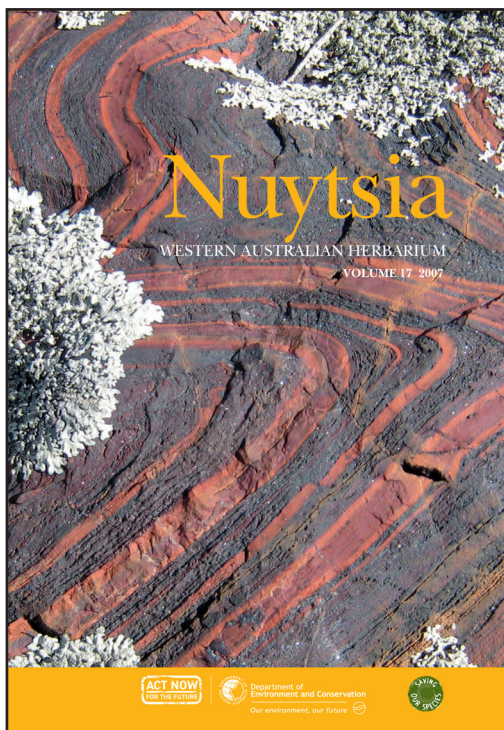


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Australia

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All enquiries and manuscripts should be directed to:

The Editor – NUYSIA
Western Australian Herbarium
Dept of Environment and Conservation
Locked Bag 104 Bentley Delivery Centre
Western Australia 6983
AUSTRALIA

Telephone: +61 8 9334 0500
Facsimile: +61 8 9334 0515
Email: nuytsia@dec.wa.gov.au
Web: science.dec.wa.gov.au/nuytsia/



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Three new and geographically restricted species of *Leucopogon* (Ericaceae: Styphelioideae: Styphelieae) from south-west Western Australia

Michael Hislop and Alex R. Chapman

Western Australian Herbarium, Department of Environment and Conservation, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Abstract

Hislop, M. & Chapman, A.R. Three new and geographically restricted species of *Leucopogon* (Ericaceae: Styphelioideae: Styphelieae) from south-west Western Australia. *Nuytsia* 17: 165–184 (2007). *Leucopogon borealis* Hislop & A.R. Chapm., *L. spectabilis* Hislop & A.R. Chapm. and *L. validus* Hislop & A.R. Chapm. are described, illustrated and their distributions mapped. All have conservation coding. Five informal, subgeneric groups for *Leucopogon* R.Br. *s. str.* in Western Australia are delineated. A lectotype is also selected for *Leucopogon apiculatus* R.Br.

Introduction

Leucopogon R.Br. is a large, predominantly Australian genus first described by Robert Brown (1810). It was reduced to sectional level under *Styphelia* by Mueller (1867). This revised classification received support from Drude (1889), Maiden and Betche (1916) and then Sleumer (1964) who made *Leucopogon* a subgenus of *Styphelia*. Bentham (1868), however, accepted Brown's generic concept and this remained the preferred classification throughout the twentieth century.

Bentham's treatment is the last full revision of the genus in Australia. He recognised 118 species including 82 from Western Australia. Bentham described three sections within *Leucopogon* (*Perojoa* (Cav.) Benth., *Heteranthesis* Benth. and *Pleuranthus* Benth.) but no corresponding type species were designated. Bentham recognised that *Perojoa* Cav. (Cavanilles 1797) was an earlier available name for the genus *Leucopogon* that had not been taken up by Brown. His adoption of that name at the sectional level implies that he considered it to be the type section. This was later confirmed when the name *Leucopogon* was conserved over *Perojoa* (Sprague 1940), and *L. lanceolatus* (Sm.) R.Br. (a member of section *Perojoa*) was conserved as its type species.

Bentham's section *Perojoa* was defined by the presence of three morphological characters: a mainly terminal inflorescence, anthers with sterile tips and a very short style. Sections *Heteranthesis* and *Pleuranthus* lack the sterile anther tips and often have axillary inflorescences and long styles. Recent cladistic studies into relationships within the tribe *Styphelieae*, using morphological data (e.g. Powell *et al.* 1997), DNA sequence data (e.g. Quinn *et al.* 2003), or a combination of the two (e.g. Taafe *et al.* 2001), have compellingly demonstrated that *Leucopogon s. lat.* is a polyphyletic assemblage of species. This effectively means that most of the species in Bentham's sections *Heteranthesis* and

Pleuranthus will need to be transferred to other genera. The process has already begun, and in the West Australian context, *Leucopogon rubicundus* Benth. and *L. pleurandroides* F.Muell. (section *Heteranthesis*) have recently been placed in an expanded *Lissanthe* R.Br. (Crayn *et al.* 2003; Crayn *et al.* 2005), and *L. durus* Benth. (section *Pleuranthus*) is now recognised as a species of *Acrotriche* R.Br. (Quinn *et al.* 2005). As research continues, the boundaries of other long established genera within the *Styphelieae* seem certain to be redefined and the installation of new genera to better accommodate elements of *Leucopogon s. lat.* is also probable. Although taxonomic difficulties still remain elsewhere in the *Styphelieae* in circumscribing natural generic groupings, the aforementioned research has also provided generally strong support for the monophyly of *Leucopogon s. str.* (= section *Perojoa*). Even within a considerably narrowed circumscription, *Leucopogon* will probably remain the largest genus in the *Styphelieae*.

In the last 10 years many unnamed Western Australian species of *Leucopogon s. str.* have come to light, some of which appear to be rare or at least geographically restricted. Most of these have been allocated informal names in the Census of Western Australian Plants. This paper establishes a taxonomic framework, comprising five informal subgeneric groups within the Western Australian members of *Leucopogon s. str.*, based on inflorescence, flower and especially fruiting morphology. It describes three new species, all of conservation significance, from one of these subgeneric groups as well as serving to lectotypify *L. apiculatus* R.Br. Further new taxa from this and other subgeneric groups will be dealt with in subsequent papers.

Morphological attributes of *Leucopogon s. str.*

The characters used by Bentham (1868) still represent the core of the differences separating members of *Leucopogon s. str.* from the other elements of *Leucopogon s. lat.*, although as observed by Taafe *et al.* (2001) there is no unique morphological feature by which the genus can be defined. All member species, however, can be assigned to *Leucopogon s. str.* by referral to the following combination of characters: sterile anther tips, terminal and upper axillary inflorescences, style included within the corolla tube, and sepals as long as or longer than the corolla tube. Most species can be readily placed on the basis of the co-occurrence of the first two of these characters, but if the anther tips are difficult to interpret, the co-occurrence of the other three can be regarded as confirmatory.

While most species in *Leucopogon s. str.* have terminal and upper axillary inflorescences, a few are rather anomalous in this respect and may superficially resemble members of *Leucopogon s. lat.* which are characterized in part by an axillary inflorescence. *Leucopogon capitellatus* DC., for example, has short axillary inflorescences extending down the flowering branchlet for many nodes below the terminal inflorescence. Inflorescences of *L. oliganthus* E.Pritz. may appear to be axillary, but in fact comprise very reduced terminal inflorescences on numerous, short, lateral branchlets which are overtopped by the subtending leaves.

The genus *Lissanthe* shares with *Leucopogon s. str.* a terminal and upper axillary inflorescence but can be separated by the following character combination: anthers lacking sterile tips, flowers usually pedicellate above the bracteoles (note that some members of *Leucopogon s. str.* are pedicellate below the bracteoles), and in Western Australian species at least, by having leaves with revolute margins abutting the midrib and so completely obscuring the abaxial surface.

The presence of sterile anther tips remains a primary attribute of *Leucopogon s. str.* These typically

appear paler than the main body of the anther and are usually more or less recurved. Although this character is often discernible to the naked eye, in some species the tips are very short and only observable under high magnification. However, one western species, *L. plumuliflorus* F.Muell. apparently lacks sterile anther tips altogether. This remarkable species is also anomalous in several other important features such that a case could certainly be made, on morphological grounds, for its recognition as a monotypic genus. Interestingly though, the recent cladistic analysis based on DNA sequence data referred to above (Quinn *et al.* 2003), indicates strongly that it belongs in the well supported clade containing all other members of *Leucopogon s. str.*

A short style included within the corolla tube was the third character used by Bentham as indicative of his section *Perojoa* (= *Leucopogon s. str.*). While all members do indeed share an included style, it does occur occasionally elsewhere in *Leucopogon s. lat.*, for instance in the species group ‘Gynoconus’ (*sensu* Powell *et al.* 1997).

