craven and *R. schadenbergii* Warb., the remainder have pseudowhorled leaves, with the exception of *R. moultonii* Ridl., in which the leaves are in an intermediate pseudowhorled-dispersed state.

Leaf lamina anatomy is an especially interesting feature. In *R. javanicum*, the leaves of fresh material are relatively thin and the primary (the major lateral) veins are distinct; the leaves appear “dryish” when snapped. In some other taxa, such as *R. brookeanum* and *R. kinabaluense*, the leaves are thickened and the primary veins are obscured, apparently by being more or less immersed within the lamina; the leaves of fresh material appear “subfleshy” when snapped. The “subfleshy” leaves apparently are, to one extent or another, sunken between the primary veins and can perhaps be best described as “puckered”. The “dryish” leaves are flat between the primary veins. The subfleshy, puckered leaf type is well shown in photographs in Argent (2006: 246, *R. brookeanum*, & 247, *R. cockburnii*). The dryish leaf type is depicted well in Callard (2014: Species Gallery, as *Rhododendron javanicum* subsp. *javanicum*).

Anatomical studies underway at the Erik Nilsen laboratory at Virginia Tech, Blacksburg, will demonstrate the structural differences between the two leaf types and provide answers as to whether or not distribution of these leaf anatomies within *Euvireya* are congruent with the phylogenetic clades recovered by Goetsch et al. (2011) (E. Nilsen, personal communication). As it is of particular interest to those interested in physiological adaptations and as many sect. *Schistanthe* species are epiphytic, one hopes the Nilsen lab will also consider the potential significance of the subfleshy leaf anatomy to such aspects as water management. My impression is that these leaf features reflect major genetic differences, possibly indicating separate evolutionary paths, and therefore should be acknowledged in classification by distinct, specific-level, taxonomic recognition as opposed to uncritical “lumping”.

The shape of the outer perulæ (inflorescence bud scales) and the nature of any indumentum also are valuable in species delimitation. Unfortunately, because of their essential ephemeral nature these usually are not available on herbarium specimens and data are only directly available for *R. brookeanum* and *R. javanicum* — collectors usually only collect rhododendrons when they are in flower, by which time the perulæ have largely fallen, and non-insightful collectors usually do not collect buds. The corolla of all taxa is funnel-shaped, with the exception of *R. cockburnii*, in which the corolla is tubular-funnel-shaped with a constriction in the tube. Surface features of the ovary, whether scaly, hairy or



**Table 1.** Character states of eleven western Malaysian *Rhododendron* species in the Euireya group. See text for discussion of characters/states. Character states in Roman font have been taken from Argent (2006), Sleumer (1966), Callard (2014) or are personal observations. Character states in *italics* are derived by inference from Argent (2006) and/or Sleumer (1966).

Taxon	Leaf arrangement	Leaf lamina	Branchlet surface	Leaf surface	Pediced surface	Outer perulae shape	Corolla form	Anther length (mm)	Ovary surface	Ovary-style interface
<i>R. brookeanum</i>	pseudowhorled	apparently thickened but primary veins possibly not fully obscured	laxly scaly	scaly, not hairy	scaly, rarely hairy	ovate subacuminate, glabrous	funnel-shaped	(4-) 4.5-5 (-7)	scaly and hairy	ovary ± abruptly tapering to style
<i>R. cladotrichum</i>	pseudowhorled		scaly and hairy	scaly, hairy	+/- glabrous	<i>ovate subacuminatae, glabrous</i>	<i>funnel-shaped</i>	(4-) 4.5-5 (-7)	<i>scaly and hairy</i>	<i>ovary ± abruptly tapering to style</i>
<i>R. cockburnii</i>	pseudowhorled	thickened and primary veins obscured		scaly, [?hairy or not]		tubular-funnel-shaped, tube with a constriction		5	glabrous	
<i>R. extraneum</i>	pseudowhorled		branchlets laxly scaly; not hairy	scaly, not hairy	scaly, not hairy	<i>ovate subacuminatae, glabrous</i>	funnel-shaped	(4-) 4.5-5 (-7)	<i>scaly and hairy</i>	<i>ovary ± abruptly tapering to style</i>
<i>R. gracile</i>	pseudowhorled, tightly to loosely so	apparently not thickened and obscuring primary veins	scaly, hairy or not	scaly, not hairy	scaly, hairy or not	<i>ovate subacuminatae, glabrous</i>	funnel-shaped	c. 4	<i>scaly and hairy</i>	<i>ovary ± abruptly tapering to style</i>
<i>R. javanicum</i>	pseudowhorled	not thickened and obscuring primary veins	laxly scaly	scaly	laxly scaly, not hairy	broadly ovate, shortly subulate-mucronate, glabrous	funnel-shaped	(2.5-) 3-3.5 (-4)	glabrous or very sparsely scaly	ovary tapering to style
<i>R. kinabaluense</i>	dispersed	thickened and primary veins obscured	scaly			funnel-shaped			hairy	
<i>R. moultonii</i>	intermediate pseudowhorled dispersed	thickened and primary veins obscured	laxly scaly	scaly	laxly scaly	funnel-shaped	funnel-shaped	5-6	glabrous	ovary abruptly tapering to style
<i>R. palawanense</i>	dispersed	perhaps thickened and primary veins possibly not fully obscured (needs confirmation)		glabrous or laxly scaly		funnel-shaped	funnel-shaped	5	glabrous or variably hairy and scaly	
<i>R. schadenbergii</i>	dispersed	perhaps thickened and primary veins possibly not fully obscured (needs confirmation)	scaly	scaly	<i>laxly scaly, not hairy</i>	<i>broadly ovate, shortly subulate-mucronate, glabrous</i>	<i>funnel-shaped</i>	5-6 (-7)	<i>glabrous or very sparsely scaly</i>	<i>ovary tapering to style</i>
<i>R. teymannii</i>	pseudowhorled	not thickened and obscuring primary veins		scaly	nearly always hairy	<i>broadly ovate, shortly subulate-mucronate, glabrous</i>	<i>funnel-shaped</i>	(2.5-) 3-3.5 (-4)	densely hairy, scaly	<i>ovary tapering to style</i>

glabrous, are useful and easily scored. Generally, the particular states are consistent within a taxon, but in *R. gracile* and *R. teysmannii* hairs may be present or absent and in *R. palawanense* the ovary may be glabrous or scaly. Another useful feature involving the style is the ovary/style interface. The ovary may taper gradually to the style or may taper abruptly and apparently this is a difference between *R. javanicum*, in which the ovary tapers to the style, and *R. brookeanum*, in which it more or less abruptly tapers to the style.

There are other characters, the states of which have diagnostic value, such as flower orientation (erect, semi-erect, spreading, semipendulous, etc.), inflorescence shape (domed or flat), anther colour (yellowish or dark reddish/purple) and pollen colour (at least grey or cream), that could be used for circumscribing the species, but data are not available for sufficient taxa to include them in Table 1. Assessment of inflorescence shape is difficult when a plant is not flowering to the maximum of its potential; reduced nourishment, reduced vigour, etc., can result in the production of flat inflorescences instead of the usual domed inflorescences that that genotype may produce when in a state of optimal vigour.

The name *R. brookeanum* var. *extraneum* Sleumer is not mentioned by Argent (2006), neither in the index nor in the text dealing with the *R. javanicum* complex. This is not just an isolated instance of a name either not appearing in Argent's book or not being satisfactorily accounted for; it happens quite frequently. Surprisingly, Argent has not even included some of his own names, such as *R. brookeanum* subsp. *brookeanum* var. *kinabaluense* (Argent, A.Lamb & Phillipps) Argent, *R. brookeanum* subsp. *gracile* (Lindl.) Argent, and several others relevant to the present discussion as far as their taxonomic and/or nomenclatural status is concerned.

Having considered the variation recorded for the taxa listed in Table 1 together with variation in other organs such as leaf lamina shape and size, etc., I believe the taxonomy of this complex is best resolved with all the taxa being accepted at species rank, as listed below. The species can be identified using the keys in Argent (2006: 234–237), with the exception of *R. extraneum* (see below).

Additional synonyms are given under the relevant taxa in Argent (2006) and Sleumer (1966).

#### ***R. brookeanum* H.Low ex Lindl.**

J. Hort. Soc. London 3: 823 (1848). — *R. javanicum* subsp. *brookeanum* (H.Low ex Lindl.) Argent & Phillipps, Bot. J. Linn. Soc. 85: 15 (1982).

*Notes.* *Rhododendron brookeanum* may be distinguished from *R. javanicum* sensu stricto by the puckered leaf lamina; the ovate subacuminate, glabrous outer perulae; and the ovary more or less abruptly tapering to the style. In *R. javanicum* the leaf lamina is flat; the outer perulae are broadly ovate, shortly subulate-mucronate, glabrous; and the ovary tapers to the style.

#### ***R. cladotrichum* (Sleumer) Craven, comb. et stat. nov.**

Basionym: *R. brookeanum* var. *cladotrichum* Sleumer, Reinwardtia 5: 224 (1960). — *R. javanicum* subsp. *cladotrichum* (Sleumer) Argent, Rhododendrons of subgenus *Vireya* 247 (2006).

*Notes.* Sleumer (1966) separated *R. cladotrichum* (as var. *cladotrichum*) from *R. brookeanum* (as var. *brookeanum*) by the branchlets being hairy and the leaf lamina midrib being densely short-hairy on both surfaces in *R. cladotrichum* and the branchlets and leaf lamina being glabrous in *R. brookeanum*.

#### ***R. cockburnii* (Argent, A.Lamb & Phillipps) Craven, comb. et stat. nov.**

Basionym: *R. javanicum* subsp. *cockburnii* Argent, A.Lamb & Phillipps, Notes Roy. Bot. Gard. Edinburgh, 42: 113 (1984). — *R. brookeanum* subsp. *cockburnii* (Argent, A.Lamb & Phillipps) Argent, Edinburgh J. Bot. 52: 364 (1995).

*Notes.* The pseudowhorled leaves, the subfleshy and puckered leaf lamina and the corolla with its constricted tube are diagnostic for the species. The corolla is depicted in Argent (2006: 247, as *R. javanicum* subsp. *cockburnii*).

#### ***R. extraneum* (Sleumer) Craven, comb. et stat. nov.**

Basionym: *R. brookeanum* var. *extraneum* Sleumer, Reinwardtia 5: 225 (1960).

*Notes.* *Rhododendron extraneum* was treated by Sleumer (1966) as a variety within *R. brookeanum*. *Rhododendron extraneum* occurs on Sumatra whereas the other three of the four infraspecific taxa of *R. brookeanum* sensu Sleumer (1966) are from Borneo. It may well be that the present taxon fell into Sleumer's "uncertain status" category, discussed above, and he placed it as a variety within *R. brookeanum*. The two specimens of *R. extraneum* in L. Meyer 4582 (the type) and Meyer 5390, cannot be keyed to a taxon in Argent's key to sect. *Euvireya* sensu Argent (F. Adema, personal communication) and this supports its status as a distinct species.

Sleumer (1966) separated this taxon from *R. gracile* (as var. *gracile*) on the basis of the leaf lamina being narrowly ovate and the corolla being 5 (–6) cm long in *R. gracile* and the leaf lamina being narrowly ovate-oblong and the corolla being 4 (–5) cm long in *R. extraneum*.

#### ***R. gracile* H.Low ex Lindl.**

J. Hort. Soc. London 3: 84, fig. (1848). — *R. brookeanum* var. *gracile* (H.Low ex Lindl.) Henslow, J. Roy. Hort. Soc. 13: 261, f. 42 (fol.), 43a (fl.) (1891). — *R. javanicum* subsp. *gracile* (H.Low ex Lindl.) Argent, A.Lamb & Phillipps, Notes Roy. Bot. Gard. Edinburgh, 42: 114 (1984). — *R. brookeanum* subsp. *gracile* (H.Low ex Lindl.) Argent, Edinburgh J. Bot. 52: 364 (1995).

*Notes.* Fide Argent et al. (1984) the leaf lamina is smooth, not puckered, and up to 3.5 cm wide. The species is well depicted in Argent (2006: 247, as *R.*

*javanicum* subsp. *gracile*). Argent (1995) considered the taxon as “clearly requiring at least subspecific status”.

***R. javanicum* (Blume) Benn.**

Pl. Jav. Rar. 85 (1838), excl. t. 19, which is *R. teysmannii* fide Sleumer (1966). — *Vireya javanica* Blume, Bijdr. Fl. Ned. Ind. 15: 854 (1826).

*Notes.* See under *R. brookeanum* for the differences between these two species.

***R. kinabaluense* (Argent, A.Lamb & Phillipps) Craven, comb. et stat. nov.**

Basionym: *R. javanicum* var. *kinabaluense* Argent, A.Lamb & Phillipps, Notes Roy. Bot. Gard. Edinburgh, 42: 113 (1984). — *R. brookeanum* var. *kinabaluense* (Argent, A.Lamb & Phillipps) Argent, Edinburgh J. Bot. 52: 363 (1995). — *R. javanicum* subsp. *kinabaluense* (Argent, A.Lamb & Phillipps) Argent, Rhododendrons of subgenus *Vireya* 248 (2006).

*Notes.* *Rhododendron kinabaluense* is characterised by its dispersed leaves, puckered leaf lamina, and appressed and often emarginate outer perulae.

***R. moultonii* Ridl.**

J. Straits Br. Roy. As. Soc. 63: 61 (1912). — *R. javanicum* subsp. *moultonii* (Ridl.) Argent, Bot. J. Linn. Soc. 85: 16 (1982). — *R. brookeanum* var. *moultonii* (Ridl.) Argent, Edinburgh J. Bot. 52: 364 (1995).

*Notes.* This species is characterised by the intermediate, dispersed-pseudowhorled arrangement of its leaves, the puckered leaf lamina, and the ovary abruptly tapering to the style.

***R. palawanense* (Argent) Craven, comb. et stat. nov.**

Basionym: *R. javanicum* subsp. *palawanense* Argent, Gard. Bull. Singapore 56: 90 (2004).

