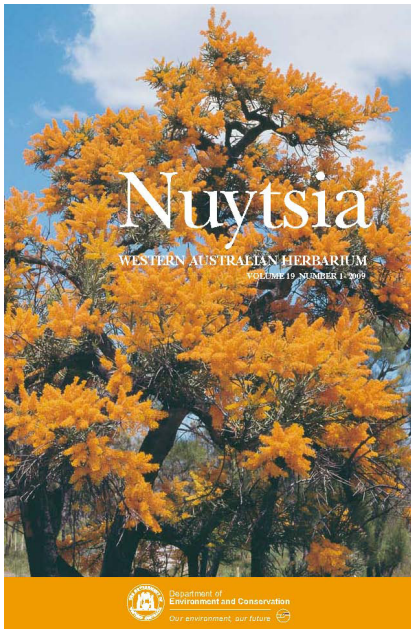


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The taxonomy of *Leucopogon bossiaea* and allied species (Ericaceae: Styphelioideae: Styphelieae) from the central south coast of Western Australia


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The taxonomy of *Leucopogon bossiaea* and allied species (Ericaceae: Styphelioideae: Styphelieae) from the central south coast of Western Australia

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Abstract

Hislop, M. The taxonomy of *Leucopogon bossiaea* and allied species (Ericaceae: Styphelioideae: Styphelieae) from the central south coast of Western Australia. *Nuytsia* 19(1): 17–35 (2009). Four new species of *Leucopogon* R.Br., *L. canaliculatus* Hislop, *L. heterophyllus* Hislop, *L. remotus* Hislop and *L. rugulosus* Hislop, are described, illustrated and their distributions mapped. For purposes of comparison, a full description of their closest named relative, *L. bossiaea* (F.Muell.) Benth., is also given. A key is provided to all of the Western Australian species currently referred to the informal subgeneric group, the *Leucopogon australis* Group (*sensu* Hislop & Chapman (2007), to which the new species belong.

Introduction

In a recent paper Hislop and Chapman (2007) recognised five informal, subgeneric groups (Groups A–E) within the Western Australian members of *Leucopogon* R.Br. *s. str.*, based in large part on aspects of their fruiting morphology. The *Leucopogon australis* group (Group A) contains those species with a basically globose or ellipsoid drupe, which is usually more or less circular in section, and with a manifestly fleshy mesocarp. This essentially represents the plesiomorphic fruit type for the tribe *Styphelieae* generally, and it was recognised that in part, what unites the member species in this group is the lack of apomorphies, fruiting or otherwise. For this reason, the group is best regarded as one of convenience, until such time as a comprehensive cladistic analysis of *Leucopogon s. str.*, based on morphological and molecular data, is available.

Leucopogon bossiaea (F.Muell.) Benth. was included in Group A by Hislop and Chapman (2007), who at the same time drew attention to the presence of a subgroup of mostly unnamed taxa related to that species. The current paper provides descriptions of four new species in this subgroup (*Leucopogon canaliculatus* Hislop, *L. heterophyllus* Hislop, *L. remotus* Hislop and *L. rugulosus* Hislop) as well as, for purposes of comparison, a full description of *L. bossiaea*. A key to all member species of Group A is also presented.

Notes on the morphology and distribution of the *Leucopogon bossiaea* subgroup

Leucopogon bossiaea and the four new species described below form a discrete, closely-knit subgroup within the larger *Leucopogon australis* group. These species share a very similar floral and inflorescence morphology, a globose or slightly depressed-globose drupe and all have fire-sensitive rootstocks. Inflorescences are generally shorter and the leaves smaller than occur elsewhere in Group A (excluding the anomalous species *Leucopogon hirsutus* Sond., *L. alternifolius* R.Br. and *L. wheelerae* Hislop, which are briefly discussed in notes after the key). Two aspects of their foliar morphology are also noteworthy. Leaf petioles in all five species are relatively long and narrow, abruptly differentiated from the laminas and more or less cylindrical throughout their length. Members of the subgroup also lack the sunken venation on the adaxial surface of the lamina which characterizes most members of Group A (again excluding the anomalous species listed above and the very thick-leaved *Leucopogon validus* Hislop). Furthermore, of the five species within the subgroup, four have a locule number of three or four, only *L. canaliculatus* having the four- or five-locular ovary which is the common number for Group A as a whole.

Corroborating evidence that the species treated in this paper comprise a natural grouping is provided by the common occurrence on all species of a distinctive decurved bud gall (Figure 1A). Examination of these galls by entomologists Dr T. Houston and Dr J. La Salle (Western Australian Museum and CSIRO Entomology respectively) has not yielded positive results as to the identity of the gall-formers, although members of the Hymenoptera or Hemiptera are thought to be the most likely causative agents. The galls are so prevalent among species from the subgroup that almost all populations observed by the author were affected, and they are present on a high percentage of herbarium collections. This type of bud gall has not been observed on any other species assigned to Group A. A similar decurved

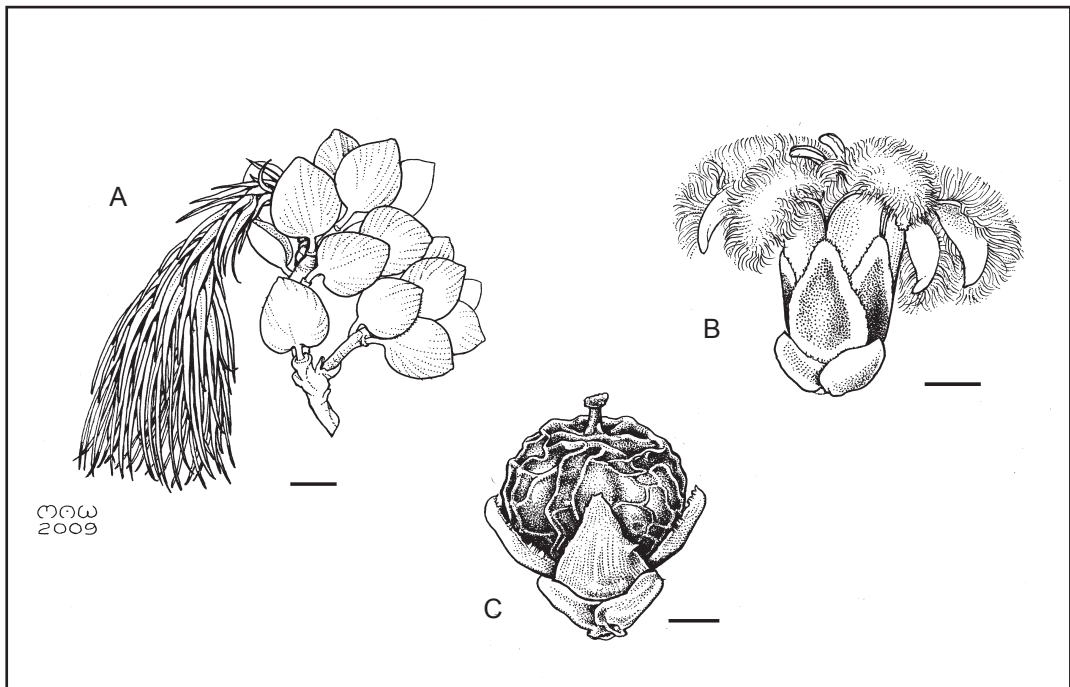


Figure 1. A – Bud gall on *Leucopogon bossiaea*. B–C. *Leucopogon heterophyllus*. B – flower; C – fruit. Scale bars: A = 2 mm; B, C = 1 mm. Drawn by Margaret Wilson from *M. Hislop* 3758 (A), *M. Hislop* 3711 (B), *M. Hislop* 3739 (C).

gall is associated with the members of Group B, but these differ in having hairy surfaces and recurved rather than straight 'scales'.

Whereas differences in floral and fruiting characters within the *Leucopogon bossiaea* subgroup are subtle, there is a manifest dichotomy in foliar morphology, such that a close relationship between the two elements may not be self evident. On the one hand are those species with more or less flat, openly grooved and glabrous leaves, and on the other those with revolute margins, partially or wholly concealing the tightly grooved and hairy abaxial surfaces. *Leucopogon heterophyllus* and *L. canaliculatus* are representative of the flat and revolute elements respectively and could be regarded as the most dissimilar species in the subgroup. The differences between them are maintained across most of their respective geographic ranges. However in the Cascades area (which falls at the eastern edge of the range of *L. heterophyllus* and at the western edge of *L. canaliculatus*) three rather problematic populations occur. These somewhat blur the boundaries between the two species and also between *L. canaliculatus* and *L. rugulosus*. These populations are discussed below in the treatments of *L. canaliculatus* and *L. heterophyllus*.

The five members of the *Leucopogon bossiaea* subgroup are distributed between the Ravensthorpe area and Israelite Bay, always within about a hundred kilometres of the south coast. Three of these, *Leucopogon bossiaea*, *L. remotus* and *L. rugulosus*, appear to be local endemics, while the other two, *L. heterophyllus* and *L. canaliculatus*, have a wider regional distribution, although neither could be considered widespread.