Other very useful, although again not totally reliable, characters are the associated ones of relative lengths of sepals to corolla tube and tube to corolla lobe. With few exceptions members of *Leucopogon s. str.* have sepals as long as or longer than the corolla tubes and tubes shorter than the lobes. Two conspicuously anomalous Western Australian species in regard to these character states are *L. verticillatus* R.Br. and the taxon currently referred to at the Western Australian Herbarium (PERTH) by the informal name *L. sp.* Windy Harbour (A. Strid 21460).

While the corolla lobes of most species of *Leucopogon s. str.* have a characteristically dense, white indumentum with only subtle variation between species groups, there are exceptions here too. The remarkable *L. verticillatus* is again anomalous since it has a relatively sparse indumentum restricted to the basal half of the lobes. Another unusual species, *L. hirsutus* Sond., has the basal portion of the lobes glabrous, with a very sparse zone of hairs close to the apex.

Apart from the primary characters of flower and inflorescence which serve to distinguish *Leucopogon s. str.*, the complete absence of aristate leaf tips is also noteworthy. While many species have acute leaf apices, none has the long pungent mucros common in members of *Leucopogon s. lat.* and elsewhere in *Styphelieae*.

Infrageneric groupings

As discussed above, Bentham’s concept of *Leucopogon s. str.* (as section *Perojoa*) appears to be generally well founded. Only the anomalous *L. plumuliflorus* was wrongly placed in section *Heteranthesis*, while three other members of *Leucopogon s. str.* (*L. atherolepis* Stscheegl., *L. bossiaea* (F.Muell.) Benth., *L. cryptanthus* Benth.) are described under section *Perojoa* but appear in the keys both for that section and for *Heteranthesis*. Only one species, *L. cymbiformis* DC., is listed erroneously as a member of *Perojoa*, but clearly belongs elsewhere.

At the subsectional level, however, it now seems clear that Bentham placed too much emphasis on aspects of foliar morphology which he combined with general observations of the inflorescence to form the basis for his concepts. Bentham described seven series within *Perojoa*. With the exception of ser. *Striatae* these appear most unlikely to represent natural groupings. *Leucopogon tamariscinus* R.Br. and *L. tenuis* DC. from ser. *Concurvae* for example have the same fruiting characteristics, a 2-locular ovary and a nectary of separate scales. However, *L. glabellus* R.Br. and *L. elatior* Sond.

from ser. *Collinae* also share these same characters, as do *L. florulentus* Benth. and *L. striatus* R.Br. from ser. *Striatae*. Although these three species pairs certainly differ from one another in regard to their foliar morphology, the floral and fruiting characteristics strongly suggest a close relationship. In a similar way, although there may be a superficial foliar likeness between *L. tamariscinus* and *L. elegans* Sond., which were placed together in ser. *Concurvae*, or between *L. glabellus* and *L. hirsutus* Sond. from ser. *Collinae*, in regard to critical floral and fruiting detail it seems very unlikely that they are closely related. And despite sharing the unusual character of opposite leaves, there is little else to suggest that the two species placed together in ser. *Oppositifoliae*, *L. opponens* (F.Muell.) Benth. and *L. oppositifolius* Sond., are close to one another.

There are enough such fundamental discrepancies to conclude that Bentham's taxonomic framework is untenable. As a first step towards a revised classification, we propose new, informal infrageneric groupings for the Western Australian members of *Leucopogon s. str.* We believe that it would be premature to formalise this classification until a full cladistic analysis based on morphology and DNA sequence data is available. It is presented as a guide to further work and to help in sampling taxa for a more formal analysis. The classification is largely based on fruiting characteristics, although inflorescence and floral characters were also found to be useful supporting characters. By far the majority of western species can be assigned to the five groups (Groups A–E) outlined below. Full descriptions of the morphology of these groups will be included in a proposed series of papers dealing with new taxa from each of the five groups. While the morphological support for the integrity of Groups B–E appears relatively strong, the status of Group A is more problematic. The drupe described below as characteristic of that group is essentially the plesiomorphic fruit type for the tribe *Styphelieae* as a whole. By contrast the fruit types of Groups C–E clearly represent apomorphies. It can be argued then that it is merely the lack of obvious apomorphies, fruiting or otherwise, that unite the member species of Group A. Nevertheless, although the group seems unlikely to be monophyletic, it can be readily defined by a combination of morphological attributes and has clear utility in this interim classification.

Group A. The *Leucopogon australis* group

Distinguishing features. Drupes depressed-obovoid, depressed-globose, globose or ellipsoid, ± terete in transverse section (excluding *L. alternifolius* R.Br.), the apex rounded at the shoulders, with significant mesocarp present. In dried specimens the fleshy mesocarp layer manifests as transverse wrinkles or a raised irregular reticulum especially towards the fruit apex (Figure 1A).

The lowest flower-subtending bracts of the inflorescence are usually quite distinct morphologically from the upper leaves. Occasionally the lowest flower on a primary inflorescence axis may be subtended by a true leaf rather than a bract. Corolla lobes glabrous abaxially. The ovary is usually 5-locular, less often with 2–4 locules. The nectary is annular and entire or variably lobed.

Members of Group A are robust, often lignotuberous shrubs, a characteristic that is uncommon elsewhere in *Leucopogon s. str.* The type species for the genus *Leucopogon*, the eastern Australian *L. lanceolatus* (Sm.) R.Br., probably belongs here, as do all of those western species with the combination of relatively large leaves and long inflorescence axes.

Leucopogon bossiaea, together with several unnamed taxa, appear to represent a discrete subgroup differing in their generally shorter leaves and inflorescences. Although robust, long-lived shrubs, they are all single-stemmed at ground level with an apparently fire sensitive rootstock. This subgroup will be treated in a forthcoming paper.