*Notes.* *Rhododendron palawanense* is characterised by the dispersed leaves, flat leaf lamina, acute (never emarginate) outer perulae, and grey pollen.

***R. schadenbergii* Warb.**

in Perkins, Fragm. Fl. Philippines 172 (1905). — *R. javanicum* var. *schadenbergii* (Warb.) Sleumer, Reinwardtia 5: 195 (1960). — *R. javanicum* subsp. *schadenbergii* (Warb.) Argent, Edinburgh J. Bot. 52: 364 (1995).

*Notes.* *Rhododendron schadenbergii* is characterised by the dispersed leaves, apparently flat leaf lamina, and cream pollen. Argent (1995) comments that this plant “warrants at least subspecific status”.

***R. teysmannii* Miq.**

Fl. Ned. Ind., Eerste Bijv. 3: 585 (1861). — *R. javanicum* var. *teysmannii* (Miq.) King & Gamble, J. As. Soc. Bengal 74: 75 (1905). — *R. javanicum* subsp. *teysmannii* (Miq.) Argent, Rhododendrons of subgenus *Vireya* 249 (2006).

*Notes.* This species is characterised by the flat leaf lamina, the very commonly hairy pedicels, and the more or less densely pubescent ovary. As noted above, *R. teysmannii* and *R. javanicum* may occur in biotic sympatry which is evidence in support of their being distinct species.

**1.2. A new name for *Rhododendron seranicum* subsp. *sparsihirtum***

***Rhododendron biappendiculatum* Craven, nom. et stat. nov.**

Replaced synonym: *R. seranicum* J.J.Sm. subsp. *sparsihirtum* Argent, Rhododendrons, camellias and magnolias 2013, 127 (2013) (as *sparsihirtus*).

*Notes.* *Rhododendron seranicum* subsp. *sparsihirtum* was distinguished from subsp. *seranicum* on the basis of it having hairs at the base of the filaments, on the disk and inside the corolla towards the base (Argent 2013). Argent also noted that the Binney plant, which is the type accession and the only specimen cited by Argent, “superficially looks identical to the other accessions of *R. seranicum* from Sulawesi, only on dissection of the flowers can the distinguishing hairs be seen” (Argent 2013).

The following material also originated from the Gunung Sojol complex in Sulawesi: *A.Rouse s.n.*, Australia, Victoria, cultivated in Hawthorn East, 20 July 2012 (CANB) [provenance: Indonesia, Sulawesi Tengah, the western lower slopes of the Gunung Sojol complex, on Tinombo-Sipatoh path, open steep grassy slope, leg. L.A. Craven, 23 July 2002, living material only collected]. This material must have been collected very close to, if not from the same, population from which living material was collected by David Binney, as, at the time of our visit in 2002, there was only the one path from the last village, Sipatoh; this was used by rattan harvesters, etc., to access the Gunung Sojol massif. The Binney-collected material subsequently afforded the type specimen of subsp. *sparsihirtum*. The Rouse material differs in several particulars from *R. seranicum*, as that species was circumscribed by Sleumer (1966). Sleumer noted that a slightly differing specimen, i.e., to *R. seranicum* in the Moluccas, had been collected from Sulawesi, but, as he gave the distribution of *R. seranicum* as being the Moluccas only, it can confidently be taken that his 1966 description and concept of the species is based upon Moluccan specimens only. The Rouse collection differs from *R. seranicum* sensu Sleumer in at least the following: the indumentum features noted by Argent (2013); the biappendiculate anthers (blunt or minutely apiculate in *R. seranicum*); the narrowly oblong-obovoid ovary, brownish when dry (oblong-conical, blackish when dry in *R. seranicum*); and the pedicels not, or scarcely, widened at the apex (thickened at apex in *R. seranicum*).

Argent (2013) also stated that the Gunung Sojol plant

agrees quite closely to *R. javanicum* ssp. *schadenbergii* (Warb.) Argent a Philippine sub-species that was recorded from Manado in the north of Sulawesi (Sleumer, 1960). However the plants from Sulawesi have much shorter anthers than is recorded for *R. javanicum* ssp. *schadenbergii* from the Philippines and it seems safer for the present to keep that subspecies restricted to the Philippines.

It seems therefore that an association of the Gunung Sojol plant with the plant from the Moluccas may not be so strong that its inclusion within the circumscription of *R. seranicum* is the best possible taxonomic disposition for the Gunung Sojol plant. Given the several differences between the two plants noted above, and given that additional differences may be discovered in future (no material from the Moluccas has been available to me and I have relied on the data in Argent (2013) and Sleumer (1966), and that obtainable from the Rouse collection in CANB), my conclusion is that the Gunung Sojol plant should be recognised as a distinct species.

The epithet *sparsihirtum* is not especially appropriate at species rank in sect. *Schistanthe* given that many of its species, when hairy, are sparsely so and for that reason a new name is given. Although Sleumer (1966) indicates that a tendency towards the appendiculate condition may be present in *R. seranicum*, the biappendiculate anthers in the Gunung Sojol plant are a striking feature.

### 1.3. A new species from Sulawesi

#### *Rhododendron torajaense* Craven, sp. nov.

From *R. rhodopus* Sleumer it differs in the coriaceous, acuminate leaf lamina; the weakly sweet-fragrant flowers; the corolla being 45–50 mm long including the lobes; and the anthers being 3 mm long. In *R. rhodopus* the leaf lamina is obtusely acuminate to narrowly acute and cartilaginous, the flowers are strongly feijoa fruit-scented, the corolla is 65–79 mm long including the lobes, and the anthers are 6 mm long.

**Holotypus:** Indonesia, Sulawesi Selatan, Tana Toraja, Batutumonga, on way to Gunung Sesean, Lat. 02° 54' 32" N, Long. 119° 53' 02" E, alt. 1359 m, 12 July 2002, G. Brown, L. Craven & L. Juswara 78 (BO). **Isotypus:** CANB.

Shrub to 1 m tall. *Branchlets* glabrescent (initially moderately densely scaly), c. 2.5–4 mm in diameter. *Leaves* 4–6-whorled (on vigorous growth the pseudo-whorls loose with the proximal leaves discretely inserted). *Leaf lamina* narrowly elliptic, elliptic, narrowly ovate or ovate, 85–170 × 35–75 mm, base cuneate to rounded, apex acuminate, margin subrevolute; abaxially and adaxially with moderately dense sessile scales with the rim irregular (but not incised) and with a raised centre; midrib prominent abaxially, adaxially prominent proximally and becoming slightly impressed towards the apex, lateral veins distinct, 8–14 per side. *Petiole* 12–27 mm long. *Inflorescence* a 7–8-flowered umbel, flowers erect to spreading. *Pedicel* 14–22 mm long. *Calyx* obsolete. *Corolla* short-salverform, 45–50 mm long including the lobes, white, weakly sweet-fragrant, tube 28–30 mm long, lobes 17–20 mm long and spreading at right angles to the tube, sparsely scaly outside and with or without pubescent hairs on the very proximal region of the tube. *Stamens* 10, unequal in length, slightly exserted; filaments 30–35 mm long, densely pubescent-hairy for the proximal c. 2/3 and glabrous above; anthers oblong, c. 3 mm long. *Disk* densely hairy. *Ovary* narrowly fusiform, 11–12 mm long, scaly



Fig. 1. *Rhododendron torajaense*. Cultivated at the Rhododendron Species Botanic Garden, Washington, USA. Photo: Hank Helm.

and very densely hairy; style c. 18 mm long, exserted to c. 8 mm, densely hairy excepting the glabrous distal c. 4 mm; stigma subdiscoid, c. 3.5 mm in diameter. *Fruit* not available. **Fig. 1.**

*Distribution and ecology.* Indonesia, Sulawesi Selatan, Tana Toraja, on way to Gunung Sesean, Batutumonga, Lat. 02° 54' 32" N, Long. 119° 53' 02" E, alt. 1359 m, on a disturbed roadside bank. Only known from one wild location.

*Conservation status.* This species is best given the conservation status Vulnerable according to the criteria of the IUCN Red List (IUCN 2012), although, as the necessary surveys have not been undertaken, Data Deficient would also be applicable. The type collection, the only collection seen, was made in the village of Batutumonga. The Batutumonga region is much disturbed with rainforest in the area above the village considerably cleared and converted to anthropogenic grassland.

*Etymology.* The specific epithet is derived from the region Tana Toraja.

*Notes.* The corolla form has been given as “short-salverform” in the description above. “Tubular-campanulate” might also be applicable. Argent (2006: 364) gives several examples of corolla form in sect. *Schistanthe* species and his illustration for “cylindrical” is the closest to the corolla form in *R. torajaense*. However, the term cylindrical is better applied to the corolla of species such as *R. perakense* King & Gamble in which the corolla lobes are erect, i.e. in line with the tube. In *R. torajaense*, the lobes are spreading at right angles to the tube and cylindrical is not the best term to use. Short-salverform is more appropriate.

The flowers of *R. torajaense* have a weak, sweet fragrance. It is not rich as in *R. konori* Becc., nor “spicy” as are the flowers of some other fragrant species, but





Fig. 2. *Rhododendron gumineense*. Cultivated at East Hawthorn, Victoria, Australia. Photo: Andrew Rouse.

is a little reminiscent of gardenias. The first plant of *Brown et al. 78* to flower at Melba did so in February 2011 and the second plant flowered in June 2011. The fragrance of the latter was very much weaker than that of the summer-flowering plant, perhaps due to the cold weather, but the scent was so slight that it is difficult to describe in qualitative terms. The fragrance of the flowers of *R. rhodopus* is very different and in this species the flowers of the field-collected material (*Brown, Craven, Juswara & Ramadhani 129*, BO, CANB) had a fragrance very much like that of the ripe fruit of feijoa, *Acca sellowiana* (Myrtaceae).

## 2. A new species of the Phacovireya group from New Guinea

### *Rhododendron gumineense* Craven, *sp. nov.*

From *R. beyerinkianum* Koord. it differs in having the leaf lamina narrowly elliptic to elliptic, 22–35 × 7–16 mm, base cuneate and often very narrowly so, apex obtuse or shortly acuminate to very narrowly acute to very narrowly acuminate; anthers 1.2–1.6 mm long; and the ovary subcylindrical and tapering to the style. In *R. beyerinkianum* the leaf lamina is narrowly ovate, to broadly elliptic, obovate or subcircular, 30–60 × 10–35 mm, base broadly tapering or rounded, apex obtuse, broadly acute, sometimes apiculate; anthers 2–2.5 mm long; and the ovary elongate conical or subovoid, usually abruptly tapering distally.

**Holotypus:** Australia, Victoria, Hawthorn East, cultivated in greenhouse, *A. Rouse s.n.*, 29 December 2012 (CANB).

Shrub to 40 × 40 cm. *Branchlets* terete, densely scaly, c. 0.8–1 mm in diameter. *Leaves* 3–5-pseudowhorled. *Leaf lamina* narrowly elliptic to elliptic, 22–35 × 7–16 mm, base cuneate and often very narrowly so, apex obtuse or shortly acuminate, very narrowly acute, or very narrowly acuminate, margin revolute; abaxially with dense dendroid scales each on a tubercle and with the limb deeply dissected; adaxially with the scales quickly deciduous and occasional hairs present along the midrib; midrib prominent abaxially, impressed to flat adaxially, lateral veins obscure abaxially and prominent adaxially, 5–8 per side. *Petiole* 7–12 mm long. *Inflorescence* 1–2-flowered, the flowers spreading to subpendulous. *Outer peralae* ovate, 8–8.5 mm long, acuminate with the acumen broad. *Pedicel* 6–9 mm long, scaly. *Calyx* obsolete. *Corolla* pink, tubular-curved with the tube flaring distally, c. 23–29 mm long including the lobes, tube curved, c. 17–20 mm long and 6–9 mm in diameter, lobes 6–9 mm long; outside the tube and lobes moderately scaly, inside glabrous. *Stamens* 10, slightly exerted; filaments c. 22–26 mm long, glabrous, anthers light brown, oblong, 1.2–1.6 mm long, base subapiculate. *Disk* scaly. *Ovary* subcylindrical and tapering to the style, 6 × 2 mm, densely scaly; style 15–20 mm long, slightly exerted and approximating the stamens in length, scaly to within 4–5 mm of the apex; stigma subcapitate, c. 1.7 mm in diameter. *Fruit* immature. **Fig. 2.**

**Table 2.** Character states of three Sulawesi *Rhododendron* species in the *Solenovireya* group. States have been taken from Argent (2006), Sleumer (1966) or are personal observations.

Taxon	Leaf lamina	Leaf scales	Outer perulac	Style
<i>R. minahasae</i>	obovate to elliptic, base cuneate to truncate, apex acute to obtuse	funnel-shaped and inserted on a pedestal or foot of lamina origin	± obtuse, subsericeous at the apex or practically glabrous	hairy and scaly almost to the top
<i>R. pubitubum</i>	elliptic or obovate elliptic, sometimes obovate, broadly attenuate towards the base, the very base rounded, not rarely subcordate, apex very broadly attenuate, obtuse to nearly rounded, occasionally very shortly retuse	marginal zone irregularly dentate or bitten, with a ± persistent, blackish and sunken centre	orbiculate to obovate, densely short subsericeous on both surfaces	subdensely hairy and laxly scaly below (the scales well visible there), laxly hairy in the middle, glabrous for the distal 10 mm
<i>R. radians</i>	ovate to ovate-oblong, base slightly to distinctly cordate, apex shortly obtusely attenuate, sometimes nearly rounded	almost regularly rounded in outline to distinctly incised	ovate-acuminate, acute, ± glabrous dorsally	laxly patent-pubescent to the lower 5/6 and bearing some scales in the lower part

*Distribution and ecology.* Papua New Guinea, Chimbu Province, Gumine. Nothing is known about the ecology of *R. gumineense*. However, the elevation of Gumine is c. 1700 m and consequently the forest type in the region would probably be lower- to mid-montane rainforest. Whether the species is epiphytic in rainforest or terrestrial on open ground is unknown. It is only known from one natural location.