Methods

This study was based on an examination of dried specimens housed at PERTH and NSW. All species in the *Leucopogon bossiaea* subgroup have been seen by the author in the field, usually at several localities, and plant growth habit and proportions given in the descriptions are based on these field observations.

Foliar measurements were taken from dried specimens. Leaf thickness was measured at the midrib, half way along the lamina. Observations of leaf venation were made from mature leaves only. Across the tribe *Styphelieae* generally it is common for young leaves to show prominently raised venation on the abaxial surface which is much less evident, if at all, at maturity. Similarly, the first leaves produced at the beginning of a flush of vegetative growth should be ignored. The lowest of these are bract-like, but then there is a morphological transition at successive nodes before the form of the mature leaves is reached.

Inflorescence length was measured from its insertion point in a leaf axil (this may be somewhat obscured by several rows of sterile bracts) to the tip of the bud rudiment. Floral measurements were taken from re-hydrated flowers in natural posture, with the exception of the corolla lobes. These were uncurled to their fullest length before measuring. Anthers were measured around the bend rather than in a straight line between the furthest points. The length of the sterile tips was measured in late bud or early flower, at or just prior to, anther dehiscence. Corolla lobe hair length was measured at a point 0.5 mm below the lobe apex. Where sufficient material was available, at least ten flowers per specimen were examined.

The distribution map was compiled using DIVA-GIS Version 5.2.0.2 and based on PERTH specimen data.

A synopsis of and key to the *Leucopogon australis* group in Western Australia

Rootstock fire-tolerant or fire-sensitive; leaves spirally arranged or in pseudo-whorls, variably antrorse or occasionally \pm patent; upper leaves and lower fertile bracts usually clearly dimorphic; inner surfaces of corolla tube glabrous, or if apparently hairy, these hairs reflexed into the tube from the base of the corolla lobes or from a narrow ring of hairs at the tube apex; abaxial surface of corolla lobes glabrous; ovary glabrous, usually 4 or 5-locular, less often 2 or 3-locular; nectary annular; drupes depressed-obovoid, depressed-globose, globose, ellipsoid or ovoid, usually \pm circular in transverse section, but transversely elliptic or trigonous in *L. alternifolius* and *L. wheelerae*, with a significant mesocarp layer present, the apex smoothly rounded at the shoulders; endocarp woody.

1. Longest leaves in pseudo-whorls
 2. Longest leaves < 40 mm long; corolla white, hairs uniformly distributed on corolla lobes (Cape Le Grand – Cape Arid – Recherche Archipelago) **L. interruptus**
 - 2: Longest leaves > 50 mm long; corolla pink, hairs restricted to lower half of corolla lobes (wetter parts of the south-west, Perth–Augusta–just E of Albany) **L. verticillatus**
- 1: Longest leaves not in pseudo-whorls
 3. Longest leaves > 30 mm long
 4. Inflorescence \pm pendulous, axis glabrous (restricted distribution E of Albany) **L. altissimus**
 - 4: Inflorescence erect, axis hairy
 5. Young branchlets entirely glabrous; leaf margins entirely glabrous
 6. Leaves narrowly ovate to narrowly elliptic (length to width ratio of longest leaves 6.1–11.2 : 1); fruit depressed globose (plants of forest and winter-wet heath in wetter parts of the south-west, Gingin–Augusta–Albany) **L. australis**
 - 6: Leaves narrowly obovate to narrowly elliptic (length to width ratio of longest leaves 2.8–6.2: 1); fruit globose, ovoid or broadly ellipsoid (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) **L. parviflorus**
 - 5: Young branchlets minutely hairy throughout, or at least around the nodes; leaf margins scabrous with minute, stiff, antrorse hairs
 7. Length to width ratio of longest leaves 7.2–13.9 : 1; widest leaves 2.5–5.0 mm wide, marginal hairs present along entire leaf length on most leaves (plants of forest and mountain heath, Augusta–Bridgetown–Albany–Stirling Range) **L. interstans**
 - 7: Length to width ratio of longest leaves 2.8–6.2 : 1; widest leaves 4–9 mm wide, marginal hairs, if present, confined to upper half (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) **L. parviflorus**
 - 3: Longest leaves < 30 mm long
 8. All leaves with manifestly recurved or revolute margins, often partially concealing the lower surface.
 9. Longest leaves 3 mm long or less; length to width ratio of longest leaves 1.4–3.1 : 1; ovary usually 3-locular, rarely 4-locular (restricted distribution NW of Esperance) **L. rugulosus**
 - 9: Longest leaves at least 5 mm long; length to width ratio of longest leaves usually >5: 1; ovary 5-, 4- or 2-locular, very rarely 3-locular
 10. Both leaf surfaces with short, patent hairs; sepals acute or subacute; ovary 2- or very occasionally 3-locular (Moresby Range) **L. borealis**
 - 10: Upper leaf surface usually glabrous or with short, tubercle-based, antrorse hairs; sepals obtuse or occasionally subacute; ovary 5- or 4- locular, very occasionally 3-locular
 11. Abaxial leaf surface deeply grooved between prominent ribs, patent-hairy in the grooves, adaxial leaf surface without evident venation, usually glabrous but if somewhat hairy, then hairs variously orientated, not tubercle-based (N and NE of Esperance) **L. canaliculatus**

- 11: Abaxial leaf surface smooth or faintly striate, glabrous, or with a sparse, evenly distributed indumentum, adaxial leaf surface with 1 or 3 sunken veins evident, always scabrous with antrorse, tubercle-based hairs
- 12: Leaf apex obtuse or rather abruptly to a blunt point, leaf margins apparently glabrous (minutely ciliolate under high magnification) (forest and coastal heath between Augusta and Cape Arid) **L. obovatus**
- 12: Leaf apex smoothly attenuate, leaf margins manifestly ciliolate with hairs 0.05–0.20 mm long (Perth–Augusta–Bridgetown–Albany)..... **L. capitellatus**
- 8: Leaves adaxially concave, flat or if margins somewhat recurved, then these not concealing the abaxial surface
13. Longest leaves < 10 mm long (very occasional specimens of *L. capitellatus* may have their longest leaves less than 10 mm)
14. Leaf bases deeply cordate, ± stem clasping, petiole very indistinct. Inflorescence axis glabrous or occasionally very sparsely hairy. Fruit trigonous or transversely elliptic in cross section
15. Sepals 1.0–1.5 mm long; corolla tube shallowly campanulate, 0.5–0.8 mm long, corolla lobes 1.0–1.4 mm long, sparsely bearded; anthers 0.4–0.7 mm long; fruit 0.9–1.2 mm long and 0.7–1 mm wide (swamps between Augusta and the Donnelly River) • **L. alternifolius**
- 15: Sepals 1.5–2.1 mm long; corolla tube campanulate, 1.3–1.8 mm long, corolla lobes 1.7–2.1 mm long, densely bearded; anthers 1.2–1.6 mm long; fruit 1.8–2.1 mm long and 1.1–1.5 mm wide (swamps between Walpole & Albany) • **L. wheelerae**
- 14: Leaf bases cordate or not, but if so then leaves with well defined petioles; inflorescence axis always manifestly hairy; fruit circular in cross section
16. Leaf surfaces and margins hairy with a mixed indumentum (hairs forming two or sometimes three ± distinct layers), the longest hairs of which are > 0.4 mm long; corolla lobes with sparse hairs confined to upper half (swamps between Cape Naturaliste and Albany with an outlier near Collie). • **L. hirsutus**
- 16: Leaf surfaces glabrous, margins minutely ciliolate; corolla lobes densely bearded throughout
17. Leaves narrowly ovate, ovate, narrowly elliptic or elliptic, length to width ratio of longest leaves 2.6–3.9: 1, lamina usually concave, less often flat, never convex, markedly incurved along longitudinal axis, apex acute, straight, base cuneate (restricted distribution NE of Esperance) **L. remotus**
- 17: Leaves depressed-ovate, broadly ovate, ± circular or elliptic, length to width ratio of longest leaves 0.8–2.5: 1, lamina concave, flat or convex, longitudinal axis ± straight, apex obtuse or subacute, usually slightly deflexed, base cuneate, rounded, truncate or cordate
18. Sepals 1.9–2.6 mm long, 1.1–1.6 mm wide; corolla tube 1.3–2.0 mm long, corolla lobes 1.9–3.5 mm long, corolla lobe to tube ratio 1.4–2: 1; style 0.6–0.9 mm long; ovary 0.6–0.7 mm long, 0.6–0.8 mm wide (Ravensthorpe to the Cascades area) **L. heterophyllus**
- 18: Sepals 1.4–1.9 mm long, 0.8–1.2 mm wide; corolla tube 1.1–1.5 mm long, corolla lobes 1.5–2.0 mm long, corolla lobe to tube ratio 1.1–1.4 : 1; style 0.4–0.5 mm long; ovary 0.5–0.6 mm long, 0.5–0.6 mm wide (restricted distribution in the Israelite Bay area) **L. bossiaea**
- 13: Longest leaves > 10 mm long
19. Sepals 2.4 mm or longer, acute or subacute; corolla lobes 2.8–4.4 (usually > 3) mm long
20. Longest fertile bracts in any inflorescence at least 2 mm long; style (including stigma) 2.0–3.0 mm long (Cape Le Grand – Cape Arid – Recherche Archipelago–Russell Range)..... **L. apiculatus**
- 20: Longest fertile bracts in any inflorescence c. 1.5 mm long; style 0.5–1.0 mm long.

