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Leionema lamprophyllum subsp. *fractum* (Rutaceae); a new and highly restricted taxon from the Hunter Valley of New South Wales

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Abstract

Leionema lamprophyllum *subsp.* fractum *(Rutaceae); a new and highly restricted taxon from the Hunter Valley of New South Wales*. A new subspecies of *Leionema lamprophyllum,* formerly included in *L. lamprophyllum* subsp. *obovatum* F.M.Anderson, is here described as new. Currently known from fewer than 50 individuals, the new subspecies is highly restricted and warrants a conservation risk code of at least Endangered. An illustration of the new taxon, notes on its distribution and habitat, and a key to all four subspecies of *L. lamprophyllum* are provided.

Introduction

Anderson (1999) undertook a morphological revision of *Leionema lamprophyllum* (F.Muell.) Paul G.Wilson, recognising three subspecies: *L. lamprophyllum* subsp. *lamprophyllum* (endemic to subalpine regions of Victoria), *L. lamprophyllum* subsp. *orbiculare* F.M.Anderson (endemic to the Rylstone–Lithgow area of New South Wales), and *L. lamprophyllum* subsp. *obovatum* F.M.Anderson (from the Australian Capital Territory, New South Wales and Victoria). In that study, leaf shape and size were shown to be the major discriminatory characters separating these three taxa. At the time, the only Hunter Valley material available for examination had been misidentified as *L. rotundifolium* (A.Cunn. ex Endl.) Paul G.Wilson, and consequently was not considered in Anderson's revision. Specimens subsequently collected from this region were included in a broad circumscription of subsp. *obovatum*.

As currently recognised, *Leionema lamprophyllum* subsp. *obovatum* is represented by several widely spaced populations in Victoria, New South Wales and the Australian Capital Territory. At present, the Hunter Valley population of this taxon is listed as 'endangered' under the NSW *Threatened Species Conservation Act 1995* (NSW Scientific Committee 2007), recognising its disjunct nature and very small population size (four individuals at that time). Research currently underway for an account detailing the endemic plant species of the Hunter Valley has led to a re-examination of plants from this population. This has been largely prompted by the highly disjunct population in the Hunter Valley (c. 300 km from the nearest known stand), and observable morphological differences between these plants and herbarium specimens.

Taxonomy

Leionema lamprophyllum* subsp. *fractum S.A.J.Bell, ***subsp. nov.***

Differs from its presumed closest relative *L. lamprophyllum* subsp. *obovatum* by the larger, rhomboidal or obtrullate leaves, the crenate to dentate leaf margins, the shortly attenuate to cuneate leaf bases, the densely stellate-hairy calyx and branchlets, and the yellow to yellowish-green flower buds.

Type: New South Wales: North Coast: Broken Back Range, Pokolbin State Forest, 30 Aug 2014, *S.A.J. Bell 4501* (*holo*: NSW987279; *iso*: MEL) [precise location withheld for conservation purposes].