*Conservation status.* *Rhododendron gumineense* is best given the conservation status Data Deficient according to the criteria of the IUCN Red List (IUCN 2012). Nothing is known about its population size or ecology.

*Etymology.* The specific epithet is derived from the place name Gumine.

*Notes.* *Rhododendron gumineense* keys to *R. beyerinckianum* Koord. in Argent (2006), from which it differs in the features given in the diagnosis above. Additionally, the species differs from *R. beyerinckianum* in habit, being a very small shrub in contrast to *R. beyerinckianum* which is a shrub or tree from 1–5 m tall. Initially I considered that the Gumine plant might represent a primary hybrid, but I have grown it to flowering from seed obtained from my own plant and there were no morphological differences between the parent plant and those plants grown from seed.

Even though described from cultivated material, *R. gumineense* has a known provenance. It was collected at Gumine by D. Stanton, Wollongong, NSW, Australia, in 1971, and sent to the Australian Rhododendron Society, Olinda, Victoria, Australia by L. Searle (Kundiawa, Chimbu Province, PNG) in 1974.

In cultivation in Australia, apparently from its first introduction, the species has been misidentified as *R. ×schoddei* Sleumer, which is a plant possibly of hybrid

origin and is best treated as a nothospecies until its biological status can be verified.

### 3. On the *Solenovireya* group in Sulawesi

Sleumer (1966) recognised two varieties within the Sulawesi species *R. radians*: var. *radians* and var. *minahasae* Sleumer. Argent (2006) added a third taxon, var. *pubitubum* (Sleumer) Argent, differentiating it from the other two varieties by “the corolla tube being densely hairy throughout its length and with the lobes hairy outside along the middle line”. Differences between these three taxa are given in Table 2.

Scanning electron micrographs of *R. dissilistellatum* Craven, *R. minahasae* and *R. radians* showing abaxial scales and stomata are given in Fig. 3. The distribution of stomata relative to scales is worthy of note in *R. minahasae* and *R. radians*. In *R. minahasae* the stomata and scales are quite evenly distributed (Fig. 3B) whereas in *R. radians* the scales are inserted in a shallow depression in a zone which lacks stomata (Fig. 3D). A reason for this distribution pattern is not immediately evident. Material of *R. pubitubum* has not been available for examination.

Based on the data given in Table 2 plus the scale distribution data, it is my conclusion that these three taxa should be treated at species rank. A new combination for *R. minahasae* is provided below.

Living material of another species collected in 2002, of which fertile material was not available in the field, subsequently flowered in cultivation. It keyed to *R. radians* in both Argent (2006) and Sleumer (1966), which is not surprising as long-tubular, white-flowered plants would key to this species alone. The newly flowered plant proved to be distinct from all other Sulawesi species of *Solenovireya* and is described below as *R. dissilistellatum* Craven.

The Sulawesi species of the Solenovireya group (sensu Craven et al. 2011) can be distinguished by the following key:

1. Corolla 40–45 mm long including the lobes . . . *R. amabile*
- 1: Corolla more than 50 mm long including the lobes
2. Leaf lamina narrowly elliptic to narrowly obovate . . . . .  
 . . . . . *R. dissilistellatum*
- 2: Leaf lamina ovate to ovate-oblong, obovate to elliptic, or obovate-elliptic
3. Leaf lamina ovate to ovate-oblong . . . . . *R. radians*
- 3: Leaf lamina obovate to elliptic, or obovate-elliptic
4. Perulae ± obtuse, subsericeous at the apex or practically glabrous; style hairy and scaly almost to the apex . . . . . *R. minahasae*
- 4: Perulae orbiculate to obovate, densely short sericeous on both faces; style hairy and scaly excepting the glabrous distal 10 mm . . . . . *R. pubitubum*

**Rhododendron dissilistellatum Craven, sp. nov.**

From *R. radians* J.J.Sm. it differs in the leaf lamina being narrowly elliptic to narrowly obovate with the base cuneate to obtuse (in *R. radians* the lamina is ovate to ovate-oblong with the base cordate), the outer perulae being elliptic to broadly elliptic (ovate-acuminate in *R. radians*), and the style being hairy to within c. 2 mm of the apex (hairy in the proximal 5/6 of the style in *R. radians*).

**Holotypus:** Australia, Australian Capital Territory, Melba, cultivated in greenhouse (from living material of G.Brown, L.Craven, L.Juswara & Ramadhanil 114), L.A.Craven 15044, September 2010 (BO). **Isotypi:** A, CANB, CEB, E, L, P.

Lax shrubs to c. 60 × 70 cm. *Branchlets* moderately densely scaly and with moderately dense short hairs, c. 1.5–2 mm in diameter. Leaves 5–10-pseudowhorled. *Leaf lamina* narrowly elliptic to narrowly obovate, 25–64 × 7–19 mm, base cuneate to obtuse, apex retuse, margin subrevolute; abaxially with the scales sessile, mostly flat and rarely subfunnel-shaped, and with scattered hairs throughout; adaxially with sessile, funnel-shaped to flat, subentire to dentate scales with a broadish flattened centre, and with short scattered hairs that are more dense proximally along the midrib; midrib prominent abaxially, impressed adaxially, lateral veins more or less obscure, c. 5–6 per side, reticulate venation obscure. *Petiole* c. 1–3 mm long. *Inflorescence* a 7–15-flowered umbel, flowers in a more or less spreading band. *Outer maximally-developed perulae* elliptic to broadly elliptic, c. 8–11 mm long, obtuse to rounded and often secondarily retuse through rupturing occurring at anthesis. *Pedicel* 7–13 mm long, scaly and hairy. *Calyx* obsolete. *Corolla* white, salverform, c. 59–79 mm long including the lobes, tube straight, c. 50–67 mm long and 2–3 mm in diameter, lobes c. 9–12 mm long, outside the tube laxly scaly and proximally with a few hairs, inside hairy to about 3/4 to the apex, lobes glabrous. *Stamens* 10, scarcely exerted; filaments c. 50–65 mm long, hairy for about 1/2 way to their apex, anthers light brown, oblong, c. 1.4–1.8 mm long, base

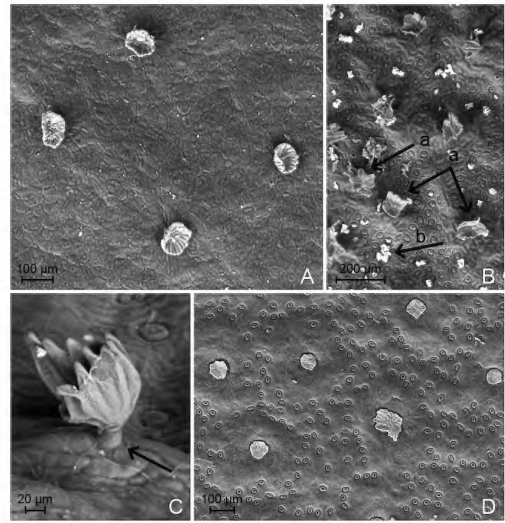


Fig. 3. Scanning electron micrographs of the abaxial leaf surfaces of *Rhododendron* species. **A** *R. dissilistellatum*. **B–C** *R. minahasae*: **B** (a) indicates scales; (b) indicates contaminant on the leaf surface; **C** arrow indicates the foot or pedestal that is of lamina origin. **D** *R. radians*. — **A** Craven 15044; **B–C** Alston 15800; **D** Brown et al. 128.

obtuse to rounded. *Disk* hairy. *Ovary* 6.5–7 × 1.2 mm, subcylindrical and tapering to the style, densely scaly and hairy; style c. 60–65 mm long, exerted to c. 12 mm, scaly proximally, hairy to within c. 2 mm of the apex, stigma c. 2 mm in diameter. *Fruit* not available. **Fig. 3A, 4.**

**Distribution and ecology.** Indonesia, Sulawesi Tengah, the western lower-mid slopes of the Gunung Sojol complex, Balukang, on Tinombo-Siboang path (between camp 3 and camp 1), Lat. 00° 28' 19" N, Long. 120° 08' 27" E, alt. 1153–1344 m, lower montane rainforest. It is only known from one natural location.

**Conservation status.** This species is best given the conservation status Data Deficient according to the criteria of the IUCN Red List (IUCN 2012). Although known from only the one location in the wild, this location is unlikely to be disturbed by forest conversion operations or slash and burn gardening in the foreseeable future. Additionally, it is possible the species is widely distributed around the lower-mid slopes of the Gunung Sojol complex.

**Etymology.** The specific epithet is derived from the Latin *dissilio*, fly apart, burst and *stella*, star. A plant in full flower, especially on a dull day, brings to mind a certain type of modern firework, in which the primary rocket explodes into numerous smaller rockets that themselves explode, giving rise to numerous radiating shafts of brilliant light (often white); the inflorescences are analogous to these final displays.



*Other specimens examined.*

INDONESIA, SULAWESI TENGAH: the western lower slopes of the Gunung Sojol complex, Balukang, on Tinombo-Siboang path (between camp 3 and camp 1), Lat. 00° 28' 19" N, Long. 120° 08' 27" E, alt. 1153–1344 m, lower montane rainforest, G. Brown, L. Craven, L. Juswara & Ramadhanil 114, 23 July 2002 (BO, CANB).

***R. amabile* Sleumer**

Reinwardtia 5: 127 (1960).

***R. minahasae* (Sleumer) Craven, comb. et stat. nov.**

Basionym: *R. radians* var. *minahasae* Sleumer, Reinwardtia 5: 130 (1960).

***R. pubitubum* Sleumer**

Reinwardtia 5: 126 (1960). — *R. radians* var. *pubitubum* (Sleumer) Argent, *Rhododendrons of subgenus Vireya* 170 (2006).

***R. radians* J.J.Sm.**

Bull. Bot. Buitenzorg III, 1: 403, t. 51 (1920).

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Fig. 4. *Rhododendron dissilistellatum*. Cultivated at Melba, A.C.T., Australia. Photo: Lyn Craven.

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## Notes on *Hibbertia* (Dilleniaceae) 10. *Hibbertia hirsuta* (subgen. *Hemistemma*: *H. vestita* group) does occur in South Australia and Tasmania

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### Abstract

A review of *Hibbertia hirsuta* (Hook.) Benth., which is prompted by its recent rediscovery in South Australia, includes a full description and a discussion of the importance of an understanding of the position and number of stamens in a flower to place the species with allied ones. Its affinities to *H. dispar* Toelken and *H. basaltica* A.M.Buchanan & Schah. are assessed and its possible cleistogamy discussed.

**Keywords:** Dilleniaceae, *Hibbertia*, taxonomy, cleistogamy, South Australia, Tasmania.

### Introduction

When Joe Quarmby consulted Bob Bates about a plant from the Meadows Creek tributary that he could not identify, the latter immediately recognised it as a new species for the South Australian flora. He soon confirmed its natural occurrence in the area by finding a second population of the species a few kilometres away along the creek. This new evidence was needed particularly as the species, *Hibbertia hirsuta* (Hook.) Benth., as it was identified, has lately been described as a Tasmanian endemic (Curtis 1956, Stone & Curtis 1971, Curtis & Morris 1975, Gray 2010). However, a closer examination of the literature shows that Mueller (1882, 1889) and Tate (1883, 1889, 1890) had already recorded its existence in South Australia, although all recent literature including three editions of the *Flora of South Australia* (Black 1926, 1952, Jessop 1986), have ignored it in spite of Tate (1883) citing details of a specimen(s) by J.G.O. Tepper and R. Tate. The only herbarium material found to date is a specimen collected by J.G.O. Tepper in 1881 (MEL119774), which has been overlooked for more than one hundred years, although it was correctly identified at the time. It is significant that Tepper also collected his specimen along Meadows Creek “on temporarily inundated flat”, while Quarmby (*J. Quarmby 189*) describes it as “seasonally wet depression”. *Hibbertia hirsuta* is extremely localised in South Australia, while it is more widespread in Tasmania, but it has not been recorded from Victoria, which is geographically closer to and more similar in climate to Tasmania.

One reason for overlooking the species for so long may be its very small flowers, as reported by Joe Quarmby (pers. comm.). *Hibbertia pallidiflora* Toelken has similar small flowers, which also gradually open (Toelken 1995, 2000), but as plants of that species are

larger and more common they are better represented in herbaria.

### Floral biology

Field observations in South Australia did not yield the envisaged breakthrough in the understanding of the breeding system of the species, except that it showed a very high percentage of seed set. An examination of the morphology of the flower together with different possible scenarios of the pollination biology are explored below. It is hoped that these will stimulate further interest, new observations and research into the problem.

Particularly important in *H. hirsuta* is the reduction of the number of petals and stamens to usually one, rarely few. Similar to specimens from Tasmania, South Australian plants examined displayed short styles bearing slightly incurved stigmas, which are at the upper level of the anther(s). This flower arrangement differs from that of *H. pallidiflora* and the vegetatively similar *H. sessiliflora* Toelken.

The small flowers, “which often remain unopened” as Curtis (in Stones & Curtis 1971) described it, cause difficulties in interpreting the breeding system of the species. The evidence that flowers never open, Bob Bates (pers. comm.) reported them to be cleistogamous, is at present incomplete. They might only open for a short time or at hours not coinciding with visits by collectors, particularly as they grow in not easily accessible localities in South Australia.

The specimens show, though not clearly, the petal(s) protruding above the apex of the clasping calyx lobes, as also illustrated by Stones & Curtis (1971, pl. 92). These authors also reported a reduction of petals, but never the absence thereof. The photo in Wapstra et al. (2010, p. 107) shows one flower with the calyx partially opened.

**Table 1.** Morphological comparison of *Hibbertia hirsuta*, *H. basaltica* and *H. dispar* to show similarities and differences.