21. Leaves 15–25 mm long; inflorescence axis 20–65 mm long; bracteoles 1.1–1.6 mm long; flowers clearly pedicellate below the bracteoles (Helena and Aurora Range)..... **L. spectabilis**
- 21: Leaves 9–16 mm long; inflorescence axis 5–15 mm long; bracteoles 1.8–2.2 mm long; flowers sessile (Parker Range)..... **L. validus**
- 19: Sepals to 2.2 mm long, obtuse (acute or subacute in *L. interstans*); corolla lobes 1.7–3.0 (usually < 2.8) mm long
22. Branchlet indumentum dense, patent or antrorse, dimorphic, the longer hairs 0.3–0.7 mm long; upper leaf surface always scabrous with antrorse, tubercle-based hairs (Perth–Augusta–Bridgetown–Albany) **L. capitellatus**
- 22: Branchlets glabrous, or if hairy, then indumentum monomorphic and usually sparse, < 0.1 mm long; upper leaf surface glabrous, except sometimes immediately above the petiole
23. Length to width ratio of longest leaves 7.2–13.9 : 1, widest leaves 2.5–5.0 mm wide, marginal hairs present along entire leaf length on most leaves (plants of forest and mountain heath, Augusta–Bridgetown–Albany–Stirling Range)..... **L. interstans**
- 23: Length to width ratio of longest leaves 2.8–6.2 : 1, widest leaves 4–9 mm wide, marginal hairs, if present, confined to upper half (plants of coastal heath along the west and south coasts between Dongara and Israelite Bay) **L. parviflorus**

Those species with the prefix • in the key are somewhat tentatively placed within Group A. Although *Leucopogon alternifolius* R.Br. and its close relative *Leucopogon wheelerae* Hislop have the fleshy mesocarp and inflorescence character in common with the other members of Group A, the drupe is either trigonous or transversely elliptic in cross section (i.e. compressed laterally), depending on whether two or three fruiting locules develop. This feature is not found elsewhere in the group. The other 2-locular species, *L. borealis* Hislop & A.R. Chapm. and *L. hirsutus* Sond. have a drupe which is either circular in cross section or very slightly compressed at maturity. The usually glabrous, prominently flexuose inflorescence axis and deeply cordate, often longitudinally folded, leaves of *Leucopogon alternifolius* and *L. wheelerae* are also unusual.

Leucopogon hirsutus has an anomalous corolla hair distribution. Instead of the typically dense indumentum characteristic of the genus, the lobes are largely glabrous apart from a zone of very sparse hairs close to the apex. The drupe of *L. hirsutus* is unique among western members of *Leucopogon s. str.* in that the suture line on the surface of the endocarp is recessed within a groove in a prominently raised broad rib. The rib itself represents the lignified margins of the two narrow, vertically compressed locules which are positioned end to end. These are significantly narrower than the very thick endocarp walls on either side of the rib. The flowers of *L. hirsutus* and *L. alternifolius* are the smallest of all of the western species of *Leucopogon s. str.*

Taxonomy

Leucopogon bossiaea (F.Muell.) Benth. *Fl. Austral.* 4: 190 (1868).– *Styphelia bossiaea* F.Muell., *Fragm.* 6: 47 (1867). *Type*: In rupibus graniticis ad sinum Great Bight, *G. Maxwell s.n.* (*holo*: MEL 75727, scanned image seen; *iso*: PERTH 07480539!; K 000348425, scanned image seen).

Erect *shrubs* to c. 100 cm high and 80 cm wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, smooth, glabrous or with a sparse indumentum of very short patent hairs < 0.1 mm long, but at length glabrescent; the bark on older stems ± fissured, grey over

brown. *Leaves* spirally arranged, antrorse, usually steeply so, elliptic, ovate, broadly ovate, or almost circular, 2.6–4.1 mm long, 2.1–3.9 mm wide; apex obtuse with a barely differentiated callus point; base rounded, truncate or occasionally shallowly cordate; petiole well defined, pale greenish-yellow, 0.5–1.0 mm long, glabrous throughout; lamina 0.3–0.4 mm thick, slightly concave adaxially, \pm flat or slightly convex, \pm straight along longitudinal axis; surfaces discolorous, glabrous, adaxial surface slightly shiny, venation not evident, abaxial surface paler with 5–7 primary veins, which vary from only slightly to quite prominently raised, the midrib not differentiated; margins glabrous or coarsely ciliate with antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–10 mm long, with 4–11 flowers, terminating in a bud-like rudiment; indumentum of sparse to moderately dense, patent hairs < 0.05 mm long; flowers erect and sessile. *Fertile bracts* broadly ovate to depressed-ovate, 0.5–0.6 mm long, 0.5–0.7 mm wide, obtuse; abaxial surface with obscure venation, glabrous; adaxial surface glabrous, or with short, appressed hairs towards apex; margins minutely ciliate. *Bracteoles* broadly ovate to almost circular, 0.8–1.0 mm long, 0.8–1.0 mm wide, obtuse, keeled; abaxial surface glabrous, the central portion greenish-grey and often tinged purple along the upper keel, becoming scarious towards margins; adaxial surface glabrous or shortly antrorse-hairy; margins ciliate. *Sepals* ovate, 1.4–1.9 mm long, 0.8–1.2 mm wide, obtuse; abaxial surface glabrous, greenish or greenish-grey in the central portion but often tinged purple towards the apex and edges, becoming scarious towards margins, the venation inconspicuous; adaxial surface with a sparse indumentum of antrorse hairs in distal half; the margins minutely ciliate with hairs < 0.05 mm long. *Corolla tube* white, broadly campanulate, usually slightly longer than (by up to 0.4 mm), or about the same length as the sepals, 1.1–1.5 mm long, 1.2–1.5 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes partly tinged pink, slightly longer than the tube (ratio = 1.0–1.4:1), widely spreading from base and recurved, 1.5–2.0 mm long, 0.9–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.4–0.6 mm long near apex, glabrous tip 0.1–0.2 mm long. *Anthers* partially exerted from tube (by 3/4–7/8 of length) in early flower, but often becoming fully exerted and held at right angles to the floral axis, 0.9–1.3 mm long, recurved at apex; sterile tips inconspicuous, 0.25–0.35 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.4–0.5 mm long, adnate to tube just below sinus. *Ovary* globose, 0.5–0.6 mm long, 0.5–0.6 mm wide, glabrous, usually 3-, less often 4-locular; *style* 0.4–0.5 mm long, tapering smoothly from the base, included within the corolla tube; *stigma* slightly expanded; *nectary* annular, 0.25–0.35 mm long, lobed for 1/3–1/2 of length, glabrous. *Fruit* globose, with smoothly rounded shoulders, glabrous, 1.4–1.6 mm long, 1.3–1.5 mm wide, longer than the calyx, the surface with prominent transverse and longitudinal ridges; style persistent.

Other specimens examined. WESTERNAUSTRALIA: [localities withheld for conservation reasons] 21 Apr. 1993, *G.F. Craig* 2562 (NSW, PERTH); 18 May 2002, *M. Hislop & F. Hort* MH 2620 (PERTH); 19 May 2002, *M. Hislop & F. Hort* MH 2632 (PERTH); 24 Apr. 2008, *M. Hislop* 3758 (CANB, K, NSW, PERTH); 29 July 1986, *J.M. Powell* 2200 (HO, NSW); 2200A (NSW); 2200B (K, L, NSW, NY); 2200C (NSW); June 1948, *D.L. Serventy s.n.* (PERTH).

Distribution and habitat. Currently known only from the Israelite Bay area east of Esperance (Figure 2), where it grows in sandy or sandy-loam soils in open mallee woodland or heath.

Conservation status. On the basis of current knowledge *Leucopogon bossiaea* appears to have a very restricted distribution. Although the known populations are conserved within Nuytsland Nature Reserve, a potential threat could be posed by the continued spread in that area of the serious perennial weed Bridal Creeper – *Asparagus asparagoides* (L.) W.F. Wight. Recently listed as Priority Two under the Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora.