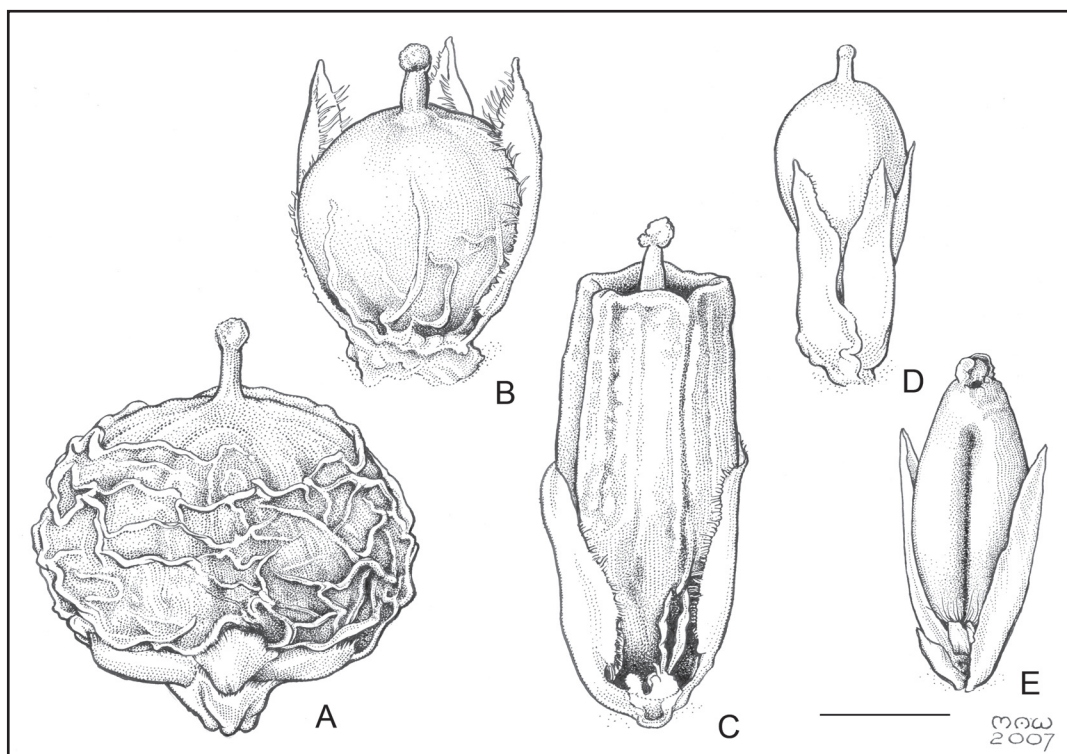


Figure 1. Examples of fruit types from each infrageneric group. A – *Leucopogon australis* (Group A); B – *Leucopogon distans* (Group B); C – *Leucopogon pulchellus* (Group C); D – *Leucopogon glabellus* (Group D); E – *Leucopogon elegans* (Group E). Scale = 1 mm. Drawn by Margaret Wilson from C. Godden, D. Bright & T. Annels SC 76-13 (A), S.W. Jackson s.n., NSW 153474 (B), R. Davis 6667 (C), R. Davis 1175 (D), R. Fairman 82 (E).

Fifteen published Western Australian taxa are here listed as members of Group A (Table 1), including the three new species described below.

Group B. The *Leucopogon distans* group

Distinguishing features. Drupes usually depressed-obovoid, depressed-globose or globose, ± terete in transverse section, the apex rounded at the shoulders, ± dry or with significant mesocarp (Figure 1B).

Two species, *L. reflexus* R.Br. and *L. gibbosus* Stschegl., have differently shaped fruit. The former has an ellipsoid drupe with a ± truncate apex and sunken style base and certainly resembles the fruit of some members of Group C. In respect to all other aspects of its morphology, however, it clearly belongs with Group B. *Leucopogon gibbosus* is remarkable in that apparently only a single ovule within the three locular ovary develops and the resulting mature fruit is asymmetrically obovoid in shape. While there are probably many species of *Leucopogon* that occasionally produce abnormally shaped fruit as a result of one or more ovules failing to develop, *L. gibbosus* appears to be alone in having an asymmetrical fruit as the norm. As with *L. reflexus*, however, there are no other morphological characters that would support its exclusion from this group.

Table 1. Infrageneric groupings in Western Australian *Leucopogon s. str.*

Round brackets indicate species that are poorly known (if at all) in respect to their fruiting characteristics and are somewhat tentatively placed on the basis of floral/inflorescence characters alone. Square brackets indicate species that are anomalous in respect of one of the primary characters used to define the group, although other critical features of their morphology suggest a close relationship.

Group A

[*Leucopogon alternifolius* R.Br.]
Leucopogon apiculatus R.Br.
Leucopogon australis R.Br.
Leucopogon borealis Hislop & A.R.Chapm.
Leucopogon bossiaea (F.Muell.) Benth.
Leucopogon capitellatus DC.
 [*Leucopogon hirsutus* Sond.]
Leucopogon interruptus R.Br.
Leucopogon obovatus (Labill.) R.Br.
Leucopogon parviflorus (Andrews) Lindl.
Leucopogon revolutus R.Br.
Leucopogon richei (Labill.) R.Br. var. *acutifolius* Benth.
Leucopogon spectabilis Hislop & A.R.Chapm.
Leucopogon validus Hislop & A.R.Chapm.
Leucopogon verticillatus R.Br.

Group B

Leucopogon atherolepis Stsche gl.
Leucopogon corifolius Endl.
Leucopogon distans R.Br.
Leucopogon gibbosus Stsche gl.
Leucopogon mollis E.Pritz.
Leucopogon penicellatus Stsche gl.
Leucopogon reflexus R.Br.

Group C

Leucopogon assimilis R.Br.
Leucopogon cinereus E.Pritz.
Leucopogon cucullatus R.Br.
Leucopogon fimbriatus Stsche gl.
Leucopogon gracillimus DC.
Leucopogon minutifolius W.Fitzg.
Leucopogon obtusatus Sond.
Leucopogon oldfieldii Benth.
Leucopogon ozothamnoides Benth.
Leucopogon polymorphus Sond.
 [*Leucopogon polystachyus* Benth.]
 (*Leucopogon psammophilus* E.Pritz.)
Leucopogon pulchellus Sond.
Leucopogon sprengelioides Sond.

Group D

Leucopogon acicularis Benth.
Leucopogon bracteolaris Benth.
Leucopogon carinatus R.Br.
Leucopogon compactus Stsche gl.
Leucopogon cryptanthus Benth.
Leucopogon decussatus Stsche gl.
Leucopogon denticulatus W.Fitzg.
Leucopogon elatior Sond.
Leucopogon florulentus Benth.
Leucopogon glabellus R.Br.
 [*Leucopogon infuscatus* Strid]
Leucopogon lasiostachyus Stsche gl.
Leucopogon lloydiorum Strid
Leucopogon opponens (F.Muell.) Benth.
 [*Leucopogon phyllostachys* Benth.]
 [*Leucopogon squarrosus* Benth.]
Leucopogon striatus R.Br.
Leucopogon tamariscinus R.Br.
Leucopogon tenuis DC.
Leucopogon tetragonus Sond.

Group E

Leucopogon elegans Sond.
Leucopogon gnaphalioides Stsche gl.
Leucopogon gracilis R.Br.
Leucopogon lasiophyllus Stsche gl.
Leucopogon oppositifolius Sond.

Unplaced species

Leucopogon amplexans Ostenf.
Leucopogon cochlearifolius Strid
Leucopogon gilbertii Stsche gl.
Leucopogon oliganthus E.Pritz.
Leucopogon plumuliflorus F.Muell.

Inflorescence as for Group A but usually shorter. Corolla lobes with an abaxial indumentum. The ovary is 5- or 3-locular and the nectary of 5 separate scales.

Although close to Group A members of this group can always be separated by the following character combination: nectary of separate scales (rather than annular) and corolla lobes with a distinct abaxial indumentum (rather than glabrous). Elsewhere among the Western Australian members of *Leucopogon s. str.*, the latter character is apparently shared only with the morphologically isolated species *L. plumuliflorus*. Plants from Group B are also relatively short lived with fire sensitive rootstocks as opposed to long lived and frequently lignotuberous—the norm for Group A.

Seven published Western Australian species are here listed as members of Group B (Table 1).

Group C. The *Leucopogon pulchellus* group

Distinguishing features. Drupes usually oblongoid, less often narrowly ellipsoid, terete or occasionally angular in transverse section, the apex relatively broad and truncate, sometimes produced into raised lobes leaving the style in a pronounced depression. Unlike the members of Group A the mesocarp is generally insignificant and does not form a raised reticulum, although sometimes regular, longitudinal striations are present (Figure 1C).

Species in Group C lack the clear differentiation between the upper leaves and the lowest inflorescence bracts that is characteristic of Groups A and B. Instead there is usually a gradual, upward transition from the lowest bracts, which are indistinguishable from the upper leaves, to the upper bracts which are significantly different in shape and texture (i.e. more ‘bract-like’). This character is generally evident on at least the main axes but often throughout the conflorescence. In the case of those species with few-flowered inflorescences and small leaves (i.e. *L. obtusatus* Sond. and allies) there is little difference between the upper leaves and any of the subtending bracts. These species form a fairly well differentiated subgroup whose members usually have a (2)3 rather than 5-locular ovary. Corolla lobes glabrous abaxially. The ovary is either (4)5- or 3(4)-locular or very occasionally 2-locular. The nectary is annular, entire or lobed.

Fourteen published Western Australian species are here listed as members of Group C (Table 1).

Group D. The *Leucopogon carinatus* group

Distinguishing features. Drupes narrowly ellipsoid or obovoid, ± terete in transverse section, the apex narrowed and with rounded shoulders, dry and without a significant mesocarp (Figure 1D).