Shrub to 1.5 m tall. *Branchlets* terete or angular when very young due to leaf decurrencies, prominently glandular-verrucose, densely pilose with simple or 2–8-rayed stellate hairs, leaf-decurrencies moderately- to densely stellate, glabrescent with age; branchlets becoming glabrous with age. *Leaves* alternate. *Petiole* mostly 0.5-1.3 mm long, sparsely stellate-hairy. *Lamina* strongly and pleasantly aromatic when crushed; rhomboidal or obtrullate, 6.0–9.0 mm long, 3.0–5.0 mm wide, glabrous but midrib usually sparsely stellate-hairy at least in the lower half, leaf base shortly attenuate to cuneate, margin usually crenate to dentate with 2–6 blunt teeth or shallow rounded lobes on each side in distal half but sometimes erose, apex obtuse; adaxial surface glossy and prominently glandular-punctate, wrinkled on drying, midrib impressed with simple or stellate hairs in lower half, lateral veins not visible; abaxial surface paler and prominently glandular-punctate. *Inflorescences* of 2–4-flowered umbellate cymes in upper axils or terminal, occasionally reduced to a single flower and sometimes the cymes apparently lacking a peduncle. *Peduncle* (0.5–)1.4–3.5 mm long, flattened or angular, prominently glandular-verrucose, moderately to densely stellate-hairy. *Pedicel* 1.5–3.7 mm long, angular and prominently glandular-verrucose, moderately to densely stellate-hairy. *Flower buds* obovoid, yellow to yellowish-green, sometimes with rusty infusions. *Sepals* deltoid, concavo-convex, mostly 0.5–0.8 mm long, glandular-verrucose, margins and lower half prominently but minutely and densely simple- or stellate-haired. *Petals* narrow-elliptic, 2.3–3.1 mm long, white but sometimes with tips pink-infused, caducous, glandular-punctate on abaxial surface, glabrous, apex inflexed, midrib prominent. *Stamens* shorter than or slightly exceeding petals, filaments slender and terete to flattened, tapering distally, 2.5–3.0 mm long, glabrous; anthers cordate-ovate, mostly 0.4–0.6 mm long, dorsifixed and versatile, pale yellow. *Gynophore* short-cylindrical, 0.3–0.5 mm long, reddish-brown, glabrous, slightly narrower than ovary. *Ovary* sub-spherical to cylindrical, 0.8–1.0 mm long, green, glabrous. *Style* terete, glabrous, 1.5–2.0 mm long, glabrous, gynobasic, usually shorter than stamens. *Fruiting cocci* mostly 1 or 2 (rarely to 4) per flower, spreading, 2.0–4.0 mm long, obliquely ovoid, sparsely glandular-punctate, outer edge minutely apiculate to shortly rostrate, beak 0.5–1.0 mm long. *Seed* ovoid, 2.0–2.2 mm long, raphe basal, testa smooth and minutely punctate, glossy black, aril cream-coloured (Fig. 1).

Additional specimens: NEW SOUTH WALES: North Coast: Broken Back Range, Pokolbin State Forest, *P.G. Richards 162, B. Wiecek & T. Tame* 5 Apr 1993 (NSW268568); N end of Broken Back Ra., NW of Cessnock, 5 Apr. 1993, *T. Tame & P. Richards 3758/162* (Hunter Regional Botanic Gardens Herbarium, MEL); Broken Back Range, 5 Aug. 2001, *S.A.J. Bell 2344* (DMHN); Broken Back Range, 3 Dec. 2014, *S.A.J. Bell 4549* (DMHN). Central Western Slopes: Munghorn Gap on Mudgee - Wollar road, 20 Sep. 1986, *R.T. Miller* s.n. (NSW700836). [precise locations withheld for conservation purposes]

At least two specimens from the Hunter Valley (NSW268568 and NSW700836) had previously been referred to *L. rotundifolium*, but this species is not known to occur within c. 300 km of the known range of *L. lamprophyllum* subsp. *fractum* and can be distinguished by the smooth (rather than glandular-verrucose) stems and quite entire, obovate to orbicular leaves. Interestingly, the type of *L. rotundifolium*, collected by Allan Cunningham in August 1827, is purportedly from 'Hills on the Hunter(s) River', and specimens exist at CANB, K, G and MEL. The Kew sheet (K717352) has a label (other than Cunningham's original) with the note 'Hunter's River, Mt Dangar' in a hand that is not Cunningham's. It is unclear if Cunningham explored Mount Dangar (a basalt remnant) at this time, only passing by its south-western flanks on his return to Bathurst from the Darling Downs in 1827 (Lee 1925; McMinn 1970a, b; Curry et. al. 2002). He had previously ascended Mt Danger in May 1825, as evidenced by his collection of *Cassinia cunninghamii* on its summit (see Orchard 2014), and it is unlikely that he would again attempt a climb in his reportedly physically exhausted state after his 13 week journey to the Darling Downs (McMinn 1970b). It is plausible that Cunningham collected the *Leionema* specimen in the Inverell to Stanthorpe region (within the Darling Downs, and the core distribution of *L. rotundifolium*), but mistakenly, and up to this point, inexplicably, labelled it with an annotation from the Hunter Valley.