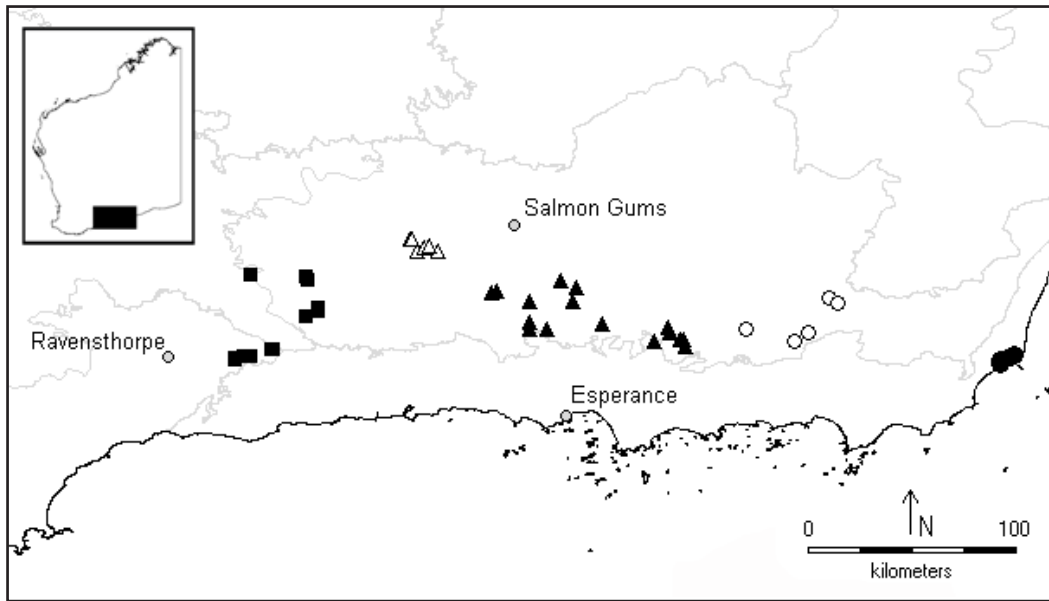


Figure 2. Distribution of *Leucopogon bossiaea* (●), *L. canaliculatus* (▲), *L. heterophyllus* (■), *L. remotus* (○), and *L. rugulosus* (△) in Western Australia.

Notes. Although Israelite Bay is situated at the eastern extremity of the South-West Botanical Province it has a surprisingly rich epacrid flora. At least twenty species are known to occur within a ten kilometre radius of the bay, most of these belonging in the tribe *Styphelieae*. *Leucopogon bossiaea* is one of two epacrids which, on the basis of current knowledge, are restricted to this area. The other is a member of *Leucopogon* s. lat. and is known by the phrase name *Leucopogon* sp. Israelite Bay (C.F. Craig 2558).

Leucopogon canaliculatus* Hislop, *sp. nov.

Leucopogi obovato (Labill.) R.Br. affinis sed foliis manifeste petiolatis paginis abaxialibus profunde exaratis differt.

Typus: Corner Griggs and Esperance – Norseman Rd, N of Scaddan, Western Australia, 17 May 2002, M. Hislop & F. Hort MH 2611 (*holo:* PERTH 06115128; *iso:* CANB, K, NSW).

Leucopogon sp. Scaddan (M. Hislop & F. Hort MH 2611), Western Australian Herbarium, in *FloraBase*, <http://florabase.dec.wa.gov.au> [accessed January 2009].

Erect, usually rather compact *shrubs* to c. 120 cm high and 100 cm wide, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, smooth, glabrous or with an irregular, sparse indumentum of patent hairs and then soon glabrescent; older stems with dark grey, ± fissured bark. *Leaves* spirally arranged, antrorse, usually steeply so, linear, 5–13 mm long, 0.9–1.6 mm wide; apex acute with an innocuous, straight or slightly recurved mucro to 0.5 mm long; base cuneate; petiole well defined, yellowish-green or pale brown, 0.7–1.3 mm long, glabrous throughout or sparsely hairy on adaxial surface; lamina 0.3–0.4 mm thick, usually revolute at maturity with the abaxial surface often ± concealed; surfaces discoloured, adaxial surface shiny, glabrous or sparsely

and shortly antrorse-hairy, venation not evident, abaxial surface paler with 5–7 prominent, primary veins and deep furrows between, the midrib not or barely differentiated, densely hairy in the furrows, ± glabrous on the exposed surface of the veins; margins usually coarsely ciliolate in the upper half with rather sparse patent to antrorse hairs. *Inflorescence* erect, mostly terminal with usually limited upper-axillary development; axis (7–)9–18 mm long, with 7–17 flowers terminating in a bud-like rudiment; indumentum of moderately dense, short, patent hairs to 0.05 mm long; flowers erect and sessile. *Fertile bracts* ovate, at least the lower ones with a cordate base, 1.1–1.7 mm long, 1.0–1.3 mm wide, obtuse; abaxial surface with inconspicuous or moderately conspicuous venation, glabrous or sparsely and very shortly hairy on central portion; adaxial surface appressed-hairy on upper bracts, ± glabrous on lower; margins ciliolate. *Bracteoles* ovate, 1.2–1.6 mm long, 1.0–1.2 mm wide, obtuse or subacute, sharply keeled; abaxial surface with short, moderately dense, patent hairs along the keel, glabrous or very sparsely hairy elsewhere, the keel and upper central portion suffused dull purple, pale greenish elsewhere, then becoming scarious towards the margins; adaxial surface antrorse-hairy in distal half; margins ciliolate. *Sepals* ovate, 1.9–2.5 mm long, 1.2–1.5 mm wide, obtuse or occasionally subacute; abaxial surface varying from almost glabrous to shortly antrorse-hairy in distal half, pale greenish in basal half, usually suffused dull purple distally, the venation inconspicuous; adaxial surface antrorse-hairy in distal half; the margins ciliolate with hairs to *c.* 0.1 mm long and broadly scarious. *Corolla tube* white, broadly campanulate, about as long as, very slightly shorter than or very slightly longer than sepals, 1.3–1.9 mm long, 1.3–2.0 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes flushed pink towards apex, longer than the tube (ratio = 1.1–1.7: 1), widely spreading from base and recurved, 1.7–2.6 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.5–0.7 mm long near apex, the basal hairs reflexed into the top of the tube by up to 0.8 mm but usually less, the glabrous tip 0.2–0.3 mm long. *Anthers* partially exerted from tube (by 2/3–3/4 of length) in the early stages of flowering but later may be fully exerted and held at right angles to the floral axis, 1.0–1.3 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.2–0.3 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.4–0.7 mm long, adnate to tube just below sinus. *Ovary* depressed-globose or globose, 0.5–0.7 mm long, 0.6–0.8 mm wide, glabrous, 4- or 5-locular; *style* 0.7–0.8 mm long, smoothly tapering from a broad base to the stigma, included within corolla tube; *stigma* not or very slightly expanded; *nectary* annular, 0.2–0.5 mm long, shallowly lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose, with smoothly rounded shoulders, glabrous, 1.3–1.8 mm long, 2.3–2.6 mm wide, slightly longer than the calyx, the surface with prominent transverse and longitudinal ridges; style persistent. (Figure 3A–C).

Other specimens examined. WESTERN AUSTRALIA: 11.5 km S of Grass Patch Tavern along Coolgardie Esperance Highway, 1 km S of Rhinds Rd, W side of highway, 20 July 2001, *B. Archer* 1933 (MEL, PERTH); 5 km SE of Kau Rock, on Kau Rocks Rd, Reserve no. 32776, 29 Mar. 1983, *M.A. Burgman & S. McNee* MAB 1125 (PERTH); 4 km E of Scaddan, 4 Oct. 1995, *R.J. Cranfield* 10449 (PERTH); 5.6 km W along Kau Rock Rd from junction of Coolinup Rd, *c.* 23 km NW of Condinup, 26 May 2005, *R. Davis* 10880 (NSW, PERTH); 55 km NE of Scaddan, 100 m W along track 2.8 km S along Styles Rd from junction of Ridley Rd, 18 June 2006, *R. Davis* 11001 (CANB, PERTH); 36 km NE of Scaddan, 7.4 km E along Lignite Rd from junction with Truslove Rd, 20 June 2006, *R. Davis* 11015 (PERTH); 15 km SE of Mt Burdett, 500 m along Mt Ney Rd from junction of Burdett Rd, 26 June 2006, *R. Davis* 11059 (PERTH); 14 km SW of Mt Ney, 9 km N along Mt Ney Rd from junction of Burdett Rd, 26 June 2006, *R. Davis* 11064 (PERTH); *c.* 5 m from shoreline at S end of salt lake, 16 km E of Grass Patch via Starcevich & Ridley Rds, 21 May 2004, *M. Hislop & F. Hort* MH 3213 (CANB, NSW, PERTH); Norwood Rd 2.4 km E of Dempster Rd, E of Scaddan, 22 May 2004, *M. Hislop & F. Hort* MH 3221 (PERTH); 1.2 km SSE of Mt. Ney Rd on Kau Rock Rd, 20 Sep. 1985, *L. Nunn* 168 (CANB, PERTH); Drainage line *c.* 1 km S of Rasyk Rd on E boundary of Loc. 447, 28 Sep. 1998, *T. Stone & L. Cambell s.n.* (PERTH).