Characters	<i>H. hirsuta</i>	<i>H. basaltica</i>	<i>H. dispar</i>
<b>Hairs on branches</b>	scattered larger and smaller fascicled hairs, rarely few simple hairs	dense larger and smaller fascicled hairs and few longer simple hairs	dense larger simple over smaller simple and/or fascicled hairs
<b>Leaf lamina</b>	(2.2–) 3.5–5 (–6.4) × (0.7–) 0.9–1.3 (–1.6) mm	(2.4–) 3.5–6 (–7.4) × 1–1.4 mm	(1.8–) 2.5–6.5 (–10.4) × (0.8–) 1–1.3 mm
<b>Hairs on leaves, upper surface</b>	scattered longer and shorter simple hairs	scattered simple, rarely forked hairs	scattered simple hairs
<b>Hairs on leaves, lower surface</b>	scarcely raised central vein and undersurface with ± dense fascicled hairs	recessed central vein and undersurface with few simple over short fascicled hairs	flush/recessed central vein with mainly long over shorter simple hairs
<b>Outer calyx lobes</b>	4–4.4 × 1.2–1.4 mm	4.5–4.7 (–5.1) × 2.3–2.5 mm	(5.2–) 5.4–5.8 (–6.1) × 1.8–2.6 mm
<b>Outer calyx outside hairs</b>	strigose, coarse simple over fascicled hairs	± strigose, few simple over mainly fascicled hairs	± strigose, few simple over mainly fascicled hairs
<b>Inner calyx lobes</b>	3.8–4 × 1.6–1.8 mm	4.3–4.7 (–4.8) × 2.5–2.8 mm	(5–) 5.2–5.6 (–6) × 2.6–3.2 mm
<b>Stamen number and position around ovary</b>	1 (2) on one side	(3–) 4 or 5 (–7) on one and 1 on other side	(2–) 4–6 (7) on one and (0) 1 or 2 on other side
<b>Anthers</b>	0.8–1 mm long	1–1.2 mm long	(1–) 1.1–1.4 mm long
<b>Seeds</b>	1.8–2 × 1.5–1.6 mm	1.6–2 × 1.2–1.5 mm	1.7–2 × 1.4–1.6 mm
<b>Habit</b>	prostrate to scrambling	prostrate to procumbent	prostrate to decumbent

A flower of the South Australian plants examined displayed only one petal clasping a dehiscent anther with some pollen in it and a cluster of pollen grains on each of the adjoining stigmas.

Plants of *H. hirsuta* show a very high degree of seed development, which could indicate selfing and, in fact, cleistogamous flowers, if the flowers can be demonstrated to remain closed. More field work is needed, as it is, for instance, not clear whether a pollinating agent is still needed to burst the anthers by vibration in order to spread the pollen, as usual in *Hibbertia* species (Bernhardt 1986). The stigmas of flowers of the South Australian *H. hirsuta* examined were covered with pollen although not, or perhaps no longer, in contact with the anther. One could speculate on the continued presence of petal(s) inviting pollinating vectors to visit the flowers. Even though they are closed or partially closed (see Wapstra et al. 2010), visiting insects might provide the thoracic vibration required to dehisce the anther(s) to cause selfing/cleistogamy by violently distributing the pollen onto the adjacent stigmas. It is unlikely that such a visitor will forcefully open the flower, as pollen, the only reward in hibernias, is sparse and was still found scattered in some flowers with developing seed.

In a detailed study of the floral ontogeny in 12 species of *Hibbertia* from different groups in the genus, Tucker & Bernhardt (2003) discussed the possible importance of the reduction of the number of stamens in specialisation and speciation in *Hibbertia*, with particular reference to a form of *H. fasciculata* R.Br. ex DC., which has its anthers reduced to three (Tucker

& Bernhardt 2000). While this form of *H. fasciculata* differs only in the reduced number of stamens and flowers open normally, *H. hirsuta* displays also a reduction in the number of petals and, apparently, the flowers are not opening fully. This changes not only the floral biology, but has also obscured its affinity to the two related species (below) with anthers on both sides of the ovary. The specialisation of the breeding system of *H. hirsuta* needs further examination, as discussed above. The possibility that this is an inbreeding species, makes the disjunct, but morphologically indistinguishable populations of *H. hirsuta* in Tasmania and South Australia even more remarkable.

### Relationships

A number of smaller species of *Hibbertia*, e.g. *H. humifusa* F.Muell. and *H. sessiliflora*, with a superficially similar habit and morphology, occur throughout the genus. Raheem (2013, pp. 3-9, 3-10) placed *H. hirsuta* next to *H. dispar* Toelken in his molecular cladogram (ITS data) of the eastern Australian species. *Hibbertia basaltica* A.M.Buchanan & Schah, a very similar species to *H. dispar* (cf. Toelken 2013), was not included in his study. This close affinity of the three species is not only reflected in their very similar morphology (Table 1), but also in a progressive loss of stamens, especially of the anterior ones closest to the bract. Furthermore, the number of petals in *H. hirsuta* is also reduced to one, rarely two. Toelken (2013) had for that reason not included *H. hirsuta* in his treatment of the *H. vestita* group, because it did not conform to the criterion of the group, i.e. stamens on both sides of

the ovary. He, however, discussed the wide range of variation, particularly in the number of stamens found in *H. dispar*.

*Hibbertia basaltica* and *H. dispar* are found in eastern Victoria and Tasmania, *H. hirsuta* in South Australian and Tasmania. Herbarium specimen data indicate that South Australian plants of *H. hirsuta* have been recorded only from temporarily wet areas in forest, while Tasmanian plants occur in drier habitats, such as, “amongst rocks in open sclerophyll forest” (*R.D. Hoogland 11748*), or, as Gray (2010) describes it, “in dry grassy places, open heath and woodlands”. The very similar *H. basaltica*, as well as *H. dispar*, is also mainly recorded from rocky or gravelly outcrops; Toelken (2013) cited a number of different habitats for different populations of *H. dispar*, among them there are forms from Flinders and Clark Island in Bass Strait, “recorded from wet areas near a lagoon” and “in sedge-land on marshy flats”.

### Taxonomy

#### *Hibbertia hirsuta* (Hook.) Benth.

Fl. Austral. 1: 26 (1863); Spicer, Handb. Pl. Tasmania 100 (1878); F.Muell., Census Pl. Tasmania 3 (1880); F.Muell., Syst. Census 1: 1, 141 (1882), includes S.A.; Tate, Trans. Proc. Rep. Roy. Soc. S. Austral. 6: 111 (1883), incl. S.A.; F.Muell., Second Syst. Census 1: 1 (1889), incl. S.A.; Tate, Fl. Extratrop. S. Austral. 14, 205 (1890), incl. S.A.; Tate, Trans. Proc. Rep. Roy. Soc. S. Austral. 12: 70 (1889), incl. S.A.; Rodway, Tasmanian Fl. 4 (1903); W.M.Curtis, Student Fl. Tasmania 1: 21 (1956); M.Stones & W.M.Curtis, Endemic Fl. Tasmania 3: 172, t. 92 (1971); W.M.Curtis & D.I.Morris, Student Fl. Tasmania edn 2, 1: 22 (1975); M.Wapstra et al., Tasmanian Pl. Names Unravelling 107, fig. (2010); A.M.Gray in M.Duretto (ed.), Fl. Tasmania Online: Dilleniaceae (2010). — *Pleurandra hirsuta* Hook., Companion Bot. Mag 1: 273 (1836); Hook.f., J. Bot. (Hook.) 2: 42 (1840); Walpers, Repert. Bot. Syst. 1: 64 (1842); Hook.f., Fl. Tasmania 1: 17 (1855). — **Type citation**: “Mr. Gunn (n. 445) — Gathered on dry hills, near Hobart Town, by Mr. Backhouse”. **Lectotype (designated here)**: Tasmania, Hobart Town, dry hills, *J.Backhouse sub Gunn 445* (K000687477!). **Remaining syntype**: V[an] D[iemen’s] Land, [Tamar River, Whirlpool Reach, Sep. 1835.] *R.C.Gunn 445* (K000687476!).

Suffrutex up to 0.15 m tall, prostrate to scrambling, moderately branched; branches thin-wiry, with leaf bases scarcely raised and scarcely decurrent, pilose but soon glabrescent. *Vestiture* on many parts persistent, sparse, consisting of fascicled and/or longer simple hairs; *on branches* sparse but denser below the inflorescence, a range of larger and smaller erect-spreading fascicled hairs (5–10 often unequally long arms) overtopped by scattered and on some branches very few porrect simple hairs, usually wearing off soon; *on leaves above* sparse, with scattered long and short erect hairs and rarely with a few forked hairs on the flanks of the revolute margins; *on leaves below* sparse with few fascicled hairs under scattered erect long and short simple hairs on the revolute margins and with dense spreading fascicled

hairs (8–12 often unequal arms on the central vein but ± similar on the undersurface) and usually without simple hairs; *on bracts* moderately dense, above and below with few small fascicled hairs overtopped by longer antrorse simple hairs; *on outer calyx lobes* moderately dense, outside with short fascicled hairs (2–4 usually unequal arms) overtopped by coarse antrorse simple hairs, inside moderately dense with finer forked hairs overtopped by coarser antrorse simple ones; *on inner calyx lobes* outside sparse, with scattered coarser simple hairs mainly along the central ridge over more widespread finer forked hairs, but glabrous membranous margins, inside glabrous. *Leaves* with pronounced intrapetiolar tuft of hairs up to 1 mm long and often ± decurrent on both sides of the petiole; *petiole* 0–0.4 mm long; *lamina* narrowly elliptic to rarely linear, (2.2–) 3.5–5 (–6.4) × (0.7–) 0.9–1.3 (–1.6) mm, gradually tapering into petiole, acute, rarely obtuse, above grooved to incurved and pilose, below exposing a tomentose undersurface between the slightly revolute margins and a narrow central vein, which is often visible to the leaf apex. *Flowers* sessile, single, terminal on terminal and axillary short shoots on distal branches; *buds* ellipsoidal; *bracts* lanceolate to almost triangular, 2–2.3 × 0.5–0.6 mm, bluntly acute, pubescent. *Calyx* unequally long and accrescent; *outer calyx lobes* 3, lanceolate, 4–4.4 × 1.2–1.4 mm, slightly longer than inner ones, acute, without ridge or recurved distal margins, outside strigose, inside strigose on upper half; *inner calyx lobes* broadly elliptic to obovate, 3.8–4 × 1.6–1.8 mm, obtuse, with ± broad membranous margins, outside pubescent, inside glabrous. *Petal* apparently only one, linear, with incurved apex, 3.2–3.7 mm long, shielding stamen. *Stamens* 1, rarely 2; *filaments* stiffly erect; *anthers* narrowly obloid and scarcely broader than and ± continuous with filament, 0.8–1 mm long and positioned with apex between the stigmas. *Pistils* 2; *ovaries* obovoid, with 2 ovules per ovary and attached above one another, pubescent; erect *styles* attached to the apex and curved inwards (sideway) to place stigmas next to anther. *Seeds* obloid to obovoid, 1.8–2 × 1.5–1.6 mm, brown; *aril* scarcely fleshy, with slightly lobed margins of the membranous cup covering the lower half of the seed.

*Distribution and ecology*. Known in South Australia (Southern Lofty region) from “clay soils on flats near creek line with *Eucalyptus viminalis* subsp. *cygnetensis*, *E. obliqua*, *E. camaldulensis* over *Acacia melanoxylon*, *A. verticillata*, *Exocarpus cupressiformis*, *Leptospermum continentale*, *Microlaena stipoides*, *Goodenia ovata*, *Hibbertia crinita*, *Haloragis heterophylla*” (*J.Quarmby 189*) and from “heavy grey clay with seasonal wet depressions with *Eucalyptus ovata* over *Leptospermum continentale*, *Banksia marginata*, *Gahnia sieberiana*, *Pteridium esculentum*, *Chorizandra enodis*, *Haloragis heterophylla* and *Gonocarpus tetragynus*” (*J.Quarmby 188*), while Gray (2010) recorded that south-eastern Tasmanian (TSE region) plants were growing “in dry grassy places, open heath and woodlands”.





Fig. 1. Type sheet of *Hibbertia hirsuta*: Lectotype indicated in red (K000687477: J.Backhouse sub Gunn 445). The remaining syntype, indicated in yellow (K000687476: R.C. Gunn 445), is accompanied with a note by Gunn: "Sent in 1835 as received from Mr. Backhouse / which he collected at Hobart Town. - Those now sent / are not in flower, but were gathered by myself / at Whirlpool-reach on the Tamar early in Sept / 1835 - growing on a dry hill-side, - the habit / evidently dwarf and procumbent, - or prostrate. -". - Reproduced with kind permission of the Board of Trustees of the Royal Botanic Gardens, Kew.

**Conservation status.** Very rare in South Australia; “scattered but not common” in Tasmania (Gray 2010).

**Diagnostic features.** Although the vegetative organs are similar to several small species of *Hibbertia*, the flowers are easily distinguished by the reduction of the number of petals and stamens to one or two.

**Variation.** Except for some range of variation in the denseness of the vestiture in local forms, as for instance in north-eastern Tasmania, where it is much denser, *H. hirsuta* shows remarkably little variation for a suspected inbreeding species.

**Typification.** A number of early specimens of this species have been accumulated on two sheets at K. On sheet A (Fig. 1), the specimen collected by J. Backhouse (left centre; inscribed “445. Dry Hills. Hobart Town”; K000687477), which is cited in the protologue of *Pleuranandra hirsuta* Hook., is here selected as lectotype, as it is flowering. The specimen gathered by R.C. Gunn (right centre; K000687476) is a syntype. It was collected at Whirlpool Reach near Launceston in Sep. 1835 and was sent to W.J. Hooker some time after the Backhouse specimen (see note by Gunn; Fig. 1), but both specimens were presumably available to W.J. Hooker when describing the species in Apr. 1836. Collections by J.D. Hooker on the type sheet, and three collections of Gunn collected in the 1840s, mounted on sheet B, are irrelevant to the typification.