Both of the inflorescence types described above, and which help to define Groups A, B and C, occur in Group D where this character is apparently only useful at the species level. Corolla lobes are glabrous abaxially. The ovary is 2-locular and the nectary always comprises 5 separate scales (with the possible exception of *L. infuscatus* Strid, which is currently tentatively placed here). These fixed floral characters make members of Group D easy to recognise even in the absence of fruit. No members of this group are known to have a fire-resistant rootstock.

At the species level both Groups C and D contain areas of particular taxonomic difficulty that await resolution such as the *L. pulchellus*–*L. polymorphus* and *L. obtusatus*–*L. fimbriatus* species complexes (Group C), and the *L. carinatus*–*L. striatus* and *L. glabellus*–*L. tamariscinus* species complexes (Group D).

Twenty published Western Australian species are here listed as members of Group D (Table 1).

Group E. The *Leucopogon gracilis* group

Distiguishing features. Drupes compressed, narrowly ellipsoid or narrowly obovoid, terminating in a rather soft, often rugose appendage, dry and without significant mesocarp, and with a longitudinal median groove (Figure 1E).

Both of the inflorescence types described under Groups A, B and D occur in Group E. Corolla lobes are glabrous abaxially. The ovary is 2-locular and the nectary annular and lobed.

This very distinctive group is easily recognisable even in the absence of fruit by the presence of a flange at the ovary apex which clearly demarcates the style from the ovary. The group also contains several species which have the corolla tube manifestly longer than the sepals—an unusual character in *Leucopogon s. str.*

Five published Western Australian species are here listed as members of Group E (Table 1).

Methods

This study is based on an examination of specimens housed at PERTH. Relevant type collections were obtained on loan from BM. Plant growth habit and proportions have been taken from collectors' field notes together with personal observations.

Foliar measurements were taken from dried specimens. Leaf thickness was measured at the midrib, half way up the lamina. Observations of leaf venation were made from mature leaves only. Across the tribe *Styphelieae* it is common for the 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 obviously bract-like, but then undergo morphological transition through successive nodes before reaching the form of the mature leaves.

Inflorescence length was measured from the insertion point of the lowest bract to the tip of the bud rudiment. Floral measurements were taken from rehydrated flowers in natural posture, with the exception of the corolla lobes. These were uncurled to their fullest length before measuring. Anthers with prominently recurved tips 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 very early flower, at or just prior to, anther dehiscence. Corolla lobe hair length was measured at a point 0.5 mm below the apex.

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

Lectotypification of *Leucopogon apiculatus*

In his description of *Leucopogon apiculatus* Brown (1810) recognised two informal variants which he referred to as (α) and (β) which were collected by him at Goose Island (BM 000929071, BM 000929072) and Lucky Bay (BM 000929073), respectively. He distinguished between the two on the basis of indumentum, with (α) having \pm glabrous leaves and shortly hairy branchlets and (β) conspicuously hairy leaves and branchlets. The latter also has rather broader leaves and Brown commented that it perhaps represented a distinct species.

Leucopogon apiculatus is now reasonably well known across its geographical range and it is opportune to re-examine Brown's conjecture that a second taxon might be present. Variant (α) is characterized by \pm glabrous leaves and a very short, moderately dense, monomorphic indumentum of patent hairs on the branchlets. Variant (β) on the other hand has a dimorphic indumentum on both leaves and branchlets with a layer of short hairs (these being rather longer and denser than in variant (α)), overlain by a second, relatively sparse layer of much longer hairs, which are also present on the leaf margins. An examination of the collections at PERTH reveals that while the indumentum character of variant (α) is common, the degree of hairiness displayed by variant (β) is not, with only two specimens closely comparable (*A.S. George* 2226 from Mt Le Grand and *J.H. Willis* 139 from Sandy Hook Island). A number of collections, however, exhibit an indumentum which is intermediate in various ways. For instance, some have the indumentum of variant (α) except for a very few scattered longer hairs, which may occur with leaf cilia (e.g. *J.M. Powell* 3458) or without (e.g. *A.S. Weston* 9888). Other collections have the marked dimorphic branchlet indumentum of variant (β) but with either glabrous or a mixture of glabrous and \pm hairy leaves (e.g. *J.M. Powell* 1868).

Moreover, these differences in the indumentum do not correlate with any floral or other characters likely to be of taxonomic significance and it now seems reasonable to conclude that Brown's two variants merely represent the opposite ends of a continuum and should have no taxonomic status.

Leucopogon apiculatus R.Br., Prod.: 542 (1810). *Styphelia apiculata* (R.Br.) Spreng., *Syst. Veg.* 1: 656 (1824). *Type*: Goose Island, Recherche Archipelago [Western Australia], 15–16 January 1802, *R. Brown s.n.* (lecto, here designated: BM 000929071; isolecto: BM 000929072).

Leucopogon shuttleworthii Sond., *In*: C. Lehmann, Pl. Preiss. 1: 307 (1845). *Type*: New South Wales [?King George Sound, Western Australia], *s. dat.*, *C. Fraser s.n.* (holo: BM 000929074).

Other specimens examined. WESTERNAUSTRALIA: [localities withheld] 20 Sep. 1995, *B. Archer* 115 (MEL, PERTH); 24 Sep. 1985, *M. Carter* 231 (CANB, PERTH); 12 Dec. 1960, *A.S. George* 2226 (PERTH); 18 Nov. 1998, *M. Hislop* 1236 (PERTH); 20 Sep. 1976, *R. Hnatiuk* 761159 (PERTH); 1 Sep. 2002, *B. Moyle & M. Pieroni* BM 02/01 (CANB, NSW, PERTH); 18 July 1982, *J.M. Powell* 1855 (AUCK, BISH, BRI, CANB, K, L, MEL, MO, NSW, PERTH, RSA); 19 July 1982, *J.M. Powell* 1868 (CANB, K, L, MEL, NSW, PERTH, RSA); 23 Nov 1985, *J.M. Powell* 3458 (HO, NSW, PERTH); 24 Nov. 1985, *J.M. Powell* 3468 (HO, NSW, PERTH); 14 Nov. 1974, *A.S. Weston* 9888 (CANB, PERTH); 10 Nov. 1950, *J.H. Willis* 139 (MEL, PERTH).

Distribution and habitat. *Leucopogon apiculatus* occurs in near coastal areas east of Esperance, from Cape Le Grand in the west to beyond Cape Arid in the east, and on the islands of the Recherche Archipelago (Figure 2). In this part of its range the species grows in deep coastal sands or shallow sand over granite in heathland communities. There are also disjunct inland populations in Cape Arid

National Park, notably in the Russell Range, and at these localities it grows in sandy loam soils over quartzite.

Conservation status. *Leucopogon apiculatus* has been assigned Priority Three status under Department of Environment and Conservation (DEC) Conservation Codes for Western Australian Flora (Atkins 2006). Most of the known populations are conserved in Cape Le Grand and Cape Arid National Parks and the Recherche Archipelago Nature Reserve with another occurrence on a shire reserve (41097) at Duke of Orleans Bay. It may well be significant that most of these are situated in well visited parts of the region. There must be a strong chance that further populations exist in more remote, near coastal areas at least as far east as Cape Pasley, as well as on other more inland hills in Cape Arid National Park. For instance, as recently as 2002 a new and apparently sizable population was found on the Diamonds Hill in the central part of Cape Arid National Park.

Although there seems reason to believe that *L. apiculatus* is relatively secure across its range, it may be prudent to retain it on the Priority list until its susceptibility to the rootrot pathogen *Phytophthora cinnamomi* can be established. Many styphelioid ericads are known to be vulnerable to this pathogen which is now widespread in Cape Le Grand National Park and also present in at least one or two places in Cape Arid National Park (E. Adams pers. comm.).