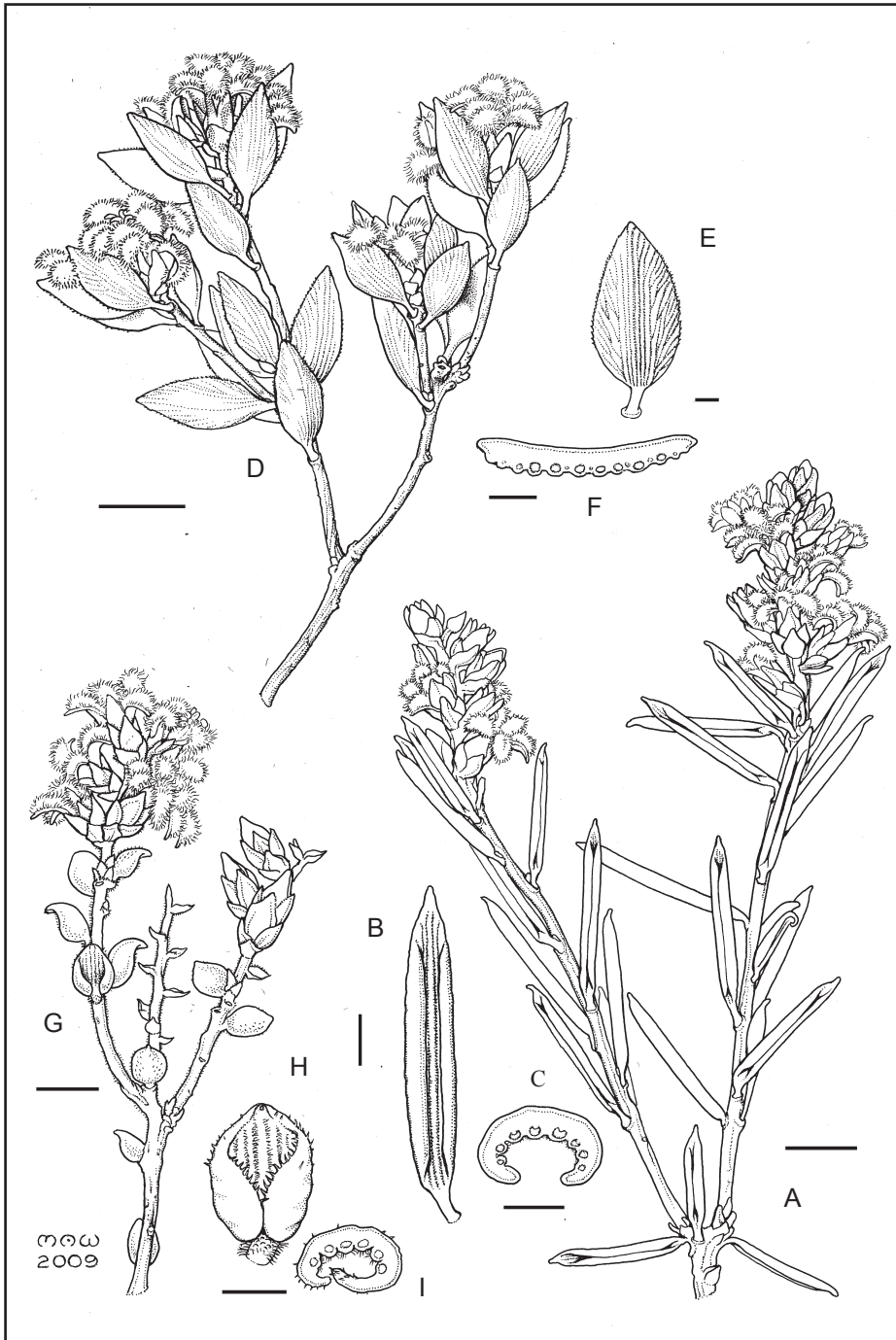


Figure 3. A–C. *Leucopogon canaliculatus*. A – flowering branchlet; B – leaf, abaxial surface; C – leaf section. D–F. *Leucopogon remotus*. D – flowering branchlet; E – leaf, abaxial surface; F – leaf section; G–I. *Leucopogon rugulosus*. G – flowering branchlet; H – leaf, abaxial surface; I – leaf section. Scale bars: A = 5 mm; B, E, H, I = 1 mm; C, F = 0.5 mm; D = 5 mm; G = 3 mm; . Drawn by Margaret Wilson from *M. Hislop* 3221 (A, B, C), *M. Hislop* 3629 (D, E, F), *W. O'Sullivan* 960 (G, H, I).

Distribution and habitat. Known from a rather narrow east – west band in the north of the Esperance region, extending from a little west of Grass Patch at least as far east as the Kau Rock Nature Reserve north of Condingup (Figure 2). The plant grows in mallee woodland or heathland communities generally in low-lying, sometimes subsaline habitats, usually over sandy loam soils but often with clay at depth.

Phenology. Flowers have been recorded from March through to July and mature fruit in September and October.

Etymology. The epithet derives from the Latin *canaliculatus* (channelled), and refers to the characteristic abaxial groove or channel produced between the abutting margins of the mature, revolute leaves.

Conservation status. The new species is locally common across its known range. Although currently recorded from only two nature reserves, based on an assessment of the local geography, it seems likely that it will be present in several others within the region. To the north and north-east of its known occurrence are large, inaccessible tracts of uncleared crown land, which includes similar low-lying country. The species is also likely to occur in this area, at least in the south. In the absence of any discernible threatening processes no conservation coding is recommended here.

Affinities. *Leucopogon canaliculatus* is superficially similar to, and has been confused with, *L. revolutus*, from which it can be readily separated by leaf characteristics. The upper leaf surfaces of the new species are glabrous or sparsely and irregularly hairy with no venation evident. The lower surfaces have deep, hairy furrows between prominently raised veins. By contrast, *L. revolutus* has the upper surfaces always scabrous with antrorse, tubercle-based hairs and one or three rather conspicuous sunken veins. The lower surfaces are more or less smooth or slightly striate and either glabrous or sparsely hairy throughout.

The closest relative of *L. canaliculatus* is the narrowly distributed *L. rugulosus*, described below. Both have revolute leaves which are hairy and deeply grooved abaxially, but in the case of the latter the leaves and inflorescences are shorter and the ovary is 3 (rarely 4)-locular, rather than 5- or 4-locular. Additionally the sepals of *L. rugulosus* are more acute, the abaxial leaf surface hairy throughout (rather than just in the grooves), the petiole shorter and always hairy throughout, and the fruit apparently narrower.

Although the two species are generally quite distinct and easily separated, two anomalous populations are known in the west of the range of *L. canaliculatus* (represented by the collections *M. Hislop* 3623 and *M. Hislop* 3708) which erode somewhat the distinctions between the two. These specimens have shorter than normal leaves (as short as 4 mm, though this is still longer than recorded for *L. rugulosus*) and inflorescence axes and frequently have 3- as well as 4-locular ovaries. This locale number was not recorded for any other collections of *L. canaliculatus* (despite comprehensive sampling – refer note under methods) but a 3-locular ovary is the norm for *L. rugulosus*. However in respect to the other separating characters between the two species, described above, both collections are quite typical of *L. canaliculatus*.

There is also a strong similarity in foliar morphology between plants from the two populations cited above and those from a population (represented by *Hislop* 3712) described below in the notes section under *L. heterophyllus*. Only the complete absence of hairs in the abaxial leaf grooves, separate the latter population from the two described above.

Leucopogon heterophyllus Hislop, *sp. nov.*

Leucopogi bossiaea (F. Muell.) Benth. affinis a qua imprimis differt sepalis grandioribus, corolla grandiore, et stylo longiore.

Typus: unmanaged Reserve No 29713, West Point Rd, 12 km N of South Coast Highway, NW of Munglinup, 27 June 2007, M. Hislop 3713 (*holo*: PERTH 07615302; *iso*: CANB, K, MEL, NSW).