A search of the collection site of NSW700836 at Munghorn Gap in August 2015 failed to locate any plants there, suggesting that if the population still exists it is likely to be small. The original collector (R. Miller) advises that it was an incidental collection, and no additional notes on habitat or population size were made at that time. Subsequent surveys of Munghorn Gap Nature Reserve by Hill (1999) did not record any *Leionema rotundifolium*.

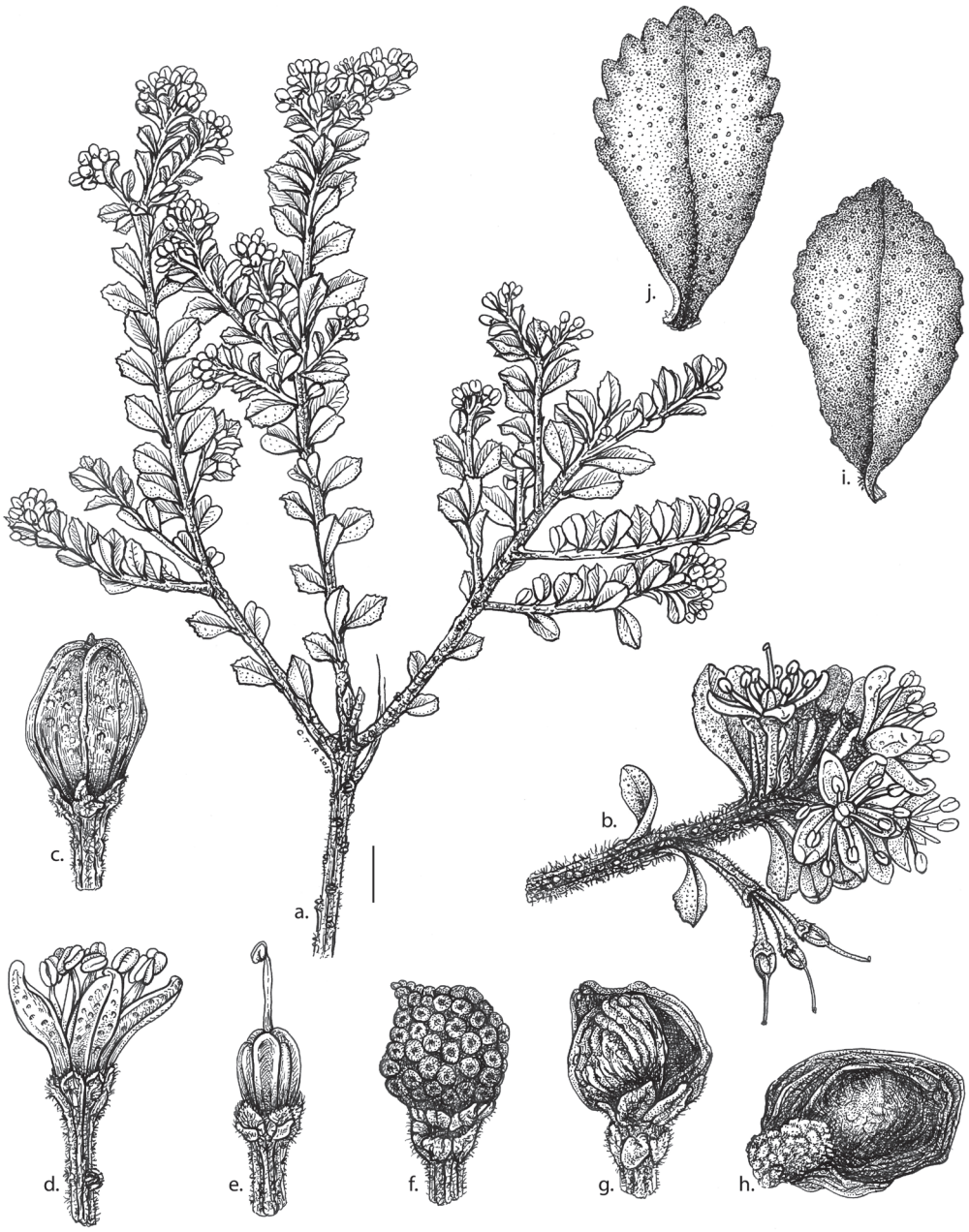

Fig. 1. *Leionema lamprophyllum* subsp. *fractum*; **a,** budding branch; **b,** flowering branchlet; **c,** individual flower bud; **d,** individual flower; **e,** flower ovary and style, with petals and anthers removed; **f,** follicle, prior to dehiscing; **g,** dehisced follicle; **h,** seed; **i, j,** leaf upper surface, showing variation in marginal teeth. Scale bar: **a** = 10 mm; **b** = 2 mm; **c**-**g** = 1 mm; **h** = 0.5 mm; **i, j** = 1 mm (**a**-**e** from holotype; **f**-**h** from *S.A.J. Bell 4549*, 3 Dec 2014). Artist: Chris Rockley.

Affinities: *Leionema lamprophyllum* subsp. *fractum* can be distinguished from other described subspecies of *L. lamprophyllum* through a combination of flower, leaf and stem indumentum characteristics (see Key below). Table 1 summarises the main differences from the presumed most closely related subsp. *obovatum*.

Table 1. Comparison of *Leionema lamprophyllum* subsp. *obovatum* and subsp. *fractum*.

Character	*obovatum*	*fractum*
Flower bud (fresh)	white to pink	yellow to yellowish-green, occasionally with rusty infusions