#### Specimens examined

SOUTH AUSTRALIA: *R.Bates* 84343, Kuitpo Forest, 5.x.2011 (AD, HO, MEL); *J.Quarmby* 188, Meadows Creek tributary, 27.x.2011 (AD); *J.Quarmby* 189, Kuitpo, 27.x.2011 (AD); *J.G.O.Tepper* MEL1197774, Meadows Creek, 10.xii.1881 (MEL).

TASMANIA: *M.Allen* HO75847, Stringy Bark Gully, Warrane, 12.x.1975 (HO); *M.Allen* HO76346, Proctors Road, 25.ix.1975 (HO); *A.M.Buchanan* 560, Finger Post Hill, 7.x.1981 (HO); *J.Buften* MEL695427, Port Arthur, 1894 (MEL); *P.Collier* 134, S Blackmans Bay, 26.xi.1984 (HO); *P.Collier* 1770, near Molesworth, 23.x.1986 (HO); *P.Collier* 4308, 6 km SW Tooms Lake, 14.x.1989 (HO); *W.M.Curtis* HO3114, Conara, Tunbridge, 20.xi.1952 (HO); *A.V.Giblin* HO3120, Mt Nelson Road, 15.x.1929 (HO); *Gunn* 445/1841, Grass Tree Hill, Hobart, 12.x.1840 (K); *Gunn* 445/1842, Hobart Town, i.1839 (K); *Gunn* 445/23.x.1844, George Town (K, NSW); *M.Hart* HO29331, Sandy Bay, 17.xi.1947 (HO); *R.D.Hoogland* 11748, summit of Mt Nelson, 14.i.1970 (CANB, K); *I.Murfet* HO3115, c. 300m SE Mt Nelson Signal Station, 30.x.1957 (HO); *L.Rodway* 13, Queens Domain, Hobart, 15.xi.1897 (HO); *L.Rodway* HO3119, Mt Nelson Range, x.1917 (HO); *L.Rodway* NSW243046, Bellevive, 5.ix.1892 (NSW).

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## Additions to the genus *Lecidella* (lichenised Ascomycetes: Lecanoraceae)

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### Abstract

Two new taxa in *Lecidella* Körb. are described: *L. leucomarginata* Kantvilas & Elix, from Kangaroo Island (South Australia) and south-western Western Australia and *L. granulosa* var. *lecanorina* Kantvilas & Elix, from Kangaroo Island (South Australia) and the coast of southern New South Wales. Both display the unusual feature of an unpigmented proper excipulum, densely interspersed with crystals. A key to *Lecidella* in temperate Australia is presented.

**Keywords:** biodiversity, Kangaroo Island, *Lecidea*, lichens, temperate Australia.

### Introduction

*Lecidella* Körb. is a genus of lichens characterised by a crustose thallus containing a trebouxoid photobiont, biatorine, typically dark coloured apothecia with a persistent proper excipulum composed of radiating thick-walled hyphae, clavate, amyloid, eight-spored asci referred to as *Lecidella*-type (Hafellner 1984; Fig. 2), an hymenium that typically separates readily in KOH, simple, hyaline, non-halonate ascospores, and curved, filiform conidia; thallus chemistry is dominated by xanthenes in the majority of species (Fletcher et al. 2009; Kantvilas & Elix 2013). With 12 species (McCarthy 2014), *Lecidella* is well-represented in the Australian lichen flora, occurring mostly in temperate latitudes on rock, bark or wood. The eight Tasmanian species were recently revised by Kantvilas & Elix (2013), who also studied comparative material from elsewhere in southern Australia. Morphological and anatomical relationships with superficially similar genera, such as *Japewiella* Printzen, *Carbonea* (Hertel) Hertel, *Tasmidella* Kantvilas, Hafellner & Elix and others, were discussed therein and are not repeated here. In this paper, we describe two further taxa from temperate latitudes.

### Methods

The study is based chiefly on collections of the authors, housed in the Tasmanian Herbarium (HO) and the Australian National Herbarium (CANB). Descriptions are based on hand-cut sections of the thallus and ascomata examined with high-power light microscopy. Mounting media included water, 15% KOH (K), Lugols Iodine after pretreatment with K

(IKI), ammoniacal erythrosin and 50% HNO<sub>3</sub> (N). Dimensions of asci and ascospores are based on 30 and 70 observations respectively. The latter are presented in the format: 5<sup>th</sup> percentile–average–95<sup>th</sup> percentile; outlying extreme values are given in parentheses. Chemical constituents were identified by thin layer chromatography (Elix & Ernst-Russell 1993) and comparison with authentic samples. Nomenclature of pigments follows Meyer & Printzen (2000).

### Taxonomy

#### *Lecidella leucomarginata* Kantvilas & Elix, sp. nov.

*Lecidellae* flavovirenti Kantvilas & Elix fortasse simillissima, sed soreidiis destitutis, excipulo proprio hyalino vel pallide griseo, pigmentum deficienti, sed crystallis insperso, et ascosporis aliquantum parvioribus, 10–15  $\mu$ m longis, 6–8  $\mu$ m latis, differt.

**Mycobank No.:** MB810540.

**Typus:** SOUTH AUSTRALIA. Kangaroo Island, Western Cove, 35°44'S 137°35'E, 0.5 m alt., on bleached dead wood of *Melaleuca* in salt marsh, 27 Sep. 2013, G. Kantvilas 234/13 (holo: HO; iso: AD, BM).

*Thallus* crustose, effuse, bright lemon-yellow, rimose-areolate, esorediate, lacking a prothallus, forming irregular, undelimited patches to 12 cm wide or more, 0.25–1 mm thick; individual areoles with upper surface unevenly verruculose and with edges mostly lifting from the substrate; photobiont cells globose, 6–18  $\mu$ m diam. *Apothecia* biatorine, abundant, 0.5–1.3 mm wide, sessile, basally constricted to adnate, sometimes sunken in the thallus surface, scattered and roundish, or crowded, misshapen and fused together; disc plane at first, soon becoming convex, grey-black

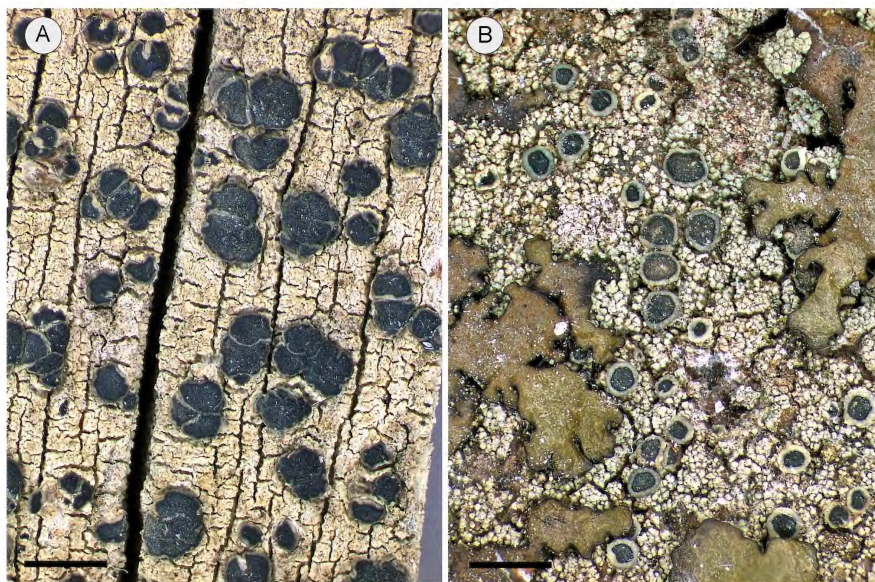


Fig. 1. Habit of new *Lecidella* taxa. **A** *L. leucomarginata*; **B** *L. granulosula* var. *lecanorina*. Scale bar: 1 mm. — **A** G. Kantvilas 234/13 (holotype), **B** G. Kantvilas 375/13 (holotype).

to bluish black to jet black, sometimes a little mottled, matt, epruinose. *Proper excipulum* colourless to pale grey or yellowish grey, rarely dark grey, sometimes piebald, glossy, sometimes a little flexuose, persistent but increasingly less obvious in older, more convex apothecia, sometimes with adhering thallus fragments, in section 25–60  $\mu\text{m}$  thick, lacking blue-green pigments, composed of radiating, branched hyphae 3–5  $\mu\text{m}$  thick, densely interspersed, especially towards the outer edge, with minute, yellowish brown to reddish brown crystals that fluoresce yellow in polarised light and dissolve fleetingly yellowish in K. *Hypothecium* 80–150  $\mu\text{m}$  thick, colourless to pale yellow-brown, occasionally yellowish orange, more intensely coloured towards the base, intensifying yellow-orange in K and N, sometimes interspersed with scattered oil droplets. *Hymenium* 60–70  $\mu\text{m}$  thick, separating readily in K, in the upper part usually dilutely greenish blue, K  $\pm$  grey-green, N+ crimson and overlain by yellowish brown crystals that dissolve in K, towards the base mostly colourless. *Asci* 45–55  $\times$  12–20  $\mu\text{m}$ , of the *Lecidella*-type. *Paraphyses* 1.5–2  $\mu\text{m}$  thick, sparsely branched; apices not markedly capitate, sometimes expanded to 2.5–4  $\mu\text{m}$ , unpigmented or with a thin internal cap and a faint external blush of blue-green, N+ crimson pigment. *Ascospores* hyaline, (9–) 10–12.4–15 (–16)  $\times$  (5.5–) 6–6.8–8  $\mu\text{m}$ , broadly ellipsoid to oblong. *Conidiomata* pycnidia, black, emergent, resembling apothecial initials, in section with wall blue-green, N+ crimson; conidia thread-like, curved, 15–20  $\times$  1  $\mu\text{m}$ . **Fig. 1A.**

*Chemical composition.* Thiophanic acid (major), 3-*O*-methylthiophanic acid ( $\pm$  minor), atranorin ( $\pm$  minor), chloroatranorin ( $\pm$  minor), arthothelin ( $\pm$  minor or trace); thallus K–, C+ orange, KC–, P–, UV+ orange.

*Etymology.* The specific epithet refers to the distinctive colourless proper excipulum of the apothecia of this species.

*Remarks.* This is a distinctive and remarkable species on account of its colourless proper excipulum, a feature also seen in *L. granulosula* var. *lecanorina* (described below). One of the defining generic characters of *Lecidella* is the black apothecial margin, comprised of radiating, thick hyphae coated in dark pigments and becoming swollen and almost parenchymatous towards the outer edge (Kantvilas & Elix 2013). In that regard, *L. leucomarginata* might appear to be misplaced in *Lecidella*. Yet, all the other salient characters, notably the anatomy of the thallus, its chemical composition consisting of xanthonenes, the distinctive ascus type, the hymenium that separates readily in KOH, the hyaline, broadly ellipsoid ascospores and the thread-like, curved conidia, are consistent with *Lecidella*. Indeed, on close inspection, the anatomy of the excipulum can also be interpreted as being of the *Lecidella*-type, except that instead of being swollen with pigment, the hyphae are densely interspersed with crystals. However, there is no hint of any development of a parenchyma at the outer edge. Traces of blue-green (*cinereorufa*-green) pigment, characteristic of most *Lecidella* species, can be detected in the hymenium by the application of  $\text{HNO}_3$ .

which yields a crimson reaction. Perhaps the most likely alternative generic placement for this species that was considered was *Japewiella*. However, this genus has a very distinctive excipulum composed of a loose reticulum of radiating, branched and anastomosing hyphae c. 1  $\mu\text{m}$  thick in a gelatinous matrix (Printzen 1999; Kantvilas 2011).

In the Australian flora, this new species appears to be most closely related to *L. flavovirens* Kantvilas & Elix, a corticolous species that likewise has a bright lemon-yellow thallus containing thiophanic acid as the major constituent, but which differs chiefly in becoming entirely sorediate. These species differ further in that *L. flavovirens* has unequivocally black apothecia, and although the proper excipulum lacks blue-green pigment, it is constructed in the typical *Lecidella* way, with the hyphae instead swollen with a dark brown pigment. In addition, the ascospores of *L. flavovirens* are also slightly longer and broader: (12–) 13–17 (–18)  $\times$  (6–) 7–10  $\mu\text{m}$  (Kantvilas & Elix 2013).

**Ecology and distribution.** On Kangaroo Island, this new species is known only from the type locality, where it was collected from remnant, fire-killed, bleached *Melaleuca* stags (several metres tall) in a salt marsh. The site is extremely degraded by draining, burning, some clearing and stock grazing. The habitat of this *Lecidella* is very species poor with respect to lichens and the only other species with which it was associated was *Ramboldia crassithallina* Kalb, a common lignicolous lichen on Kangaroo Island. In the near vicinity of the type locality where living individuals of *Melaleuca* remain, the epiphytic flora is richer and includes species of *Ramalina*, *Usnea*, *Lecanora* and *Parmotrema*, but no *Lecidella* was encountered. *Lecidella leucomarginata* also occurs in south-western Western Australia where it grows on the bark of *Acacia* and *Melaleuca* in open, dry sclerophyll woodland. Here associated species included *Austroparmelina pruinata* (Müll. Arg.) A.Crespo, Divakar & Elix, *Baculifera xylophila* (Malme) Marbach, *Buellia reagenella* Elix, *Flavoparmelia rutidota* (Hook.f. & Taylor) Hale, *Haematomma eremaum* R.W.Rogers, *Lecanora caesiorubella* Ach., *Pertusaria subarida* A.W.Archer & Elix, *Punctelia subalbicans* (Stirt.) D.J.Galloway & Elix and *Ramalina inflata* subsp. *australis* G.N.Stevens.