Erect *shrubs* to 150 cm high and 120 cm wide, but usually smaller, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* light brown, glabrous, or with a very short, irregular indumentum of patent hairs; the bark on older stems grey, fissured and often somewhat stringy. *Leaves* spirally arranged, antrorse, usually steeply so, varying from depressed-ovate, broadly ovate, deltoid or \pm circular to ovate, elliptic or rarely obovate, 2.0–6.4 mm long, 1.9–4.7 mm wide; apex obtuse or subacute, with a rather indistinct callus point; base cuneate, rounded, truncate or cordate; petiole well defined, pale greenish-yellow to yellowish-brown, 0.6–1.3 mm long, glabrous throughout; lamina 0.25–0.40 mm thick, concave adaxially, flat, convex or with manifestly recurved margins; surfaces discolorous, glabrous, adaxial surface shiny, venation not evident, abaxial surface paler with 5–7 \pm raised primary veins, the midrib not differentiated; margins glabrous or coarsely ciliate with antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–10 mm long, with 3–10 flowers, terminating in a bud-like rudiment; indumentum of sparse, patent hairs <0.05 mm long; flowers erect and sessile. *Fertile bracts* broadly ovate or ovate, 0.5–0.8 mm long, 0.6–0.8 mm wide, obtuse; abaxial surface with venation very obscure, glabrous; adaxial surface with short, appressed hairs towards apex; margins minutely ciliate. *Bracteoles* broadly ovate, 0.9–1.5 mm long, 0.8–1.3 mm wide, obtuse, keeled; abaxial surface glabrous, or with a very few short hairs about the upper keel, the central portion greenish, usually suffused purple along the upper keel and in a submarginal band, becoming paler and scarious towards the margins; adaxial surface shortly antrorse-hairy; the margins minutely ciliate. *Sepals* ovate, (1.7–)1.9–2.6 mm long, 1.1–1.6 mm wide, obtuse; abaxial surface glabrous, the central portion greenish or greyish-green, \pm suffused purple towards apex and in a submarginal band which is well differentiated from the paler, scarious marginal band, the venation inconspicuous; adaxial surface with a sparse indumentum of antrorse-appressed hairs in distal half; the margins minutely ciliate with hairs <0.05 mm long. *Corolla tube* white, broadly campanulate, about as long as, slightly longer than or slightly shorter than sepals (by up to 0.3 mm), 1.3–2.0 mm long, 1.5–2.0 mm wide, glabrous externally and internally apart from a few hairs below the base of the lobes. *Corolla lobes* white, sometimes wholly or in part tinged pink, much longer than the tube (ratio = 1.4–2: 1), widely spreading from the base and recurved, 1.9–3.5 mm long, 0.8–1.0 mm wide at the base, glabrous externally, densely bearded internally, indumentum white, 0.6–0.8 mm long near apex, the glabrous tip 0.1–0.2 mm long. *Anthers* partially exerted from tube (by 3/4–7/8 of length) in early flower, but often becoming fully exerted and held at right angles to the floral axis, 1.0–1.8 mm long, recurved at apex; sterile tips inconspicuous, 0.3–0.4 mm long; *filaments* terete, attached 2/3–3/4 above anther base, 0.6–0.9 mm long, adnate to tube just below sinus. *Ovary* globose or depressed-globose, 0.6–0.7 mm long, 0.6–0.8 mm wide, glabrous, 3- or 4-locular; *style* 0.6–0.9 mm long, tapering smoothly from the base, included within the corolla tube; *stigma* slightly to distinctly expanded; *nectary* annular, 0.3–0.5 mm long, entire or lobed for up to 1/3 of length, glabrous. *Fruit* globose or depressed-globose, with smoothly rounded shoulders, 1.7–2.1 mm long, 1.8–2.3 mm wide, longer than calyx, the surface with a reticulum of transverse and longitudinal ridges; style persistent. (Figures 1B–C, 4)

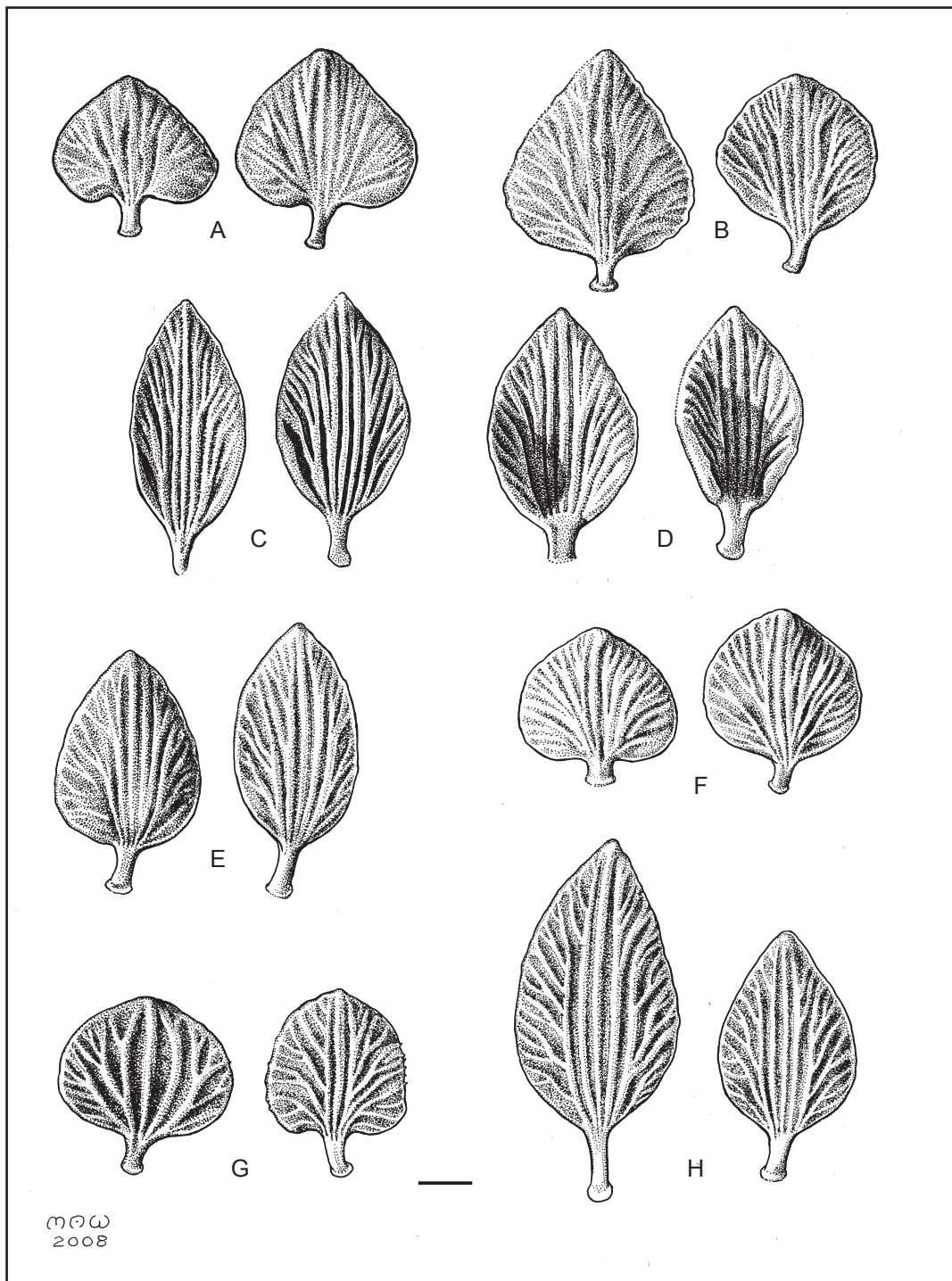


Figure 4. *Leucopogon heterophyllus*. Examples of variation in leaf morphology (abaxial surfaces shown) within and between populations. Scale bar: 1 mm. Drawn by Margaret Wilson from *M. Hislop* 3704 (A), *M. Hislop* 3114 (B), *M. Hislop* 3711 (C), *M. Hislop* 3228 (D), *M. Hislop* 3741 (E), *M. Hislop* 3713 (F), *M. Hislop* 3621 (G), *M. Hislop* 3721 (H).

Other specimens examined. WESTERN AUSTRALIA: 1.6 km along track leaving Esperance Rd at 30.5 km from Ravensthorpe to NE, 17 May 1998, *M. Bennett* 141 (PERTH); 6.25 km south along West Point Rd from intersection with Rawlinson Rd, 22 Oct. 1997, *E.A. Brown* 97/380, *P.G. Wilson & N. Lam* (CANB, CHR, NSW, NY, PERTH, UNSW); 35.5 km ENE of Muckinwobert Rock, 6.21 km NE of Melaleuca Rd on West Point Rd, 30 Sep. 1984, *M.A. Burgman* 3920 (PERTH); 8.5 km NW of Ravensthorpe and Esperance shire boundary on Cascades Rd, proposed MRD gravel pit no. 2 on east side, 25 July 1995, *G.F. Craig* 3246 (PERTH); 35.5 km ENE of Muckinwobert Rock, 6.21 km NE of Melaleuca Rd on West Point Rd, 30 Sep. 1984, *M.A. Burgman* 3936 (PERTH); Lake King – Cascades Road, 23.2 km NW of West Point Rd, NW of Cascade, 25 July 2006, *M. Hislop* 3621 (CANB, NSW, PERTH); South Coast Highway 30 km E of Ravensthorpe and then 100 m N along rough track, 27 Apr. 2007, *M. Hislop* 3704 (CANB, NSW, PERTH); West Point Rd, 12.8 km W of Cascades Rd, NW of settlement of Cascade, 26 June 2007, *M. Hislop* 3710 (CANB, NSW, PERTH); Melaleuca Rd 300 m S of West Point Rd, NW of settlement of Cascade, Western Australia, 26 June 2007, *M. Hislop* 3711 (CANB, K, MEL, NSW, PERTH); Coujinup Rd 6.9 km N of South Coast Highway, E of Ravensthorpe, 27 June 2007, *M. Hislop* 3714 (CANB, PERTH); Lake King – Cascades Rd, 36.7 km SE of Lake King – Norseman Rd, 15 Aug. 2007, *M. Hislop* 3721A & 3721B (CANB, NSW, PERTH); unmanaged Reserve No 29713, West Point Rd, 12 km N of South Coast Highway, NW of Munglinup, 21 Oct. 2007, *M. Hislop* 3737 (CANB, NSW, PERTH); Melaleuca Rd 300 m S of West Point Rd, NW of settlement of Cascade, 21 Oct. 2007, *M. Hislop* 3739 (NSW, PERTH); West Point Rd, 12.8 km W of Cascades Rd, NW of settlement of Cascade, 21 Oct. 2007, *M. Hislop* 3740 (CANB, PERTH); Lake King – Cascades Rd, 36.7 km SE of Lake King – Norseman Rd, 21 Oct. 2007, *M. Hislop* 3741 (CANB, PERTH); 1 km W of Burlabup Ck on Esperance – Ravensthorpe Rd, 35 km E of Ravensthorpe, 16 Nov. 1981, *K.R. Newbey* 9409 (PERTH); 1 km W of Burlabup Ck on Esperance – Ravensthorpe Road, c. 33 km E of Ravensthorpe, 27 Sep. 1968, *P.G. Wilson* 8003 (CANB, PERTH).