Indumentum	calyx glabrous to glabrescent; branchlets sparsely minutely stellate	calyx and branchlets moderately to densely minutely stellate
Leaf length	4–6(–8) mm	6–9 mm
Leaf shape	obovate to broadly-obovate	rhomboidal or obtrullate
Leaf margin	entire to minutely erose or crenulate in the distal half	irregularly crenate to bluntly dentate in the distal half
Leaf apex	rounded to truncate, rarely retuse or obtuse	obtuse

Key to subspecies of *Leionema lamprophyllum* (following Anderson 1999)

1. Leaves suborbicular to orbicular, (1.7–) 2.4–3.2 (–3.9) mm long, apex rounded to minutely mucronate ... **subsp. *orbiculare***

1: Leaves elliptic to obovate or rhomboidal, (2.6–) 4.0–10.6 (–14.2) mm long, apex acute to obtuse 2

2. Leaves elliptic, (5.6–) 7.6–10.6 (–14.2) mm long; apex acute, margin entire to minutely erose toward apex; petals (3.3–) 3.7–4.3 (–4.4) mm long; pedicel (3.0–) 3.5–5.0 (– 6.0) mm long ..... **subsp. *lamprophyllum***

2: Leaves obovate to rhomboidal, 2.6–9.0 mm long; apex obtuse (rarely subacute), margin entire to minutely erose, crenulate or crenate toward apex; petals (2.0–) 2.4–3.7 (–4.3) mm long; pedicel (1.0–) 1.5–2.7 (–3.8) mm long 3

3. Leaves obovate to broadly-obovate, 4–6(–8) mm long, entire to minutely erose or crenulate in distal half, apex rounded or truncate, rarely retuse or obtuse; calyx and branchlets sparsely minutely stellate; flower buds white to pink..... **subsp. *obovatum***

3: Leaves rhomboidal or obtrullate, 6–9 mm long, irregularly crenate to dentate in distal half, apex obtuse; calyx and branchlets densely minutely stellate; flower buds yellow to yellowish-green ..... **subsp. *fractum***