Typification. The selection of BM 000929071 as the lectotype of *L. apiculatus* follows the intention of W.L. Chew and J.M. Powell, both of whom annotated the specimen to that effect but later retired

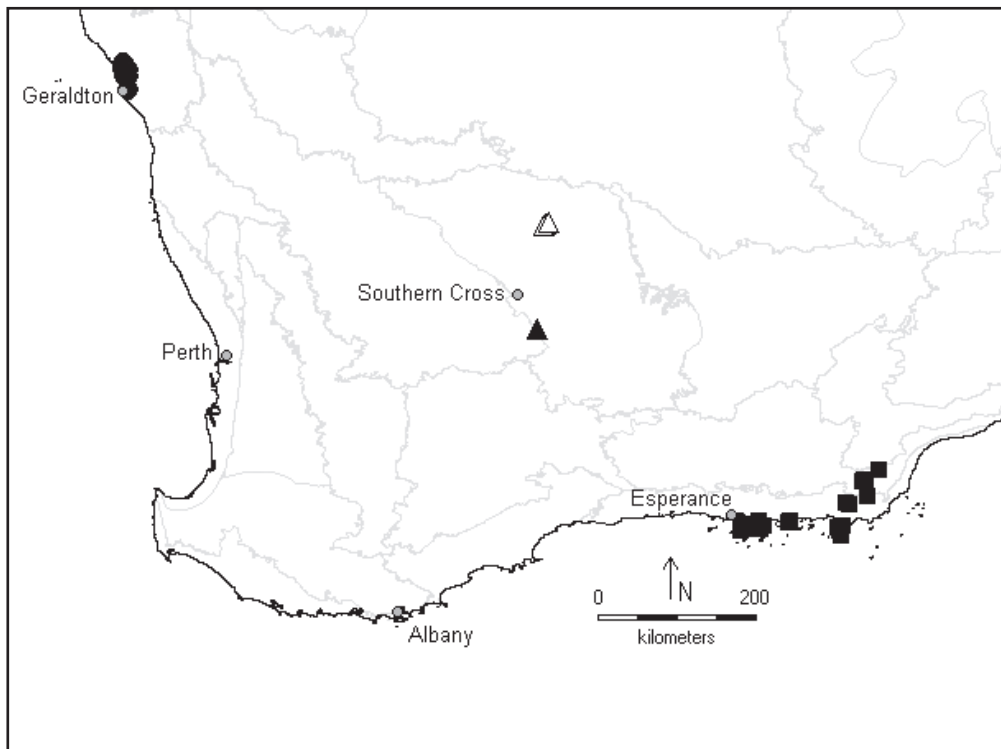


Figure 2. Distribution of *Leucopogon apiculatus* (■), *L. borealis* (●), *L. spectabilis* (△), and *L. validus* (▲) in southwest Western Australia. Interim Biogeographic Regionalisation (Version 6.1, Department of the Environment and Water Resources 2007) boundaries are indicated in grey.

without publishing the lectotypification. It represents Brown's variant (α).

The type locality provided for *L. shuttleworthii* is almost certainly an error, which Bentham (1868) believed was due to 'a mistake in the label'. The holotype itself has the original locality of "New South Wales" crossed out and "King George Sound" pencilled in, but this too is very likely to be erroneous as the species has never been otherwise recorded west of Esperance.

New species

Leucopogon borealis Hislop & A.R.Chapm., *sp. nov.*

Leucopogi revoluta R.Br. affinis sed pagina abaxiali folii manifeste sulcato, ovario biloculari differt.

Typus: north of Geraldton, Western Australia [precise locality withheld for conservation purposes], 10 August 1993, *A.S. George* 17018 (*holo*: PERTH 04616073; *iso*: CANB, NSW).

Leucopogon oblongus J.M.Powell ms., in G. Paczkowska & A.R. Chapman, West. Austral. Fl.: Descr. Cat. p. 238 (2000), *nom. inval.*

Erect, lignotuberous *shrubs* to *c.* 120 cm high and wide. Young *branchlets* chestnut brown, with moderately dense or dense indumentum of patent, straight hairs to 0.1 mm long, which are persistent to the second or third year but at length glabrescent; bark on older wood grey or greyish-brown and usually distinctly fissured. *Leaves* spirally arranged, variously orientated from steeply antrorse to distinctly retrorse often on the same branchlet, linear or very narrowly elliptic, 8–19 mm long, 0.7–2.8 mm wide; apex obtuse with a broad, sometimes poorly defined, recurved mucro; base cuneate; petiole well defined, greenish-yellow, 0.7–1.5 mm long, with a dense indumentum of patent hairs throughout; lamina 0.25–0.4 mm thick, variably recurved or revolute so that the undersurface may be clearly visible or totally concealed by the abutting leaf margins; surfaces \pm concolorous, adaxial surface slightly shiny, with persistent, moderately dense indumentum of short patent hairs, venation not or barely evident, abaxial surface with 5–7 conspicuous, primary veins alternating with distinct grooves, the midrib not differentiated, densely hairy with short, patent hairs throughout, the margins scabrous with very short antrorse hairs. *Inflorescence* erect, terminal and upper axillary; axis 8–28 mm long, with 9–20 flowers, terminating in a bud-like rudiment or sometimes an attenuate point; indumentum of dense, patent, straight hairs 0.1–0.4 mm long; *flowers* erect, sessile or pedicellate below the bracteoles for up to 1.4 mm. *Fertile bracts* ovate, 1.3–1.8 mm long, 0.8–1.1 mm wide, subacute; abaxial surface with moderately conspicuous venation, moderately or densely hairy with mostly patent hairs; adaxial surface usually glabrous or with a few hairs towards apex; margin ciliolate. *Bracteoles* ovate, 1.8–2 mm long, 1–1.3 mm wide, subacute, sharply keeled; abaxial surface moderately or densely hairy with patent or widely antrorse hairs on the central and upper portions becoming glabrous towards margins, dark red-brown along keel, grey-green on either side and then with broad, light brown, scarious, marginal bands; adaxial surface with short antrorse hairs in distal half; margins ciliolate. *Sepals* ovate, 2.5–3.2 mm long, the outer usually distinctly shorter than the inner, by up to 0.5 mm, 1.2–1.4 mm wide, acute or subacute; abaxial surface with moderately dense or dense indumentum of patent or shallowly antrorse hairs to *c.* 0.3 mm long, the venation usually rather inconspicuous and only the midrib evident, less often with veins moderately conspicuous, the central portion grey-green but usually suffused red-purple towards apex and with broad, light brown, scarious marginal bands;

the adaxial surface with short antrorse hairs in distal half although these sometimes very sparse; margins ciliolate with hairs to 0.3 mm long. *Corolla tube* white, broadly campanulate, much shorter than sepals (by up to 1.6 mm), 1–1.5 mm long, 1.3–1.8 mm wide, glabrous externally and internally. *Corolla lobes* white, much longer than tube (ratio = (1.9–)2.5–3.5:1), widely spreading from base and recurved, 2.5–3.6 mm long, 0.8–1 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.5–0.8 mm long near apex, the basal hairs reflexed into the top of the tube by up to 0.3 mm, the glabrous tip to 0.2 mm long. *Anthers* exerted from tube for most of their length (by c. 7/8 of length), 1.5–1.8 mm long, often abruptly recurved at apex; sterile tips rather inconspicuous, 0.4–0.6 mm long; *filaments* terete, attached c. 1/2 above anther base or a little below, 0.8–1 mm long, adnate to tube just below the sinus. *Ovary* globose or broadly ellipsoid, 0.5–0.6 mm long, 0.5–0.6 mm wide, glabrous, 2(3)-locular; *style* 0.6–0.7 mm long, tapering smoothly from a broad base (c. 0.4 mm wide), included within corolla tube; *stigma* slightly to distinctly expanded; *nectary* annular 0.3–0.4 mm long, entire or very shallowly lobed, glabrous. *Fruit* ellipsoid, with smoothly rounded shoulders, glabrous, 1.6–1.8 mm long, 1.2–1.4 mm wide, shorter than the calyx, surface with distinct transverse and longitudinal ridges towards the apex, endocarp thin; style persistent. (Figure 3)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld] 25 Aug. 1983, R.J. Cranfield 2897 (PERTH); 9 Sep. 1966, A.S. George 7941 (CANB, NSW, PERTH); 25 Sep. 1977, D. & N. McFarland s.n. (CANB, PERTH); 28 Aug. 1965, K.R. Newbey 2189 (PERTH); 4 July 1995, S. Patrick SP 2302 (PERTH); 15 Aug. 1996, S. Patrick 2732 (PERTH); 7 July 1982, J.M. Powell 1707 (CANB, K, L, MEL, NSW, PERTH); 9 Sep. 1966, R.V. Smith 66/395 (MEL, PERTH); 7 Sep. 1962, Dr. F.W. Went 26 (PERTH).