#### Additional specimens examined

WESTERN AUSTRALIA. Wotto Nature Reserve, First North Road, 21 km NE of Eneabba, 29°42'29"S 115°24'37"E, 275 m alt., 5 May 2004, J.A. Elix 28868 (CANB, HO, PERTH); same locality, 5 May 2004, J.A. Elix 28875 (CANB); Gwambygine Nature Reserve, 11 km S of York, 31°58'24"S 116°48'38"E, 245 m alt., 4 Apr. 2006, J.A. Elix 31756, 37406 (CANB); Walebing, Quarrell Range, Moora-New Norcia Road, 22 km S of Moora, 30°41'38"S 116°12'20"E, 275 m alt., 2 Apr. 2006, J.A. Elix 37549 (CANB); Fourteen Mile Brook Nature Reserve, 13 km NW of Narrogin along Wandering Road, 32°50'08"S 117°06'07"E, 335 m alt., 6 Apr. 2006, J.A. Elix 43229 (CANB).

#### *Lecidella granulosa* var. *lecanorina* Kantvilas & Elix, var. nov.

*Respectu praesentiam chodatini, hypothecium incol-ratum et ascosporas 9.5–14.5  $\mu\text{m}$  longas, 5–7.5  $\mu\text{m}$  latas, varietati granulosae similis, sed excipulo proprio hyalino vel pallide griseo, pigmentum destituito, crystallis flavo-brunneis dense insperso differt.*

**Mycobank no.:** MB810541.

**Typus:** SOUTH AUSTRALIA. Kangaroo Island, Creek Bay Farm, 35°50'S 138°06'E, 85 m alt., on rock in mallee woodland, 12 Sep. 2013, G. Kantvilas 375/13 (holo: HO).

**Thallus** crustose, pale yellowish grey to greyish green, minutely granular, esorediate, lacking a prothallus, forming small, irregular, undelimited "islands" 2–3 cm wide amongst other lichens; individual granules mostly 0.05–0.1 mm wide, dispersed or contiguous; photobiont cells globose, 6–18  $\mu\text{m}$  diam. **Apothecia** biatorine, 0.4–0.7 mm wide, sessile, basally constricted, scattered, roundish; disc plane at first, soon becoming undulate or convex, grey to brownish grey to grey-black, sometimes a little mottled, matt, epruinose. **Proper excipulum** colourless to pale grey or yellowish grey, sometimes partly or wholly dark grey, glossy, persistent, in section 40–60  $\mu\text{m}$  thick, lacking blue-green pigments, composed of radiating, branched hyphae 4–5  $\mu\text{m}$  thick, densely interspersed, especially towards the outer edge, with minute, yellowish brown to reddish brown crystals that fluoresce yellow in polarised light and dissolve to form a pale yellow solution in K. **Hypothecium** 50–100  $\mu\text{m}$  thick, colourless to pale yellow-orange especially at the base, intensifying yellow-orange in K and N, not interspersed. **Hymenium** 50–75  $\mu\text{m}$  thick, mostly separating readily in K, in the upper part overlain by a thick layer of yellowish brown granules that dissolve in K, usually also with patches of greenish blue, K  $\pm$  grey-green, N+ crimson pigment, especially adjacent to the excipulum, towards the base mostly colourless. **Asci** 50–60  $\times$  12–20  $\mu\text{m}$ , of the *Lecidella*-type. **Paraphyses** 1–2  $\mu\text{m}$  thick, mainly simple, occasionally sparsely branched towards the apices; apices variable, not capitate or expanded to 3.5–4.5  $\mu\text{m}$ , unpigmented or with the apical cell with an internal, blue-green cap, and the subterminal cell faintly blue-green, N+ crimson. **Ascospores** hyaline, (8–) 9.5–11.8–14.5 (–16)  $\times$  5–6.4–7.5 (–8)  $\mu\text{m}$ , broadly ellipsoid to oblong. **Conidiomata** not seen. **Fig. 1B, 2.**

**Chemical composition.** Chodatin (major), isoarthothelin (minor), thiophanic acid (minor), 2,5,7-trichlorolichexanthone (minor); thallus K–, C+ orange, KC–, P–, UV+ orange.

**Etymology.** The infraspecific epithet alludes to the fact that the apothecia, with their pale coloured proper exciple, somewhat resemble those of a *Lecanora*.

**Remarks.** The granular to areolate thallus containing chodatin as a major compound (an uncommon substance, not least in *Lecidella*), the predominantly colourless hypothecium and the relatively small ascospores indicate unequivocally that this new lichen is closely



**Key to *Lecidella* in temperate Australia<sup>1</sup>**

1. Growing on rock or on bryophytes overgrowing rock
  2. Hypothecium yellow-brown to dark brown, with the colour intensifying in K and N
    3. Vicinacin present; diploicin and thuringione absent . . . . . *L. sublapicida*
    - 3: Vicinacin absent; diploicin and thuringione present . . . . . *L. carpathica*
  - 2: Hypothecium colourless or at most pale yellowish brown at the base
    4. Thallus rimose-areolate, usually containing atranorin (K+ yellowish) together with other compounds
      5. Thallus areoles rather lumpy and verruculose, lacking a prothallus, containing atranorin and zeorin (sometimes only in trace amounts); apothecia 0.4–1.5 mm wide; mostly on calcareous or nutrient-enriched substrata . . . . . *L. stigmatata*
      - 5: Thallus areoles ± plane, growing on a blackish, effuse prothallus; apothecia to 0.8 mm diam.; on siliceous substrata
        6. Diploicin and/or caloploicin, ± thiophanic acid present; arthothelin and thuringione absent . . . . . *L. buelliastrum*
        - 6: Diploicin, caloploicin and thiophanic acid absent; arthothelin and thuringione present . . . . . *L. enteroleucella*
    - 4: Thallus granular, lacking atranorin but containing chodatol
      7. Proper excipulum black, in section densely infused with blue-green pigment and lacking crystals . . . . . *L. granulosa* var. *granulosula*
      - 7: Proper excipulum colourless to pale yellowish grey or mottled dark grey, in section lacking blue-green pigment but densely interspersed with crystals that dissolve pale yellow in KOH . . . . . *L. granulosa* var. *lecanorina*
- 1: Growing on bark or wood
  8. Thallus not sorediate
    9. Thallus containing atranorin only (C–); hymenium interspersed with oil droplets and crystals that do not dissolve in K . . . . . *L. destituta*
    - 9: Thallus containing xanthonenes (C+ orange); hymenium not interspersed, or at most with an epihymenial layer of granules that dissolve in K
      10. Hypothecium colourless to pale brownish; apices of paraphyses with an *internal* cap of pigment . . . . . *L. xylogena*
      - 10: Hypothecium pale yellow-brown to yellow-orange, colour intensifying in K; apices of paraphyses unpigmented or with an *external* cap of blue-green, N+ crimson pigment
        11. Ascospores 15–24 × 8–13 µm; excipulum in section mainly opaque brown, with blue-green, N+ crimson pigment at the edges . . . . . *L. montana*
        - 11: Ascospores 9–15 × 5–8 µm; excipulum in section mainly colourless to dilute brown, with blue-green, N+ crimson pigment at the edges . . . . . *L. elaeochroma*
  - 8: Thallus sorediate
    12. Proper excipulum colourless to pale yellowish grey or mottled dark grey, in section lacking blue-green pigment but densely interspersed with crystals that dissolve pale yellow in KOH . . . . . *L. leucomarginata*
    - 12: Proper excipulum black, in section lacking crystals, opaque dark brown or with blue-green pigment.
      13. Ascospores 12–18 × 6–10 µm; apices of paraphyses unpigmented or with an *external* cap of blue-green, N+ crimson pigment; excipulum in section opaque dark brown, lacking blue-green pigment; soredia arising in discrete soralia . . . . . *L. flavovirens*
      - 13: Ascospores 7–14 × 4.5–9 µm; apices of paraphyses with an *internal* cap of pigment; excipulum in section grey-green to pale brownish, usually with blue-green pigment towards the outer edge; soredia not in discrete soralia, arising from a dissolution of the thallus . . . . . *L. xylogena*

<sup>1</sup> Australian records of *L. asema* (Nyl.) Knoph & Hertel (Elix 2008, 2010) are misdeterminations of *L. flavovirens*.

related to *L. granulosa* (Nyl.) Knoph & Leuckert as delimited and described by Kantvilas & Elix (2013), and by Knoph (1990) and Rambold (1989) (under its synonym *L. chodatii*). Yet the pale, unpigmented proper excipulum of the specimens studied is so distinctive and visually striking, and unusual for the genus as a whole (see also discussion under *L. leucomarginata* above) that we feel that they deserve taxonomic recognition. Specimens of var. *granulosula* invariably contain *cinereorufa*-green pigment in their excipulum, which is constructed of radiating, swollen hyphae typical of *Lecidella*. The new variety instead has a totally unpigmented excipulum which is densely interspersed with crystals, identical to what is displayed by *L. leucomarginata*. In his discussion of *L. granulosa* (as *L. chodatii*), Knoph (1990) mentions that crystals are seen “occasionally”, but he makes no mention of crystals

being correlated with an absence of pigment or that he saw any specimens with an unpigmented excipulum. No crystals were observed in any Australian specimens of var. *granulosula* studied; we were unable to study any non-Australian material. In several species of *Lecidella*, specimens from exposed habitats tend to have more intensely pigmented apothecia. In the case of var. *lecanorina*, specimens from exposed habitats certainly have darker apothecial discs, but this does not translate into a higher concentration of blue-green pigment; the amount of pigmentation tends to be ± constant across all specimens, with most of the darker coloration of the disc deriving from crystals, and the blue-green pigment being very dilute and located mainly in that part of the epihymenium adjacent to the excipulum.

In Tasmania, there is a further, undescribed saxicolous taxon with an unpigmented excipulum.



This species has a well-developed, yellowish, areolate thallus containing atranorin, 2,5,7-trichloro-3-O-methylnorlichexanthone (both major) plus zeorin and isoarthothelin (minor). It grows in sheltered underhangs in dry sclerophyll forest. We have excluded it from this study pending further collections.

*Ecology and distribution.* This new variety is known from South Australia (Kangaroo Island) and the coast of southern New South Wales, and this widely disjunct distribution suggests that it is probably more widespread, albeit inconspicuous and overlooked. It has been recorded from sheltered aspects on coastal rocks (chiefly sandstone and laterite) where it grew in rather nutrient-enriched conditions, together with *Buellia aeruginosa* A.Nordin, Owe-Larsson & Elix, *Candelariella vitellina* (Hoffm.) Müll.Arg., *Haleciana subsquamosa* (Müll. Arg.) van den Boom & Mayrhofer, *Lecanora dispersa* (Pers.) Sommerf., *Verrucaria fusconigrescens* Nyl., *Xanthoria ligulata* (Körb.) P.James and species of *Caloplaca* and *Amandinea*. The type specimen is from a more inland locality in dry lowland woodland, where it grew beneath a canopy of mallee eucalypts, associated with *Xanthoparmelia subprolixa* (Nyl. ex Kremp.) O. Blanco et al. and species of *Caloplaca*.

#### Additional specimens examined

SOUTH AUSTRALIA. Kangaroo Island, northern end of Antechamber Bay, 35°46'S 138°04'E, 5 m alt., 22 Sep 2013, *G. Kantvilas* 264/13 (HO).

JERVIS BAY TERRITORY. Bristol Point, 35°08'S 159°44'E, 1 m alt., 17 Nov 2012, *G. Kantvilas* 606/12 (HO).

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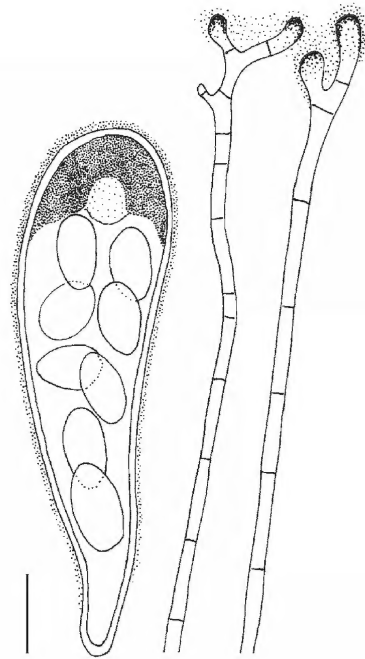


Fig. 2. The *Lecidella*-type ascus (with amyloid portions stippled), ascospores and paraphyses (with pigmented areas stippled), as exemplified by *Lecidella granulosa* var. *lecanorina*. Scale bar: 10 µm. — *G. Kantvilas* 375/13 (holotype).



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## *Goodenia valdentata* (Goodeniaceae), a new rare species endemic to Davenport Range, South Australia

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### Abstract

A new arid zone species endemic to Davenport Range in South Australia is formally described as *Goodenia valdentata* P.J.Lang. It belongs in subsection *Goodenia* and fits within a group of species allied to *G. grandiflora* Sims. Previously, *G. valdentata* has been confused with *Goodenia saccata* Carolin and *G. chambersii* F.Muell., and characters distinguishing the three species are tabulated. *Goodenia valdentata* appears most closely related to *G. chambersii*, with *G. saccata* a more distant relative strongly linked to *G. albiflora* Schldl. by the synapomorphies of crenulate-laciniate corolla wing margins and flattened, short, white hairs inside the corolla. Based on its restricted range *G. valdentata* warrants listing as rare in South Australia.

**Keywords:** biodiversity, new species, taxonomy, Australia, *Goodenia* subsect. *Goodenia*.

This new species of *Goodenia* Sm. was first collected by B.G. (Bruce) Andrews<sup>1</sup> in October 1968 on Nilpinna Station. It is represented by nine collections in the State Herbarium of South Australia (AD), all from the vicinity of Davenport Range, a small isolated range on the boundary between Nilpinna and Peake Stations, c. 750 km NNW of Adelaide. Six of the existing AD collections have hitherto been identified as *Goodenia saccata* Carolin and the other three as *G. chambersii* F.Muell. (State Herbarium of South Australia 2013). Although related to these species, comparison of herbarium material shows that the new taxon is consistently and clearly distinct from both.

### *Goodenia valdentata* P.J.Lang, sp. nov.

**Typus:** F.J.Badman per W.R.Barker 5267, 28 Aug. 1986, 0.5 km SE of Levi Springs Bore, 28°22'35"S 136°09'32"E, Lake Eyre Region, South Australia, (holo.: AD 99524087; iso.: CANB, K).