Variation within subsp. *obovatum* approaching subsp. *fractum*: Some herbarium specimens of *L. lamprophyllum* subsp. *obovatum* approach subsp. *fractum* in certain leaf and calyx characters, but differ in others. For example, NSW70056 (Tingiringi Mtns, NSW-VIC border, nr. Delegate, *E. Betche, s.n.,* Mar 1889) possesses crenulate to crenate leaf margins and slightly stellate-hairy buds, but leaves are broad-obovate rather than obtrullate. NSW248984 (Southern Tablelands, Micalong Creek, c. 9km S of Wee Jasper, *P. Ollerenshaw 1762,* 1 Sep 1986; dupl. CBG) and NSW700843 (Victoria, Brisbane Ranges National Park, *V. Stajsic 288 & S. Spence,* 8 Aug 1991; dupl. CANB, MEL, PERTH) show very small (3–4 mm) obovate to obtrullate leaves, and have glabrous or only slightly stellate-hairy calyces and branchlets. NSW90426 (ACT, Cotter River, near Black Springs, *L.G. Adams 622,* 5 May 1963; dupl. B, CANB, K, L, MEL, US) has obovate to broad-cuneate leaves with entire to crenulate margins, but glabrous to only minutely stellate-hairy calyces and branchlets.

Distribution: Recorded from Munghorn Gap, east of Mudgee (but not recollected there since 1986), and along the northern escarpment of the Broken Back Range east of Cessnock, both in the Hunter Valley of New South Wales. The two locations are very disjunct from other subspecific taxa, particularly subsp. *obovatum* (Figure 2). To date, the Broken Back Range has not been extensively explored botanically, and other populations may be present in suitable habitat. Further investigation is required in the vicinity of the 1986 collection from Munghorn Gap (NSW700836); a brief exploration in August 2015 failed to locate any individuals there. A previous vegetation survey undertaken within Munghorn Gap Nature Reserve reported only *Phebalium squamulosum* subsp. *gracile* and *P. glandulosum* subsp. *glandulosum* (Hill 1999).

Flowering: Budding has been observed to commence in early May, with flowers fully open during September. Mature fruit have been collected in December.