Distribution and habitat. *Leucopogon borealis* is restricted to the Moresby Range between Geraldton and Northampton (Figure 2), where it grows in rocky, sandy loam soils over sandstone, usually in dense, low growing, heathland communities.

Phenology. The main flowering period is between July and October. Mature fruit as well as flowers are present on some specimens collected in September.

Conservation status. This species has been assigned Priority Two status (DEC Conservation Codes for Western Australian Flora) under the manuscript name *Leucopogon oblongus* ms (Atkins 2006). Within the Moresby Range it is currently known from three nature reserves and from two or three populations on private property. The species still requires further survey to fully assess the extent of its distribution in the area but it does seem reasonable now to assume that it is restricted to this small and scattered range of hills.

The Moresby Range is currently thought to be free from infection by *Phytophthora* spp. (A. Chant pers. comm.) which causes fatal rootrot disease in many species of styphelioid ericads. With tight land clearing restrictions also in force across the range, there do not appear to be any other immediate threats to the known populations.

Etymology. The epithet is taken from the Latin (*borealis* – northern). Although a number of styphelioid ericads grow to the north of the Moresby Range, including several species of *Leucopogon* s. lat., on the basis of current knowledge, this is the most northerly occurring true *Leucopogon* in Western Australia.

Affinities. *Leucopogon borealis* appears to be relatively isolated morphologically as well as geographically



Figure 3. *Leucopogon borealis*. A – flowering branchlet; B – leaf detail, adaxial surface LHS, abaxial surface RHS; C – leaf section; D – flower; E – flower, longitudinal section; F – fruit. Scale bars: A = 10 mm; B = 5 mm; C = 0.5 mm; D, E = 1 mm; F = 0.5 mm. Drawn by Margaret Wilson from A.S. George 17018.

within the *Leucopogon australis* species group. It bears a superficial resemblance to *L. revolutus* R.Br. but is readily separated from that species by the abaxial leaf surface being distinctly grooved rather than smooth or faintly striate, in having a 2- rather than 5-locular ovary and a greater corolla lobe to tube ratio.

In its leaf morphology *L. borealis* is also quite similar to *L. compactus* Stschegl. from the south coast of Western Australia and it was initially referred to by J.M. Powell on old labels as *L. sp. aff compactus*. However, the floral and fruiting characters of that species indicate that it is a member of the *L. carinatus* species group.

Notes. An isotype of *L. revolutus* (PERTH 02998165), the species with which *L. borealis* is compared in the diagnosis, has been examined in the course of this study.

Leucopogon spectabilis Hislop & A.R.Chapm., *sp. nov.*

Leucopogon apiculato R.Br. affinis sed bracteis et bracteolis brevioribus, axibus inflorescentii longioribus et stylo longiore differt.

Typus: Helena and Aurora Range, Western Australia [precise locality withheld for conservation purposes], 28 September 1995, B.J. Lepschi 2077 (*holo:* PERTH 04195868; *iso:* CANB, K, MEL, NSW).

Leucopogon sp. Helena & Aurora (B.J. Lepschi 2077), in G. Paczkowska & A.R. Chapman, West. Austral. Fl.: Descr. Cat. p. 240 (2000).

Erect, narrow and sparingly branched *shrubs* to c. 100 cm high. Young *branchlets* light brown, glabrous, with grey longitudinal bands developing on older wood, the bark at maturity uniformly grey and rather fissured. *Leaves* spirally arranged, steeply antrorse, narrowly elliptic, 15–25 mm long, 2.9–5.2 mm wide; apex attenuate, sub-pungent; base attenuate; petiole moderately well defined, light brown or yellowish, 1.5–2 mm long, glabrous; lamina 0.25–0.35 mm thick, adaxially concave or flat; surfaces glabrous, discolorous, slightly shiny and dark green above, with rather indistinct venation or with 3–5 grooves evident, paler below with 5–7 fairly inconspicuous, flat or slightly raised primary veins, the midrib not differentiated; margins glabrous on mature leaves. *Inflorescence* erect, terminal and upper axillary; axis (20–)25–65 mm long, with 14–32 flowers and often up to 3 sterile bracts between the terminal flower and the bract like rudiment; indumentum of moderately dense, patent, straight hairs, 0.05–0.07 mm long; *flowers* erect or spreading, pedicellate below the bracteoles for 0.4–2.1 mm and also sometimes above the bracteoles for up to 0.5 mm. *Fertile bracts* triangular or ovate, 0.7–1.3 mm long, 0.6–0.7 mm wide, obtuse or subacute; abaxial surface glabrous, with distinct venation; adaxial surface with appressed hairs; margins ciliolate. *Bracteoles* ovate, 1.1–1.6 mm long, 0.7–0.9 mm wide, acute, keeled; abaxial surface glabrous, green on either side of the keel, becoming scarious towards the margins; adaxial surface with appressed hairs distally; margins ciliolate. *Sepals* ovate or narrowly ovate, 2.5–3.3 mm long, 0.9–1.1 mm wide, acute or subacute; abaxial surface glabrous, with moderately conspicuous venation, mostly greenish but often with pink interveinal stripes distally; adaxial surface with appressed hairs in distal half; margins ciliolate and scarious or scarious only towards base. *Corolla tube* white, broadly campanulate, as long as or shorter than sepals (by up to 0.6 mm), (1.3–)1.5–2 mm long, 1.8–2.6 mm wide, glabrous externally and internally. *Corolla lobes* white, much longer than tube (ratio = 2–2.3:1), widely spreading from base and usually recurved, 3.1–4.4 mm long, 0.8–1.3 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.6–1 mm long near apex, slightly shorter towards base and then with some longer

reflexed basal hairs extending into the top of the tube by up to 0.9 mm, the glabrous tip 0.1–0.2 mm long. *Anthers* partially exerted from tube (by 2/3–3/4 of length), (1.4–)1.6–2.2 mm long, usually prominently recurved at apex; sterile tips with conspicuous pale apices, 0.5–0.7 mm long; *filaments* terete, attached 1/3–1/2 above anther base, 0.5–0.9 mm long, adnate to the tube just below the sinus. *Ovary* depressed-obovoid to depressed-globose, 0.4–0.6 mm long, 0.6–0.8 mm wide, glabrous, 5-locular; *style* 0.5–0.8 mm long, tapering smoothly from a broad base (0.3–0.4 mm wide) to a point *c.* half way up the style and then cylindrical above, included within the corolla tube; *stigma* slightly expanded and 5 lobed; *nectary* annular, 0.2–0.3 mm long, very shallowly lobed, glabrous. Mature *fruit* not seen but the somewhat immature fruit present on the holotype is depressed obovoid in shape with well defined transverse ridges and longitudinal grooves. (Figure 4)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld] 9 Sep. 2005, V. Clarke VTC 558 (PERTH); 27 Sep. 1995, N. Gibson & M. Lyons 3339 (CANB, NSW, PERTH).

Distribution and habitat. Apparently restricted to the Helena and Aurora Range, *c.* 100 km NE of Southern Cross (Figure 2), where it confined to exposed ironstone ridges. It grows in shallow red brown loam in rock crevices, among open shrubland communities dominated by *Dryandra arborea*, *Calycopeplus helmsii* and *Melaleuca leiocarpa*, often alongside another rare local endemic, *Tetratheca aphylla*.

Phenology. The main flowering period is between August and October with the exact timing and duration probably dependent on seasonal rainfall.

Etymology. The epithet is from the Latin (*spectabilis* – remarkable, spectacular) in reference to the large flowers and long inflorescences which make this a particularly attractive species.