*Goodenia saccata* auct. non Carolin: Jessop, List Vasc. Pl. S. Austral. ed 4, 87 (1993), as to LE occurrence.

Perennial, erect-stemmed *subshrub* to 80 × 80 cm. *Stems* branched, with a fine, velvety indumentum of dense, short, simple hairs and sparse, short, glandular hairs; prominently ridged, becoming woody. *Leaves* usually with 1–6 widely spaced, patent, narrow petiolar lobes or pinnae 2–5 mm long, arising along the petiole 7–20 (–25) mm long; *lamina* narrowly ovate to ovate, 16–36 (–46) × 9–25 mm, deeply and coarsely dentate with 14–25 (–29) teeth (including 1–9 (–13) secondary teeth), primary teeth 1.5–5 mm long with an elongated terminal tooth, 2.5–7.5 (–9) mm long, forming

an acute to acuminate apex; midrib prominent on abaxial surface, strongly and sharply raised at base, gradually shallower towards apex and disappearing near base of the terminal tooth (but continuing almost to the apex in upper inflorescence leaf-bracts); mid vein only weakly evident in lower two thirds of adaxial surface; both surfaces finely velvety with patent, stiff, short, fine, simple hairs, c. 0.1 mm long, and obscure, sparse, short glandular hairs. *Inflorescence:* flowers solitary, or rarely 2-flowered, in axils of upper stems, forming weakly differentiated leafy racemes or rarely thyrses; *bracts* leaf-like, becoming more elongate and deeply-toothed up the stem; *peduncles* 1–1.5 mm long; *bracteoles* very narrowly lanceolate, 6–10.5 × 0.8–1.2 mm, with mid-rib on abaxial side; *pedicels* angular, 5–11 mm long, persistent, articulate 1.2–2 mm below base of ovary. *Hypanthium* with 5 prominent, velvety ribs continuous with calyx lobes and covered in dense, simple hairs, intervening areas with mid-dense, short, glandular hairs, 5–7.8 mm long, grading into a basal stalk, 1.2–2 mm long. *Calyx lobes* green, leafy, narrow-lanceolate, 5.7–8 × 1.1–1.5 mm, with a midrib in the lower 1/2–2/3, often with 1–3 (–4) weak teeth. *Corolla* a bright, rich yellow, often with purple veining inside on the lower part, 25–30 mm long, articulate; *outside* pubescent with dense, patent, short, fine, simple hairs; *inside* glabrous apart from fine, soft hairs at base of the tube, rows of prominent enations present in basal parts; *pouch* on upper 1/3–1/2 of the hypanthium, 2.5–4.5 mm long, shallow; *lobes* distinct from wings, lanceolate to narrow-triangular, with apices acute to acuminate, with a narrow blunt tip extending a little beyond the wings; *wings* entire, with sparse, marginal setae 0.4–0.7 mm long, not projected beyond lobe apex but gradually, or abruptly, narrowed apically to form a

<sup>1</sup> B.G. Andrews was briefly working in the area for North Broken Hill Ltd and developed an interest in the local flora; he submitted a total of 79 collections to the State Herbarium, all made in 1968.





**Fig. 1–3.** *Goodenia valdentata*. 1 habit and habitat: flowering shrub on sandstone outcrop; 2 flowers and foliage; 3 detail of leaves. — *D.E.Murfet 7034 et al.* Photos: D.J. Duval, S.A. Seed Conservation Centre.





Fig. 4. *G. valdentata*. Flowers, showing tapered corolla wings, and style with fine spreading hairs visible on the upper part. — D.E.Murfet 7034 et al. Photo: D.J. Duval, S.A. Seed Conservation Centre.

combined acute to obtuse apex. *Adaxial corolla lobes* diverging from fused corolla at 7–10 mm from base, 12–18 mm × 1.9–2.5 mm; wings ± equal, 7–12 × 1.4–2 mm; lacking distinct auricles. *Abaxial corolla lobes* separating at a further 3.5–6.5 mm past divergence of adaxial lobes, 10.5–16 × 2.5–3.5 mm; wings 7–9 × 1.5–2.8 mm. *Stamen* filaments linear, 7–7.5 mm long; anthers narrowly oblong to linear, 2.2–3.7 × 0.5–0.7 mm, apiculate, with small, ovate extension 0.3–0.6 mm long. *Style* 16–21 mm long, pale cream with some short, glandular hairs and soft, fine, spreading hairs, 0.5–1 mm long, for almost its entire length, but becoming purple and with longer hairs to 1.5 mm near junction with indusium. *Indusium* inclined forwards at almost right-angles to style, pale purplish-grey, obovoid-trapezoid, 2–2.6 mm long, dorsiventrally compressed, with apical margin lightly convex from above and 3.8–4.1 mm wide, base 2.1–2.5 mm wide, glabrous except for some long hairs in a darker, purplish zone at its base, orifice beset with dense, white bristles 0.4–0.6 mm long. *Fruit* ellipsoid, 10–14 × 5–7 mm, tapered at base into a short stalk, 0.5–2.5 mm long, 2-valved; *valves* extending 2–3 mm beyond attachment of calyx lobes, apices rostrate and usually bifid, sometimes splitting towards base and giving the appearance of a 4-valved fruit; septum 2/3–3/4 the length of loculus. *Seeds* light brown, broadly elliptic, 3.6–4.1 × 2.3–2.6 mm, papillulose, surrounded by a raised thickened margin with a squared-off edge. Fig. 1–4, 7, 10.

*Diagnostic features.* The new species has bracteolate pedicels and falls in subsection *Goodenia* (Carolin 1992), comprising over 53 species. Within this subsection it belongs with a loose group of species allied to *G.*



Fig. 5. *G. chambersii*. Flowers, showing the abruptly terminated corolla wings and absence of hairs around the style apex. — D.J.Duval 1888 & M.J.Thorpe. Photo: D.J. Duval, S.A. Seed Conservation Centre.

*grandiflora* Sims, a widespread and variable species extending from coastal N.S.W. and Qld to the ranges of central Australia in N.T., and W.A. The group also includes *G. brunnea* Carolin, *G. kingiana* Carolin, and *G. macmillanii* F.Muell., as well as *G. chambersii*, *G. saccata* and possibly *G. albiflora* Schldl., all species that have been previously treated as *G. grandiflora* or varieties thereof. Species of this group are shrubby perennials (excepting *G. albiflora* which is a resurgent rhizomatous perennial), and they are usually long-lived, and found on rocky substrates. *Goodenia valdentata* is clearly distinct from all these species, but is most like *G. grandiflora*, *G. chambersii* and *G. saccata* in its general appearance. It differs from *G. grandiflora* by its narrower leaves that are never cordate at the base, the more deeply serrate leaf margin, and consistently ciliate corolla wings (with long sparse setae) that taper to the lobe apex. *Goodenia valdentata* most closely resembles the two South Australian endemic species, *G. chambersii* and *G. saccata*, with which it has been previously confused. Diagnostic characters separating these three taxa are summarised in Table 1.

*Goodenia valdentata* has distinctive corolla wings that are gradually to steeply tapered apically (Fig. 4) rather than abruptly terminated. Combined with the main body of the lobe this produces an obtuse to acute apex. In contrast, the combined apex in *G. chambersii* is truncate (Fig. 5) or often emarginate where the wings are angled forwards beyond the apex; in *G. saccata* it is truncate with the lobe apex protruding as a short acute extension.

The three species can also be separated on leaf characters alone. The leaves of *Goodenia valdentata* are distinctive by their longer lateral teeth (to > 3 mm)



Fig. 6. Isotype of *G. saccata* (detail), showing short white flattened hairs on inside of corolla and crenulate-laciniate wing margins. — HJ.Eichler 12676 (MEL 23070). Photo: JSTOR Global Plants.

and the attenuate terminal tooth that is especially pronounced on the upper leaf-bracts (Fig. 3 & 10). They are consistently more elongate than the ovate-orbicular leaves of *G. chambersii* and approach those of *G. saccata* in their general shape, but differ by their deeper, more regular teeth. By contrast *G. saccata* has more secondary teeth, producing a somewhat irregular almost bidentate margin. The leaves of both *G. valdentata* and *G. saccata* are strictly speaking pinnatisect and bear 1–6 small petiolar pinnae. The pinnae in *G. valdentata* are narrower and less well developed than in *G. saccata*, while in *G. chambersii* they are always absent.

An unusual feature of *G. valdentata* is the development of 1–3 weak teeth on many of the calyx lobes. This was observed in four of the six collections of *G. valdentata* with flowers but in only seen once in *G. saccata* (on the holotype), and not at all in *G. chambersii*.

**Affinities.** *Goodenia valdentata* is geographically situated between *G. chambersii* and *G. saccata* species (Fig. 13) and shares some morphological features of each. *Goodenia chambersii* is found on breakaways in gypseous landscapes around Coober Pedy, Arckaringa and Evelyn Downs, and also extends southwards in an arc on residuals of the Stuart Range, well to the west of the range of *G. valdentata*. *Goodenia saccata* is endemic to the northern Flinders Ranges and occurs as three discrete major populations on basement rocks, in the Arkaroola-Yankaninna, Blinman-Parachilna-Moolooloo and Leigh Creek-Beltana areas.

*Goodenia valdentata* matches *G. chambersii* in its larger, bright yellow flowers with a mostly glabrous indusium, prominent enations on the inside of the corolla, and entire wings that are distinctly ciliate with widely-spaced setae, particularly in their lower part. The latter character was among three highlighted by Carolin (1992) in justifying the recognition of *G. chambersii* as distinct from *G. grandiflora*. This status is supported by the molecular phylogenetic analysis of Goodeniaceae by Jabaily et al. (2012) where *G. chambersii* and *G.*



Fig. 7. *G. valdentata* seed. — LHS: BS69-25204; RHS: B.Andrews, 10 Oct. 1968.

*grandiflora* emerged as well separated sister species. The distinctive seed features of *G. chambersii* (more prominent sculpturing and a smoother, more tapered rim) are not shared by *G. valdentata* or *G. saccata*, which both have seeds with a squared rim typical of other species in the *G. grandiflora* group (Fig. 7–9). *Goodenia valdentata* is close to *G. saccata* in general leaf shape, presence of petiolar pinnae, its seed characters and in having spreading hairs distributed over the entire length of the style. However, *G. saccata* differs by its lighter and slightly glaucous foliage, predominantly white flowers (see Notes, p. 54), larger corolla tube pouch, and sweet scent (noted as especially strong in the late afternoon). A similar set of features is found in *G. calcarata* F.Muell.<sup>2</sup> and *G. albiflora* and is indicative of a pollination syndrome, possibly for night-flying insects, such as moths. More importantly, *Goodenia saccata* has two distinctive apomorphic features that are absent in *G. valdentata*, but shared with *G. albiflora*: stiff, short, white, flattened-clavate (to narrow-oblongate) hairs on the inside of the corolla, and irregularly crenulate-laciniate corolla wing margins (Fig. 6). Its closest relationship appears to be with *G. albiflora* rather than *G. valdentata*.

Overall, the new species appears more closely related to *G. chambersii* than to *G. saccata*, despite the obviously divergent leaf morphology of the former.

**Distribution.** *Goodenia valdentata* is endemic to Davenport Range and associated drainage lines, in the Lake Eyre Region of South Australia (Fig. 13 & 14). It is not to be confused with the Davenport Range of Northern Territory, but is part of a system generally referred to as the Peake and Denison Ranges (Twidale 2007, Ambrose et al. 1981), comprising small isolated remnants of the Adelaide Geosyncline fold belt, from which the Mt

<sup>2</sup> *Goodenia calcarata* (F.Muell.) F.Muell. exhibits a similar pollination syndrome, but has the pouch extended into a prominent nectary spur. However, it appears less closely related and also differs by its ephemeral habit, entire corolla wing margins, and stiff purple hairs on the inside of the corolla that are slightly thickened but not flattened as in *G. saccata* and *G. albiflora*.





**Fig. 8.** *G. chambersii* seed. — LHS: B.Lay 638; RHS: E.H.Ining, 22 Oct. 1955.



**Fig. 9.** *G. saccata* seed. — LHS: K.H.Brewer 640; RHS: L.D.Williams 11722.

Lofty and Flinders Ranges were formed. The range straddles the boundary of Nilpinna Station and The Peake Station, and populations of *G. valdentata* occur on both properties.

**Habitat.** The major rock type in the Davenport Range is sandstone of the Burra Group from the Late Proterozoic (S.A. Dept Mines and Energy 1982). Collectors' field notes describe *G. valdentata* as occurring on rocky outcrops or hill slopes (4 collections) or watercourses (5 collections). In all but one case, mention is made of the substrate being rocky or having a moderate to dense cobble strew. It is recorded as growing in: crevices of deep red-brown rocks, skeletal brown soil, clayey sand, and silty clay loam. The vegetation of Davenport Range is mostly Open Woodland dominated by mulga and chenopods (Gee et al. 1996). For the two collections

from Biological Survey of S.A. quadrats, data on surrounding vegetation indicate a very sparse tree or shrub stratum dominated by *Acacia* species (*A. ligulata*, *A. salicina* and *A. tetragonophylla*) or red gum (*Eucalyptus camaldulensis*) in the watercourses.