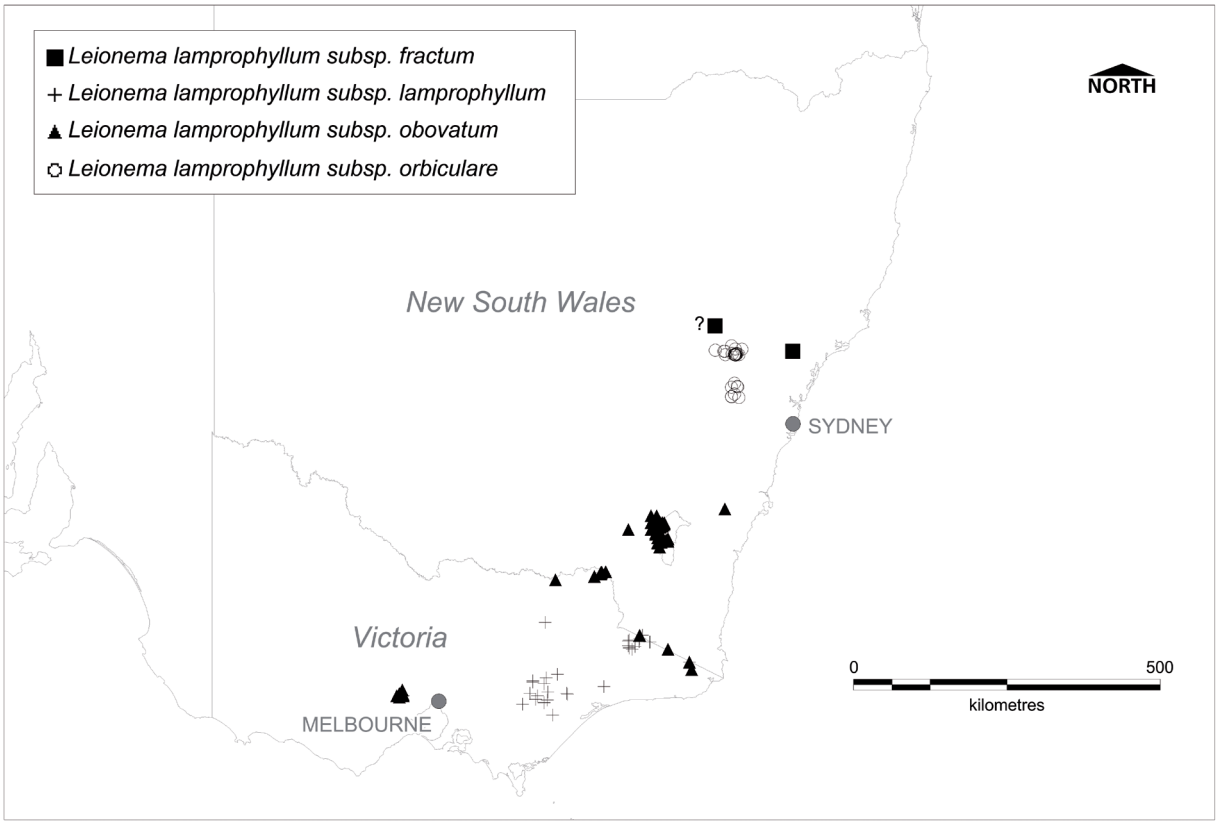

Fig. 2. Distribution of *Leionema lamprophyllum* in south-eastern Australia (Source: AVH). The Munghorn Gap collection of subsp. *fractum* (NSW700836) is shown with '?' as this population has not been vouchered since 1986.

Habitat: On the Broken Back Range, this taxon occurs in sparse heathland or very open low woodland in skeletal sandy soils, on a steep (c. 45°) northerly to north-westerly facing broken spur-end of a rugged, rocky cliffline of the Triassic Narrabeen series, at 515 m elevation (Figure 3). Common associates include *Corymbia maculata, Eucalyptus sparsifolia, Pultenaea spinosa, Leptospermum trinervium, Acacia parvipinnula, Dillwynia sieberi, Persoonia linearis, Leucopogon muticus, Astrotricha* sp. Quorrobolong (S. Lewer 40), *Correa reflexa* var. *reflexa, Patersonia sericea, Entolasia stricta, Cleistochloa rigida, Pomax umbellata, Lepidosperma gunnii* and *Lomandra confertifolia* subsp. *rubiginosa*. The threatened *Eucalyptus fracta* and *Prostanthera cineolifera* are also present in this habitat or nearby. Habitat at the Munghorn Gap collection site is described as 'transitional soils, between basalt and sandstone, growing with *Zieria compacta* in slightly sheltered places between sandstone boulders'. This location is also on Triassic Narrabeen geology, at 660 m elevation, and reportedly downslope of a Tertiary basalt deposit. Field observations from August 2015 showed the area to be an open forest of *Eucalyptus rossii*, *E. sparsifolia* and *Callitris endlicheri*, with *E. piperita* and *Angophora floribunda* in protected gullies amongst sandstone 'pagoda' formations.

Population size: In December 2014, thirty-eight plants were counted from the Broken Back population, ranging in size from young specimens 15–20 cm high through to older specimens of 140 cm. Most plants occurred on northerly to north-westerly aspects, on sandstone benches and in rock fissures. A search of adjacent habitat (to 100 m either side) failed to locate further individuals, neither did inspection of the next broken spur-end to the east. Given the likelihood that some plants were overlooked due to the steep cliffs present in this locality, it is estimated that up to fifty specimens may be present at this population. The rugged nature of the Broken Back Range suggests that other populations of this taxon may be present in similar habitat, and these should be searched to increase knowledge of total plants. Similarly, although no plants could be found at Munghorn Gap in August 2015, further searches in this area are warranted.

Conservation status: At present, the population of *Leionema lamprophyllum* subsp. *fractum* within the Hunter catchment is listed (as subsp. *obovatum*) as an Endangered Population under the NSW *Threatened Species Conservation Act 1995*. At the time of its listing, only four individuals were known; however targeted counts reported here raise this population size to thirty-eight. All plants occur within Pokolbin State Forest, and none is known from a dedicated conservation reserve. Protection of *L. lamprophyllum* subsp. *fractum* is still warranted, perhaps as an endangered taxon rather than an endangered population, given the low numbers of known plants (<50) and the potential for a single stochastic event, such as cliff collapse, to impact on the

population. A small informal camp site accessed by a four wheel drive trail currently exists immediately upslope of this population, but no plants appear to be impacted upon by disturbance associated with it. A conservation risk code (ROTAP: Briggs & Leigh 1996) of 3E is proposed for this taxon, given the ~150 km separation between the two collection localities. Under IUCN (2001) criteria, a code of CR (Critically Endangered) is appropriate, based on the currently known total population of fewer than 50 individuals (Criteria B & D).