Conservation status. This species is listed as Declared Rare Flora under the Western Australian Wildlife Conservation Act 1950, under the phrase name *Leucopogon* sp. Helena and Aurora (B.J. Lepschi 2077) (Atkins 2006).

The ranges to which the species is apparently restricted are composed primarily of banded ironstone. With iron ore mines already operational in the area, mining development must represent an immediate threat to the species' future. Recent botanic surveys of other ranges of banded ironstone in this region have not located any new populations of *L. spectabilis* (V. Clarke pers. comm.). Another potential threat could be posed by the arrival of goats in the area, currently thought to be absent (V. Clarke pers. comm.).

Affinities. The closest relatives of *L. spectabilis* appear to be *L. apiculatus* and *L. validus* Hislop & A.R. Chapman. It differs from the former in its shorter bracts and bracteoles and longer style, and from the latter in its longer, thinner leaves and larger flowers. It differs from both in its pedicellate flowers and longer inflorescence. The new species is also similar in foliar morphology to the widespread *L. australis* R.Br. but is easily separated by its larger, pedicellate flowers.

Notes. Detailed observations of the rootstock of *L. spectabilis* have not been made because the basal parts are invariably obscured by the sides of the deep, narrow rock fissures through which the plants grow.

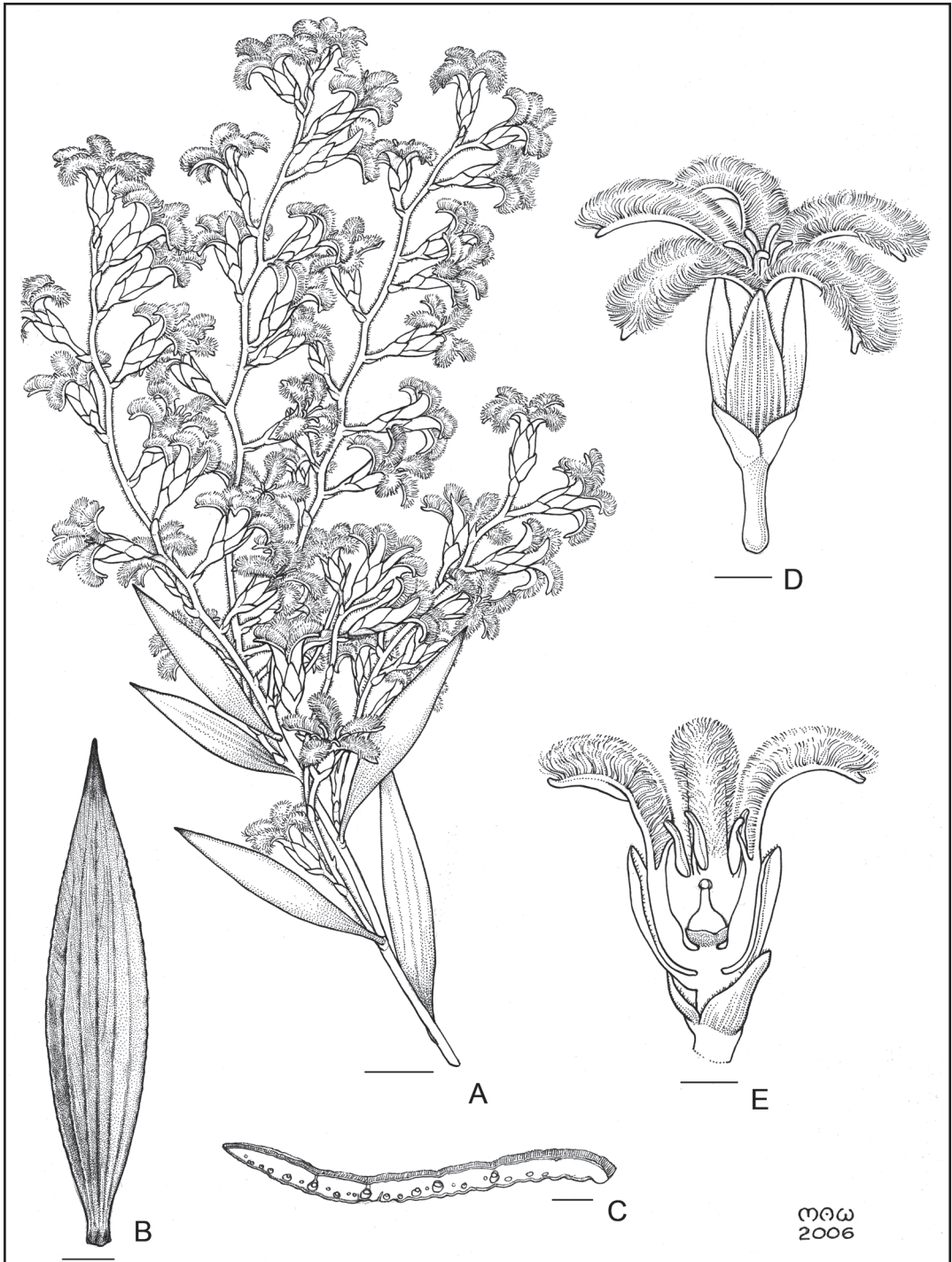


Figure 4. *Leucopogon spectabilis*. A – flowering branchlet; B – leaf, adaxial surface; C – leaf section; D – flower; E – flower, longitudinal section. Scale: A = 5 mm; B = 3 mm; C = 0.5 mm; D, E = 1 mm. Drawn by Margaret Wilson from N. Gibson & M. Lyons 3339.

Leucopogon validus Hislop & A.R.Chapm., *sp. nov.*

Leucopogi apiculato affinis sed foliis brevioribus crassioribus, bracteis brevioribus, et stylo longiore differt.

Typus: Parker Range, Western Australia [precise locality withheld for conservation purposes], 2 August 2003, *M. Hislop & F. Hort* MH 2978 (*holo*: PERTH 06758827; *iso*: CANB, K, NSW).

Leucopogon sp. Parker Range (F.H. & M.P. Mollemans 2860), Western Australian Herbarium, in FloraBase, <http://florabase.dec.wa.gov.au> [accessed April 2007].

Robust, lignotuberous *shrubs* to *c.* 120 cm high and 120 cm wide. Young *branchlets* light brown, smooth, glabrous, quickly becoming grey and slightly fissured at maturity. *Leaves* spirally arranged, antrorse, usually steeply so, narrowly elliptic or occasionally narrowly ovate, 9–16 mm long, 2–3.5 mm wide; apex obtuse or subacute; base cuneate; petiole well defined, light brown or yellowish, 1.4–2.5 mm long, sparsely and shortly hairy on adaxial surface, glabrous abaxially; lamina 0.4–0.55 mm thick, always strongly concave adaxially; surfaces discoloured, adaxial surface slightly shiny and dark green with sparse short hairs towards base, venation not evident, abaxial surface paler, glabrous, with 5–7 fairly inconspicuous flat or slightly sunken primary veins, the midrib not differentiated; margins glabrous. *Inflorescence* erect, terminal and upper axillary; axis 5–15 mm long, with 6–12 flowers terminating in a bud-like rudiment or sometimes an attenuate point; indumentum of dense, patent, straight hairs 0.08–0.1 mm long; *flowers* erect and sessile. *Fertile bracts* broadly ovate, 1–1.5 mm long, 1–1.4 mm wide, obtuse; abaxial surface with venation moderately conspicuous on upper bracts, less so on lower, glabrous; adaxial surface usually appressed hairy although lower bracts may be \pm glabrous; margins ciliolate. *Bracteoles* ovate, 1.8–2.2 mm long, 1.1–1.4 mm wide, acute or subacute, sharply keeled; abaxial surface with short, moderately dense, patent hairs along keel and more generally towards base, greenish on basal portion, usually suffused reddish-purple distally, becoming scarious towards margins; adaxial surface antrorse hairy in distal half; margins ciliolate. *Sepals* ovate or narrowly ovate, 2.5–3.4 mm long, 1–1.6 mm wide, acute or subacute; abaxial surface glabrous, with conspicuous venation, basal central portion and veins greenish, interveinal areas prominent reddish-purple distally; adaxial surface antrorse hairy in distal half; margins ciliolate with hairs to *c.* 0.1 mm long, and scarious. *Corolla tube* white, broadly campanulate, shorter than sepals (by up to 0.9 mm), 1.6–2 mm long, 1.7–2.2 mm wide, glabrous externally and internally. *Corolla lobes* white, longer than tube (ratio = 1.6–2:1), widely spreading from base and usually recurved, 2.8–4 mm long, 1–1.2 mm wide at base, glabrous externally, densely bearded internally, indumentum white, 0.6–1.1 mm long near apex, the basal hairs reflexed into top of the tube by up to 0.7 mm, the glabrous tip 0.2–0.3 mm long. *Anthers* partially exerted from tube (by 2/3–3/4 of length), 1.5–2.2 mm long, prominently recurved at apex; sterile tips pale, conspicuous, 0.5–0.7 mm long; *filaments* terete, attached 1/3–1/2 above anther base, 0.8–1.2 mm long, adnate to tube just below sinus. *Ovary* depressed-globose, 0.5–0.7 mm long, 0.7–1 mm wide, glabrous, 5-locular; *style* 0.7–1 mm long, either tapering smoothly from a broad base (0.3–0.4 mm wide) to the stigma or to a point along the distal half of the style and then cylindrical above that, included within the corolla tube; *stigma* very slightly expanded; *nectary* annular, 0.4–0.5 mm long, shallowly lobed for up to 1/3 of length, glabrous. *Fruit* depressed-obovoid or depressed-globose, with smoothly rounded shoulders, glabrous, 1.5–1.6 mm long, 1.9–2 mm wide, shorter than the calyx, the surface with minute transverse wrinkles, style base sunken in central depression; style persistent. (Figure 5)