Distribution and habitat. *Leucopogon heterophyllus* extends from a little east of Ravensthorpe to the Cascade area and north at least as far as the Lake King – Cascade Rd (Figure 2). It generally occurs in sandy loam soils, often over laterite, and as a component of the shrubby understorey of open mallee woodlands.

Phenology. The main flowering period is between May and July. Mature fruit has been collected between late September and November.

Etymology. The epithet is derived from the Greek *heteros* (different or unequal) and *phyllon* (leaf), in reference to the particularly variable leaf morphology of this species.

Conservation status. Although not widespread, *Leucopogon heterophyllus* occurs in an area of southern Western Australia where there remain extensive tracts of uncleared land. Its preferred habitat is locally common in that area and the known populations are generally large. For these reasons it is not recommended, at this stage, for inclusion on the DEC's Priority list.

Affinities. *Leucopogon heterophyllus* is most closely related to *L. bossiaea*, variants with broadly ovate, often cordate leaves being especially similar to that species. The two differ primarily in flower size, with the new species having larger floral parts: sepals 1.9–2.6 mm long and 1.1–1.6 mm wide (compared to 1.4–1.9 mm and 0.8–1.2 mm respectively in *L. bossiaea*), corolla tube 1.3–2.0 mm long (1.1–1.5 mm), corolla lobes 1.9–3.5 mm long (1.5–2.0 mm), corolla lobe to tube ratio 1.4–2: 1 (1.0–1.4: 1), style 0.6–0.9 mm long (0.4–0.5 mm), and ovary dimensions 0.6–0.7 mm long by 0.6–0.8 mm wide (0.5–0.6 mm by 0.5–0.6 mm). The fruit of *L. heterophyllus* are also larger; 1.7–2.1 mm long

and 1.8–2.3 mm wide, compared with 1.4–1.6 mm by 1.3–1.5 mm in *L. bossiaea*. The two species are allopatric, being separated by between 250 and 300 km.

Variants of *L. heterophyllus* with longer, elliptic leaves may resemble *Leucopogon remotus*, which is described below, but can be separated by consistent foliar differences. These two species are also allopatric, with the latter having a restricted distribution north-east of Esperance. The leaves of *L. remotus* are usually distinctly concave adaxially, less often flat, and are characterized by having the lamina markedly incurved along the longitudinal axis and in having a straight, acute apex. The longer-leaved variants of *L. heterophyllus* by contrast have generally narrower leaves (i.e. the length to width ratio of longest leaves is 1.36–2.55: 1, compared to 2.64–3.89: 1 in *L. remotus*), which are either flat, adaxially convex or with manifestly recurved margins. The longitudinal axis of the lamina is \pm straight, and the apex obtuse or subacute and often slightly deflexed. The fruit of *L. remotus* are also smaller.

Notes. Three more or less recognisable, geographical variants occur across the species' range. The western populations between the eastern end of the Ravensthorpe Range and the Oldfield River have relatively short, broadly ovate leaves (always with many leaves wider than long), and cordate, truncate or rounded bases. Leaf curvature is either flat, slightly concave adaxially or slightly convex and the main veins on the abaxial surface are usually moderately raised with broad shallow grooves between.

East of the Oldfield River occurs a second variant in which the leaves are always longer than broad, often distinctly so, usually ovate or elliptic in shape, occasionally obovate, and flat, adaxially convex, or with manifestly recurved margins. The bases are cuneate or rounded, and the veins on the abaxial surface are more prominently raised with the intervening grooves deeper and narrower than in the western variant.

The foliar differences between the two variants described above are quite consistent and were the species only known from these areas there might be grounds for recognising a second taxon. However this pattern of foliar difference breaks down in collections from the northern populations, even though these appear to be more isolated geographically from both the eastern and typical variants than those are from each other. Plants collected along the Lake King – Cascade Road have leaves with generally higher length to width ratios than the western populations, but not as high as those seen in the eastern leaf venation and shape of the leaf base are also generally intermediate.

At the south-eastern edge of the species' range there occurs a population (represented by *M. Hislop* 3712) which, even within the context of such a variable species, stands out as being significantly different. It has the majority of leaves linear or narrowly obovate, with more or less tightly recurved margins and deep, narrow grooves between the prominent veins on the abaxial surface. In general foliar morphology, it is similar to the species pair *Leucopogon canaliculatus* and *L. rugulosus* (described elsewhere in this paper), although both are readily separated by the hairs in the abaxial grooves. It is not clear at this stage whether this entity should be regarded as an anomalous variant of either *L. heterophyllus* (it is not included in the above description of the species) or *L. canaliculatus* or as a separate taxon.

The plasticity of the foliar morphology of this species is unusual and beyond the range encountered elsewhere in Group A. The leaves not only vary very considerably in shape but also in curvature and in the prominence of the abaxial venation. The pattern of foliar variation however shows very little correlation with any potential differences in the flowering or fruiting morphology.

Leucopogon heterophyllus occurs in large part in uncleared and untracked country. A better understanding of its pattern of variation may have to wait until the area has been more fully explored botanically.

Leucopogon remotus Hislop, *sp. nov.*

Leucopogi bossiaea (F. Muell.) Benth. affinis a qua imprimis differt foliis longioribus angustioribus et magis acutis, basi cuneata vice cordatae vel rotundatae.

Typus: North-east of Esperance [precise locality withheld for conservation reasons], Western Australia, 26 July 2006, M. Hislop 3627 (*holo*: PERTH 07350597; *iso*: CANB, NSW).

Leucopogon sp. South Coast (K.R. Newbey 8213), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 240 (2000).

Erect, usually rather compact *shrubs* to c. 70 cm high and 70 cm wide, but usually shorter, single-stemmed at ground level with a fire-sensitive rootstock. Young *branchlets* glabrous or with a sparse indumentum of very short patent hairs < 0.1 mm long, which may persist to the second or third year, at length glabrescent; bark on older stems dark grey and becoming fissured. *Leaves* spirally arranged, antrorse, usually steeply so, narrowly ovate to ovate, less often narrowly elliptic to elliptic, 4.0–9.5 mm long, 1.9–3.0 mm wide; apex acute, with a short pale callus point; base cuneate; petiole well-defined, greenish-yellow or pale brown, 0.9–1.7 mm long, glabrous or with a few short hairs on the adaxial surface, glabrous abaxially; lamina 0.30–0.45 mm thick, usually concave adaxially, less often flat, incurved along longitudinal axis, especially towards the apex; surfaces slightly discoloured, glabrous, adaxial surface not or scarcely shiny, mid-green, venation not evident, abaxial surface paler with 5–7 prominently raised primary veins, the midrib not differentiated; margins usually coarsely ciliate with antrorse hairs, less often glabrous. *Inflorescence* erect, usually terminal, with little upper-axillary development; axis 3–9 mm long, with 4–11 flowers terminating in a bud-like rudiment; indumentum of sparse to moderately dense, patent hairs < 0.1 mm long; flowers erect and sessile. *Fertile bracts* ovate to broadly ovate, 1.0–1.2 mm long, 0.8–1.0 mm wide, obtuse; abaxial surface glabrous, venation usually obscure; adaxial surface sparsely hairy; margins ciliate. *Bracteoles* ovate, 1.1–1.6 mm long, 0.7–1.1 mm wide, obtuse or subacute, keeled; abaxial surface glabrous apart from a few short hairs near the keel apex, greenish-grey and often suffused reddish-purple along the central portion, becoming scarious towards the margins; adaxial surface appressed, antrorse-hairy; the margins ciliate. *Sepals* ovate, 1.7–2.1 mm long, 1.0–1.3 mm wide, obtuse or subacute; abaxial surface glabrous, greenish in lower central portion, becoming suffused a dull purple above, venation obscure, apart sometimes from a pale midrib close to the apex; adaxial surface with appressed, antrorse hairs; margins broadly scarious and ciliate with hairs < 0.1 mm long. *Corolla tube* white, broadly campanulate, usually longer than sepals by up to 0.6 mm, or occasionally c. as long as sepals, 1.3–2.0 mm long, 1.7–2.0 mm wide, glabrous externally and internally except for a few hairs below the base of the lobes. *Corolla lobes* white, sometimes flushed pink towards apex, slightly longer than the tube (ratio = 1.1–1.5: 1), widely spreading from the base and recurved, 2.0–2.3 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.5–0.6 mm long near apex, glabrous tip 0.1–0.2 mm long. *Anthers* partially exerted from tube (by 2/3–3/4 of length) in early stages of flowering but often becoming fully exerted and held \pm at right angles to the floral axis, 1.0–1.5 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.3–0.4 mm long; *filaments* terete, attached 1/2–2/3 above anther base, 0.4–0.6 mm long, adnate to tube just below the sinus. *Ovary* depressed-globose or globose, 0.5–0.7 mm long, 0.6–0.7 mm wide, glabrous, 3–4(–5)-locular; *style* 0.5–0.7 mm

long, tapering smoothly from a broad base (0.3–0.4 mm wide) to the stigma, included within corolla tube; *stigma* not or very slightly expanded; *nectary* annular, 0.3–0.5 mm long, shallowly lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose, with smoothly rounded shoulders, glabrous, 1.4–1.6 mm long, 1.6–1.7 mm wide, longer than calyx, the surface with a moderately conspicuous reticulum of transverse and longitudinal ridges; style persistent. (Figure 3D–F)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Oct. 2007, R. Butcher & J.A. Wege RB 1212 (PERTH); 14 Nov. 1993, G.F. Craig 3020A & 3020B (ESP, PERTH); 30 June 2006, R. Davis 11089 (PERTH); 26 July 2006, M. Hislop 3629 (CANB, NSW, PERTH); 16 Aug. 2007, M. Hislop 3722 (CANB, NSW, PERTH); 8 Nov. 1980, K.R. Newbey 8213 (PERTH).