**Conservation status.** The known range of *G. valdentata* spans 21 × 13 km, based on the seven more precisely located collections (Fig. 14). With such a restricted extent, it clearly warrants listing as a Rare species. There are no obvious immediate threats to the conservation of this species, but it could also qualify as Vulnerable if its distribution within this area is found to be only sparse and patchy. Using the IUCN 2001 categories as adopted by the National Parks and Wildlife Council (2003), a plant may be assigned Vulnerable (VU) status under criterion D2 for a restricted area of occupancy (as

**Amended key to South Australian ± shrubby, cauline-leaved species of subsection *Goodenia* ('Group B' of Carolin & Cooke 1986)**

- 1: Leaves with petiolar pinnae (these often reduced)
  - 2: Leaf lamina lanceolate, viscid, with simple hairs almost absent ..... *G. brunnea*
  - 2: Leaf lamina narrowly to broadly ovate (-triangular), finely velvety, with abundant short, simple hairs
    - 3: Leaf margin irregularly dentate/bidentate, longest lateral teeth 1–3 mm long; corolla mostly off-white with crenate-laciniate wing margins ..... *G. saccata*
    - 3: Leaf margin strongly and evenly dentate, longest lateral teeth 3–5 mm long; corolla yellow with ± entire wing margins ..... *G. valdentata*
- 1: Leaves simple, with petioles lacking pinnae, or sessile
  - 4: Leaves and stems with plentiful glandular and/or non-glandular hairs
    - 5: Leaves petiolate, with abundant simple hairs
      - 6: Leaves broadly ovate to orbicular, green, with fine short erect hairs ..... *G. chambersii*
      - 6: Leaves linear to narrowly elliptic, silvery-grey, with appressed T-shaped hairs ..... *G. mueckeana*
    - 5: Leaves sessile and stem-clasping, with abundant glandular hairs
      - 7: Leaves strongly stem clasping, mostly > 3 cm long; indusium entire ..... *G. amplexans*
      - 7: Leaves weakly stem clasping, mostly < 3 cm long; indusium notched ..... *G. benthamiana*
  - 4: Leaves and stems glabrous or glabrescent, without conspicuous hairs
    - 8: Leaves strongly glaucous, flowers white ..... *G. albiflora*
    - 8: Leaves green, flowers yellow
      - 9: Leaves narrowly elliptic to oblanceolate; corolla with minute simple hairs outside ..... *G. vernicosa*
      - 9: Leaves ovate to elliptic, rarely narrower; corolla lacking simple hairs
        - 10: Leaves thick; sepals 2–4 mm long; bracteoles to 1.5 mm long ..... *G. varia*
        - 10: Leaves thin; sepals 3–11 mm long; bracteoles to 6 mm long ..... *G. ovata*





Fig. 10. *Goodenia valdentata*. Holotype, F.J.Badman per W.R.Barker 5267.

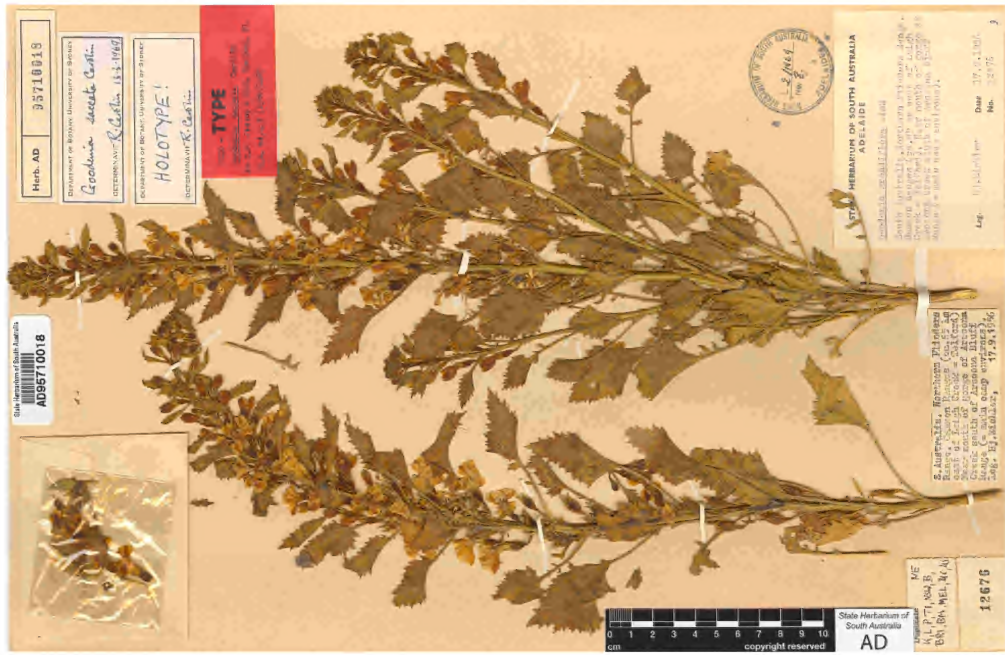


Fig. 12. *Goodenia saccata*. H.J. Eichler 12676, holotype.



Fig. 11. *Goodenia chambersii*. E.H. Ising 3626A, a paratype of *G. helenae* Ising.





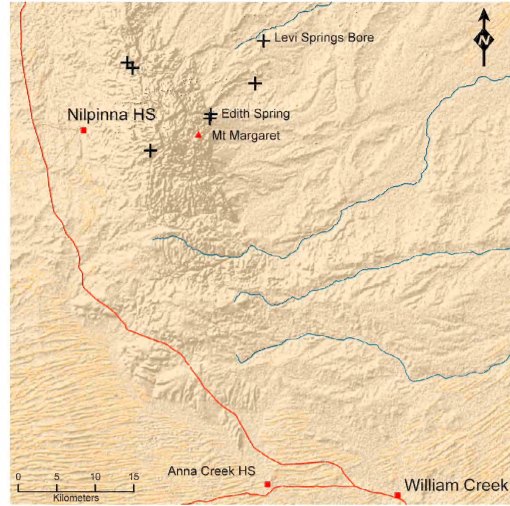
**Fig. 13.** Distribution of *Goodenia valdentata*, *G. chambersii* and *G. saccata*, based on AD collections.

opposed to extent) of “typically less than 20 km<sup>2</sup>”. Currently there is insufficient information to estimate the area of occupancy. Collectors’ field notes merely describe it as [locally] moderately common or common (5 collections). To ascertain whether it qualifies as Vulnerable, details on population sizes and their coverage within the range area are required, so at this stage only Rare status is recommended.

**Etymology.** The epithet *valdentata* is formed from a contraction of the Latin words *valde*, strongly, and *dentatus*, toothed, and refers to the leaf margin with prominent teeth, which are more pronounced than in related species.

**Notes.** One factor contributing to the confusion of *G. valdentata* with *G. saccata* is the description of white or yellow flower colour for the latter. *Goodenia saccata* appears to be a consistently white-flowered species, but its flowers were first described as “cream to yellow” (Carolin 1986), and later as “yellow or off-white” (Carolin 1992). It is unlikely that Carolin would have seen fresh material and these descriptions are probably based on the uniform yellowish tinge to the corolla seen on some herbarium specimens, which is probably an artefact of drying and aging.

Flowers of the holotype sheet (Fig. 12) appear particularly yellowish, but on other plants from the



**Fig. 14.** Detail of *Goodenia valdentata* distribution (+) based on the seven collections with a resolution of 1 km or better.

same collection (e.g. the isotype, MEL 23070) they are clearly white. The possibility of yellow-flowered variants within the population cannot be eliminated completely, but it seems unlikely given the absence of field-based records of yellow-flowered forms, and the following evidence. More common species known in the field to be consistently white-flowered such as *G. albiflora* and *G. calcarata* do sometimes produce dried specimens with a yellowish tone on the flowers (e.g. *R.Taylor 507* and *D.J.Duval 1544*, respectively). Also, one herbarium specimen of *G. saccata* with yellowish flowers (*K.H.Brewer 546*) has field notes describing the flowers as white. In the four other AD collections of *G. saccata* with field notes that refer to flower colour, it is also given as white. Further support is provided by recent field observations of the two eastern populations, one by the author and several by K. Brewer, who reported that the flowers were always predominantly white or “off-white”, although sometimes suffused with yellow towards the base.

*Goodenia valdentata* collections examined other than type, all from AD

SOUTH AUSTRALIA. **Lake Eyre:** *B.Andrews*, 10 Oct. 1968, Nilpinna Station; *F.J.Badman 5148*, 18 Apr. 1992, Peake Station, Edith Spring (Dups: BRI, NY); *F.J.Badman 7051*, 12 Aug. 1993, 13 km NW of Mt Margaret, Peake Station; *F.J.Badman 7070*, 12 Aug. 1993, 12 km NW of Mt Margaret, Peake Station; *R.Bates 59193*, s.dat. [c. 15 Aug. 2001 based on adj. nos.], Davenport Range (SW gorge), Nilpinna (Dups: MA, SIU); *J.L.Chivell & A.Shalekoff BS69-25204*, 1 Mar. 1996, 15.7 ENE Nilpinna; *D.E.Murfet 7034*, *D.J.Duval & T.S.Te*, 9 Oct. 2010, Davenport Range, c. 10 km ESE of Nilpinna Station; *A.C.Robinson & S.A.Bemmer BS69-28610*, 1 Mar. 1996, 23 km ENE Nilpinna Homestead.

Table 1. Diagnostic characters distinguishing *Goodenia chambersii*, *G. valdentata* and *G. saccata*.

	<i>G. chambersii</i>	<i>G. valdentata</i>	<i>G. saccata</i>
<b>Indumentum of stems &amp; leaves</b>			
simple hairs	mid-dense	very dense	mid-dense
glandular hairs	sparse to mid-dense, conspicuous	sparse, inconspicuous	mid-dense, prominent
<b>Petiolar pinnae</b>			
number	none	1–6	1–6
shape	—	narrowly oblong	narrowly triangular to triangular
<b>Lamina</b>			
shape	broadly ovate to orbicular	narrowly ovate to ovate	(narrowly-) ovate to broadly ovate-triangular
length/width ratio	0.9–1.3	1.4–2.0	1.0–2.2
<b>Leaf margins</b>			
	crenate-dentate	prominently & acutely dentate elongate terminal tooth	irregularly compound-dentate
number of teeth	9–20	14–25	18–45
secondary teeth	rare	few	many
lateral tooth length (max.)	0.8–3 mm	3–5 mm	1–3 mm
terminal tooth length	to 4.5 mm	to 7.5 mm	to 4 mm
<b>Flowers per axil</b>			
	1–3	1 (–2)	1–3
<b>Corolla</b>			
colour	yellow	bright yellow	mostly off-white
pouch	shallow, on upper 1/2 of hypanthium	shallow, on upper 1/3–1/2 of hypanthium	prominent, on upper 2/3–3/4 of hypanthium
enations	yes	yes	absent, or a few weak ones
vestiture inside	pilose in lower 1/3–1/2	pilose only near base	hispid, flattened straight white hairs in lower 2/3–3/4
wing margins	entire	entire	crenulate-laciniate
wing marginal setae	yes	yes	no
wing termination	not tapered apically, often projecting beyond lobe	gradually to steeply tapered apically, not exceeding lobe	usually abruptly terminated short of lobe apex
lobe & wing apex	truncate or emarginate	acute or obtuse	truncate with protruding tip
<b>Style</b>			
spreading hairs	only in lower 1/2–2/3, and near base of indusium	entire length	entire length
indusium surface	mostly glabrous	mostly glabrous	hirsute with soft hairs
<b>Seed</b>			
mature colour	mid to dark (reddish-) brown	pale brown	pale brown
margin	flush or slightly raised	strongly raised,	strongly raised,
rim	tapered or rounded	flat with squared-off edges	flat with squared-off edges
sculpture	papillose-verrucose	papillulose	papillulose

*Goodenia chambersii*, selected specimens (of 27 seen), all from AD (except otherwise indicated)

SOUTH AUSTRALIA. **Lake Eyre:** *D.J.Duval* 1888, 1 Sep. 2010, 4 km E Arckaringa Station; *E.H.Ising* 3626A, 15 Oct. 1950, Evelyn Downs, 90 miles SW of Oodnadatta (Dups: MEL, K, BM, P, TI, US, CANB); *E.H.Ising*, 22 Oct. 1955, Evelyn Downs, Oodnadatta; *P.J.Lang* BSOP-438, 12 May 2000, Just inside western boundary of Arckaringa Station; *B.Lay* 638, 11 Oct. 1971, Residuals of Stuart Range, c. 80 km NW of Millers Creek Station, Balta Baltana; *J.McDouall* *Stuart (expedition)*, 1859, N.W. interior of South Australia (lectotype: MEL 23048; isotype: K; images seen); *T.Webb* 9, 21 Sep. 2010, c. 10 km E of Coober Pedy; *H.P.Vonow* 3535 *et al.*, 14 Dec. 2010, Arckaringa Station, S of Wurley Hole; *J.H.Willis*, 23 Jul. 1979, Allandale Homestead, SE of Oodnadatta (Dup. of MEL 2118360).

*Goodenia saccata*, selected specimens (of 25 seen), all from AD

SOUTH AUSTRALIA. **Flinders Ranges:** *H.W.Andrew*, Aug. 1920, Mt Bayley, near Beltana; *K.H.Brewer* 546 & *T.S.Te*, 26 Nov. 2010, Glass Gorge road, c. 5 km from Parachilna Gorge; *K.H.Brewer* 640 & *K.Waugh*, 9 Dec. 2011, between Yankaninna Homestead and the outstation at Owicandana; *P.E.Cornick* AD28, Aug. 1979, Arkaroola; *Hj.Eichler* 12676, 17 Sep. 1956, Gammon Ranges, near mouth of gorge of Arcoona Creek, south of Arcoona Bluff Range (holotype: AD 95710018; isotypes: MEL 23070, B, L, images seen; BRI, NSW, BM, K, NE, P, TI, UC, US, n.v.); *Hj.Eichler* 12997, 26 Sep. 1956, Arcoona Dam, 6.5 km SW of Copley (Dup.: CAL); *E.H.Ising* 511, 7 Oct. 1918, Witchen's Well, Moolooloo; *D.N.Kraehenbuehl* 23, 5 Oct. 1958, Near junction of Moolooloo and Parachilna roads (Dup.: RSA); *D.E.Symon*



6762, 5 Sep. 1969, W end of Parachilna Gorge (Dups.: NSW, K, B, L); *L.D. Williams 11722*, 4 Nov. 1980, 12.2 km [N of] Yankaninna HS.

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