Other specimens examined. WESTERNAUSTRALIA: [localities withheld] 10 Jan. 2002, *A.D. Crawford* ADC 175 (PERTH); 2 Aug. 2003, *M. Hislop & F. Hort* MH 2977 (PERTH); 2 Aug. 2003, *M. Hislop & F. Hort* MH 2979 (PERTH); 20 June 1990, *F.H. & M.P. Mollemans* 2860 (PERTH); 31 Aug. 1990, *F.H. & M.P. Mollemans* 3349 (PERTH).

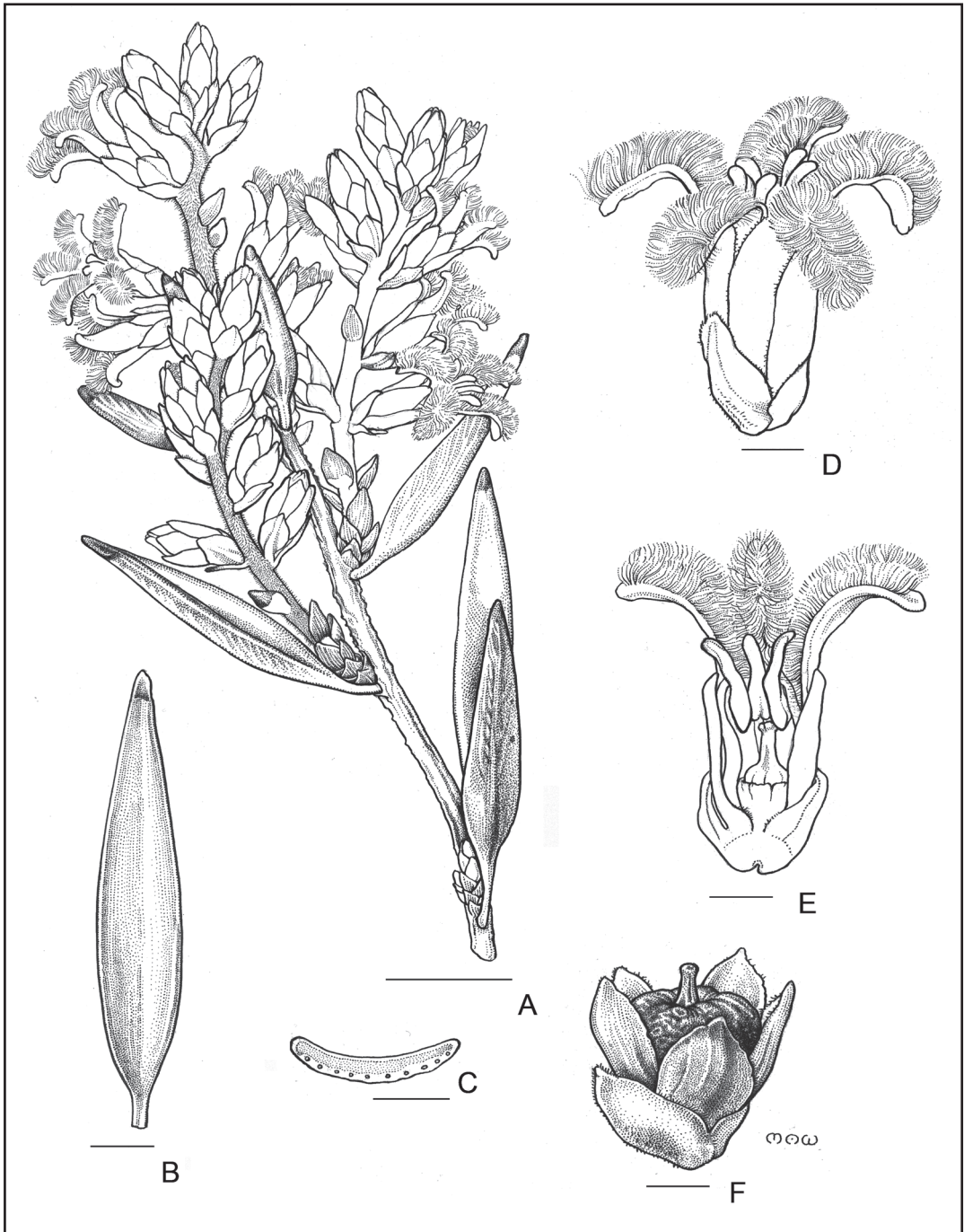


Figure 5. *Leucopogon validus*. A – flowering branchlet; B – leaf, adaxial surface; C – leaf section; D – flower; E – flower, longitudinal section. Scale: A = 3 mm; B = 2 mm; C–F = 1 mm. Drawn by Margaret Wilson from *M. Hislop & F. Hort 2977*.

Distribution and habitat. Currently known only from a small area of the Parker Range c. 50 km SE of Southern Cross (Figure 2) where it grows on and around exposed, low, lateritic breakaways in very open shrubland which includes *Callitris canescens*, *Melaleuca leiocarpa*, *Hakea pendens* and *Isopogon robustus*. The latter is a recently named, rare species which is also known only from this immediate area.

Phenology. Flowers between June and September. Mature fruit has been collected in January.

Etymology. Named from the Latin *validus* (strong, robust). A reference to the habit of this plant and its impressive toughness, thriving as it does in such an apparently hostile habitat.

Conservation status. This taxon has been assessed as Priority One (DEC Conservation Codes for Western Australian Flora) under the phrase name *Leucopogon* sp. Parker Range (F.H. & M.P. Mollemans 2860) (Atkins 2006). Although currently known from only one large population, it occurs in a remote part of Western Australia in an area that has not been subject to extensive land clearing. It therefore seems quite possible that further, well targeted surveys could bring new populations to light. The known population seems relatively secure, although the potential spread of goats into the area may pose a threat.

Affinities. The new species appears most closely related to *Leucopogon apiculatus* and *L. spectabilis*. It can be separated from the former by its shorter bracts and longer style, from the latter by its shorter inflorescence and from both in having shorter, thicker leaves.

Notes. Unaccountably, *Leucopogon validus* has been confused in the past with a very different taxon of restricted distribution from the Geraldton area which is currently referred to at PERTH by the name *Leucopogon teretostylis* J.M.Powell ms.

Acknowledgements

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