Fig. 3. Habitat of *Leionema lamprophyllum* subsp. *fractum*, Broken Back Range.

Etymology: The subspecific epithet, *fractum*, is derived from the Latin *fractus*, broken, and is a direct reference to the very broken and fractured sandstone habitat (spur-end) in which this taxon occurs. It also pertains more broadly to the Broken Back Range, the site of the only known extant population of this subspecies.

Discussion

Apart from Binns (1996), only limited botanical study has been made of the flora of the Broken Back Range. Despite this, it is already known to harbour a number of significant taxa. The threatened Pokolbin Mallee (*Eucalyptus pumila*), Broken Back Ironbark (*Eucalyptus fracta*) and Singleton Mallee (*Eucalyptus castrensis*) occur almost exclusively on this Range (Cambage 1919; Hill 1997; Hill & Stanberg 2002), while the threatened and poorly understood *Prostanthera cineolifera* is also present. The rare *Eucalyptus expressa* was first recorded in this area (Binns 1996; Bell & Nicolle 2012), and good populations of other rare species such as *Angophora euryphylla, Acacia bulgaensis, Eucalyptus fergusonii* subsp. *dorsiventralis* and *Grevillea montana* also occur. On the northern footslopes of the range, an undescribed eucalypt with affinities to *Eucalyptus fibrosa* is currently under study (see Klaphake 2010). *Astrotricha* sp. Quorrobolong (S. Lewer 40), also under study, occurs widely in the immediate locality.

The three subspecies of *Leionema lamprophyllum* delineated by Anderson (1999) all exhibit disjunct populations across south-eastern Australia, with only subsp. *orbiculare* and subsp. *obovatum* present in New South Wales. Geographically, *Leionema lamprophyllum* subsp. *orbiculare* is the closest taxon to subsp. *fractum* (80–130 km distant), but differs substantially in the very small and orbiculate leaves. Morphologically, subsp. *obovatum*, within which subsp. *fractum* was formerly placed, appears most similar to the new taxon, and the two share general features such as leaf shape (obovate to rhomboidal) and short pedicels (c. 1–4 mm). However, subsp. *fractum* is geographically isolated from the nearest known population of subsp. *obovatum* by approximately 300 km, and possesses various features that distinguish it from what appears to be its closest relative (see Table 1). The new taxon also occurs on soils derived from Triassic quartz-rich sediments from the Mesozoic Era, while subsp. *obovatum* grows in granite-derived Paleozoic soils from the Devonian, Silurian and Ordovician periods. All defined subspecies of *Leionema lamprophyllum* reportedly occur in exposed rocky habitats on skeletal soils, typically in open heath and scrub or open eucalypt woodland (Anderson 1999).

A number of new *Leionema* taxa have been described for south-eastern Australia over the last decade (e.g. Horton et al. 2004; Walsh 2004; Duretto et al. 2006), including formal recognition of previously recognised forms within described taxa. For example, Duretto et al. (2006) formalised four taxa at subspecific rank for *L. bilobum*, a species, like *L. lamprophyllum*, with a widely disjunct distribution. Walsh (2004) extracted *L. ceratogynum* from *L. phylicifolium*, noting among other features differences in habitat and leaf morphology. It is appropriate, therefore, that material from the Hunter Valley, previously included in *L. lamprophyllum* subsp. *obovatum*, be recognised as distinct based on distribution, morphological and habitat grounds. The new taxon is considered a subspecies of *L. lamprophyllum* rather than a new species of *Leionema*, in keeping with the level of morphological variation and geographical disjuncture recognised within currently accepted taxa in the genus (see brief discussion on use of differing ranks in Walsh 2015). In addition, the similarity of certain leaf and calyx characters observed in some collections of subsp. *obovatum* (discussed above) further suggest the rank of subspecies to be most appropriate, despite the presumed lack of gene flow likely between such widely separated taxa.

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