Distribution and habitat. *Leucopogon remotus* is known only from a restricted area north-east of Esperance, where it grows on sandy-loam soils in mallee woodland communities. (Figure 2).

Phenology. Flowering specimens have been collected in June and July, but it is likely that flowering continues at least through much of August and maybe into early September. Mature fruit has been collected in October and November.

Etymology. Named from the Latin *remotus* (distant, remote). A reference to the remote, very sparsely populated country in which the species is endemic.

Conservation status. This species was originally listed under the phrase name *Leucopogon* sp. South Coast (K.R. Newbey 8213) and is currently assigned Priority One status in the Conservation Codes for Western Australian Flora (Atkins 2008). Although currently known only from a few populations in a restricted area north-east of Esperance, these are very close to the edge of the agricultural zone and it does seem probable that the species will also occur to the north of the clearing line. If future surveys are able to confirm this, its conservation status will need to be reassessed, as there are no obvious threats to the known populations.

Affinities. The new species clearly belongs to the *Leucopogon bossiaea* subgroup, with its two closest relatives being *L. bossiaea* and *L. heterophyllus*. The former differs from *L. remotus* in its shorter, obtuse leaves which have broadly rounded or cordate rather than cuneate bases. Differences between *L. remotus* and *L. heterophyllus* are discussed under that species.

Leucopogon rugulosus* Hislop, *sp. nov.

Leucopogi canaliculato Hislop affinis sed foliis et inflorescentiis brevioribus, ovario 3-(nullomodo 4–5-) loculari differt.

Typus: North-west of Esperance [precise locality withheld for conservation reasons], Western Australia, 17 May 2002, M. Hislop & F. Hort MH 2601 (*holo:* PERTH 06132820; *iso:* CANB, NSW).

Leucopogon sp. Roberts Swamp (K.R. Newbey 8173), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 240 (2000).

Erect *shrubs* to c. 100 cm high and 100 cm wide, single-stemmed at ground level and with a fire-sensitive rootstock. Young *branchlets* light brown, with a sparse to moderately dense indumentum of

patent, straight or somewhat decurved hairs to 0.2 mm long, which are persistent to the second or third year but at length glabrescent, the mature stems becoming grey with smooth or slightly fissured bark. *Leaves* spirally arranged, usually slightly antrorse, less often more steeply so or \pm patent (always spreading from a steeply antrorse petiole), obovate or elliptic, 1.7–3.1 mm long, 1.1–1.7 mm wide; apex with a blunt, recurved mucro to *c.* 0.2 mm; base rounded or cordate; petiole well defined, greenish-yellow, 0.3–0.5 mm long, with a dense indumentum of short, patent hairs throughout; lamina 0.35–0.45 mm thick, margins revolute, often abutting abaxially in lower half; surfaces discolorous, adaxial surface shiny, with irregular transverse wrinkles and a sparse or moderately dense indumentum of short, slightly antrorse hairs, usually persistent but sometimes glabrescent, venation not evident, abaxial surface paler with 5–7 broad, primary veins and deep furrows between, the midrib not differentiated, densely hairy with short patent hairs throughout; margins irregularly scabrous with patent and antrorse hairs. *Inflorescence* erect, terminal and upper-axillary; axis 3–9 mm long, with 3–9 flowers, terminating in a bud like rudiment; indumentum of dense, patent, straight hairs, 0.08–0.1 mm long; *flowers* erect, sessile. *Fertile bracts* ovate or broadly ovate, usually with a cordate base, 0.9–1.3 mm long, 0.8–1.1 mm wide, subacute or acute; abaxial surface with irregular indumentum of short patent hairs, venation usually obscure; adaxial surface with appressed antrorse hairs. *Bracteoles* ovate, 1.1–1.7 mm long, 0.9–1.3 mm wide, acute, keeled; abaxial surface with short, moderately dense, patent hairs along keel, and a shorter irregular indumentum elsewhere, pale greenish in basal portion, usually suffused red-purple along the keel and in a sub-marginal band; adaxial surface appressed antrorse-hairy; margins scarious and ciliolate. *Sepals* ovate, 1.9–2.3 mm long, 1.1–1.5 mm wide, acute or subacute; abaxial surface glabrous and greenish in lower, central portion, very shortly antrorse-hairy and red or brownish purple above, venation obscure apart from the pale midrib which is usually evident close to apex; adaxial surface appressed antrorse-hairy for most of length; margins scarious and ciliolate with hairs to 0.15 mm long. *Corolla tube* white, campanulate, as long as sepals or shorter (by up to 0.3 mm), 1.3–1.9 mm long, 1.4–1.7 mm wide, glabrous externally and internally. *Corolla lobes* white, sometimes flushed pink towards apex, slightly longer than the tube (ratio = 1.1–1.4: 1), widely spreading from base and recurved, 1.7–2.5 mm long, 0.8–1.0 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.6–0.8 mm long near apex, the basal hairs reflexed into top of tube by up to 0.8 mm, the glabrous tip 0.1–0.2 mm long. *Anthers* of recently opened flowers partially exerted from tube (by 1/2–2/3 of length) but then often becoming fully exerted and held at right angles to the floral axis, 1.0–1.4 mm long, slightly recurved at apex; sterile tips inconspicuous, 0.2–0.3 mm long; *filaments* terete, attached 2/3 to 3/4 above anther base, 0.4–0.6 mm long, adnate to tube just below sinus. *Ovary* depressed-globose or globose, 0.5–0.6 mm long, 0.5–0.7 mm wide, glabrous, 3(4)-locular; *style* 0.4–0.6 mm long, tapering smoothly from a broad base (*c.* 0.3 mm wide), included within the corolla tube; *stigma* scarcely to distinctly expanded; *nectary* annular, 0.2–0.35 mm long, lobed for up to 1/3 of length, glabrous. *Fruit* depressed-globose or globose, with smoothly rounded shoulders, glabrous, 1.5–1.6 mm long, 1.6–1.8 mm wide, slightly shorter than to slightly longer than calyx, the surface with a rather conspicuous reticulum of transverse and longitudinal ridges, the style persistent. (Figure 3G–I)

Other specimens examined. WESTERN AUSTRALIA: 16 Dec. 2005, *E.D. Adams* 13/1205 (PERTH); 24 May 1983, *M.A. Burgman & S. McNee* 1482 (NSW, PERTH); 6 May 2003, *J. A. Cochrane s.n.* (PERTH); 19 Sep. 1993, *G.F. Craig* 2953, 2953A, 2953B, 2953C (PERTH); 19 Sep. 1993, *G.F. Craig* 2960A, 2960B, 2960C (PERTH); 15 Nov. 1980, *K.R. Newbey* 8173 (PERTH); 13 Aug. 1997, *W. O'Sullivan* 246 (PERTH); 5 Jun. 2000, *W. O'Sullivan* 960 (NSW; PERTH).

Distribution and habitat. *Leucopogon rugulosus* appears to have a very restricted distribution in the Cascades area NW of Esperance (Figure 2). It grows on sandy or sandy loam soils in heathland or open mallee woodland, and in generally low lying areas sometimes quite close to saline drainage lines.

Phenology. Appears to flower over an extended period beginning in May or earlier and continuing until at least September by which time mature fruit are also present.

Etymology. From the Latin *rugosus* (wrinkled or creased) with diminutive *-ul* (slightly), in reference to the transverse wrinkling which is characteristic of the upper leaf surface of this species.

Conservation status. Under the phrase name *Leucopogon* sp. Roberts Swamp (K.R. Newbey 8173), this species has been assigned Priority One under DEC Conservation Codes for Western Australian Flora (Atkins 2008). It is known only from a small area of the south coast of Western Australia. However this is remote, and in botanical terms, poorly known country with large areas of undisturbed natural vegetation. The true distribution of the species may be larger than currently appears the case. Aside from the now unlikely possibility of a resumption of land clearing in the area, there are no obvious threats to the known populations.

Affinities. The closest relative of *Leucopogon rugulosus* is *L. canaliculatus*. Distinguishing features between the two are discussed under that species.

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